University of the State of New York

New York State Museum

Frederick J. H. Merrill Director
John M. Clarke State Paleontologist

Memoir 5

GUELPH FAUNA IN THE STATE OF NEW YORK

BY

JOHN M. CLARKE AND RUDOLF RUEDEMANN

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1903

University of the State of New York

REGENTS

With years of election

1892 William Croswell Doane DD. LL.D. *Vice Chancellor*, Albany
1873 Martin I. Townsend M.A. LL.D. - - - - - - Troy
1877 Chauncey M. Depew LL.D. - - - - - - New York
1877 Charles E. Fitch LL.B. M.A. L.H.D. - - - - Rochester
1878 Whitelaw Reid M.A. LL.D. - - - - - - New York
1881 William H. Watson M.A. LL.D. M.D. - - - Utica
1881 Henry E. Turner LL.D. - - - - - - - Lowville
1883 St Clair McKelway M.A. L.H.D. LL.D. D.C.L. - - Brooklyn
1885 Daniel Beach Ph.D. LL.D. - - - - - Watkins
1888 Carroll E. Smith LL.D. - - - - - - - Syracuse
1890 Pliny T. Sexton LL.D. - - - - - - - Palmyra
1890 T. Guilford Smith M.A. C.E. LL.D. - - - - Buffalo
1893 Lewis A. Stimson B.A. LL.D. M.D. - - - - New York
1895 Albert Vander Veer M.A. Ph.D. M.D. - - - - Albany
1895 Charles R. Skinner M.A. LL.D.
Superintendent of Public Instruction, ex officio
1897 Chester S. Lord M.A. LL.D. - - - - - Brooklyn
1897 Timothy L. Woodruff M.A. Lieutenant Governor, ex officio
1899 John T. McDonough LL.B. LL.D. Secretary of State, ex officio
1900 Thomas A. Hendrick M.A. LL.D. - - - - - Rochester
1901 Benjamin B. Odell jr LL.D. Governor, ex officio
1901 Robert C. Pruyn M.A. - - - - - - - - Albany
1902 William Nottingham M.A. Ph.D. - - - - Syracuse
One vacancy

SECRETARY

Elected by Regents

1900 James Russell Parsons jr M.A. LL.D.

DIRECTORS OF DEPARTMENTS

1888 Melvil Dewey M.A. LL.D. *State Library and Home Education*
1890 James Russell Parsons jr M.A. LL.D.
Administrative, College and High School Dep'ts
1890 Frederick J. H. Merrill Ph.D. *State Museum*

PREFACE

During the prosecution of the study herewith given of a fauna essentially new to the New York series of geologic formations, I have been under special obligation to Professor Albert L. Arey, of Brooklyn, the first to discover and record the presence of a Guelph fauna at Rochester, for the use of his collections, of which many specimens are here figured. In this place, also, I desire to make acknowledgment for courtesies received from Colonel C. C. Grant of Hamilton Ont. This work has, further, been essentially aided by the fine collections from the tough dolomites at Shelby, made by D. D. Luther, who has also contributed important stratigraphic details.

John M. Clarke
State Paleontologist

GUELPH FAUNA IN THE STATE OF NEW YORK

INTRODUCTION

TYPICAL GUELPH DOLOMITES OF ONTARIO AND THEIR FAUNA

The Guelph formation of Canada has been regarded by geologists as a local stratigraphic development succeeding the Niagara or Lockport limestone and antedating the desiccation of the sea which precipitated the deposits of the Salina stage. The formation in central Ontario, the region of its typical and highest development, has the aspect of a great lentil thinning to the southeast toward the Niagara river and to the northwest at Manitoulin island in Lake Huron, in the interval attaining a thickness of not less than 200 to 300 feet. Whether it is interrupted at this northern point is not determined, but it has recently been shown that certain characteristic fossils of the fauna occur in the territory of Keewatin about James's bay (Equan river); Dr Whiteaves has described two species of Trimerella from this region and these seem to indicate the presence of the formation.[1] The actual amount of deposit has however not been accurately measured, and the exposed sections have for the most part proved to be along the quite uniformly northwest strike of the strata. The entire formation is quite completely dolomitized, and this pervading alteration, together with the distinctly fragmental and sandy character of much of the deposit, indicates substantial deviation from the static conditions under which the normal Niagaran fauna was laid down. To the probable origin of these dolomites attention will be directed in a later paragraph. The fauna accompanying this formation has peculiarities of composition which separate it from any earlier manifestation of the Upper Siluric or at least from the Wenlockian fauna of the Niagaran (Rochester) shales and the modified continuation of that fauna into the Lockport limestones of New York.

It is striking for several of its peculiarities both positive and negative. These may be itemized briefly: (1) The prevalence of holostomatous, probably opercle-bearing gastropods of the genera Coelocaulis, Pycnom-

[1] Ottawa Naturalist [Oct. 1902], p. 139.

phalus, Euomphalus and Polytropis (*auct.*) and of schizostomatous genera of the style of Murchisonia, Pleurotomaria, Loxoplocus, etc. These are all often of notable size and are more abundant individually and in species than at any other Siluric date in American sections. (2) Abundance of cephalopods of cyrtoceran genera, of Phragmoceras, Trochoceras, etc. (3) Presence and special life period of the heavy-shelled, edentulate brachiopods, Monomerella, Trimerella and Rhinobolus. (4) Immense abundance at certain localities of the ponderous shelled clam Megalomus. (5) Paucity of other lamellibranchs and of brachiopods, bryozoans and trilobites. (6) Existence of corals and coral-making stromatoporoids, for the most part in an incomplete and semimacerated condition. Their abundance in the fauna is unquestionable, but their present condition is no true indication of their original state.

A fauna of such composition is distinctly late Siluric, at the same time quite as distinctly unlike any other element of the Appalachian Siluric sections.

The term Guelph, then, indicates both a faunistic and, in its typical province, a lithologic element of distinctive significance in the Siluric succession. In no sense is it a late presentment of the Niagaran fauna as expressed in the shale beds beneath the Lockport limestone. It is true and natural that species of the preceding fauna should present themselves in the Guelph congeries, and though this is not carried to great extent, yet we may always expect to find therein some well known and widespread survivors of the lower fauna.

GUELPH FAUNA OF NEW YORK AND ITS STRATIGRAPHIC RELATIONS

Historical

During the construction of the Erie canal, 1817–25, the rock cuttings near Newark in Wayne county brought to light an impure light colored dolomite. Some fossils were obtained from this rock by Dr G. W. Boyd, assistant to Professor James Hall, geologist in charge of the fourth district of the State, and this occurrence was first noted with woodcuts and names of the fossils in the final report on the geology of that district [1843, p. 137[1]]. As it was evident that the horizon of these few and inconspicuous though significant species (Loxonema boydi, Avicula triquetra, Euomphalus sulcatus, Orthoceras laeve, Atrypa, Delthyris, Cornulites) was above that of the Niagaran fauna, known best then, as now, from its development in the lower beds or Rochester shales, though recognized as continuing into the overlying Lockport limestone, Professor Hall regarded them as appertaining to the life of the Onondaga Salt group — the Salina formation of present usage. A few years later Professor Hall's attention was directed by Sir William Logan to the profuse occurrence of similar fossils in dolomites at Guelph and Galt Ont., and in 1848 he visited these localities, collected freely, and, in 1852, he described and illustrated a considerable number of species obtained by him at that time.[2] In regard to the stratigraphic position of the beds bearing this fauna, he states his view as follows [p. 340]:

A simple inspection of the plates . . . will show that these fossils are typical of a distinct period from that of the Niagara group, and, though the few species yet known from the base of the Onondaga salt group in New York seem scarcely sufficient to indicate a well marked period or to claim positive identity in age with those of the Galt limestone, yet we are compelled to regard them thus or to rank the latter as a group entirely distinct from any yet recognized. . . Whether we regard them (the Galt and New York fossils) as of the age of the Onondaga Salt group or not, we know that they lie above the strata typified by the numerous fossils already described as belonging to the Niagara group and strictly should form no part of that group.

This opinion was expressed long before Robert Bell, now acting director of the Canadian Geological Survey, proposed to distinguish the formation in Ontario by the term *Guelph;* Hall's term "Galt limestone" being a dangerous approach to the better known and older stratigraphic name,

[1] Professor Hall, in a subsequent reference to this discovery [N. Y. State Cab. Nat. Hist. 20th an. Rep't. 1868. p. 305 (rev. ed. p. 347)] mentions the origin of the rock exposure, though nothing is said of it in the fourth district report.

[2] Pal. N. Y. 2:341 *et seq.*

"Gault." It is clear from the expressions above quoted that Hall was the first to recognize the faunistic distinction of this association from the Niagaran;[1] but the discriminating observations of the Canadian geologists, Logan, Bell and Murray, aided notably in elevating Guelph sedimentation to the dignity of an event separable from the Niagaran. Professor Hall, after extending his studies of the Upper Siluric dolomites over the area of their distribution in Wisconsin, Illinois and Iowa, was inclined, in subsequent expressions, to caution in respect to the separation of Niagaran and Guelph faunas;[2] and to these we shall have occasion to refer in bringing the data here presented into harmony with facts previously known.

The Wayne county, N. Y., locality for "Onondaga Salt group" fossils was long ago lost. Nothing more is known of it than was given by Hall in 1843; and no examination of the region in later years has given any clue to exposures of this horizon, but some remarks on the horizon there presented are given in a subsequent paragraph.

The Lockport or Niagaran dolomite in western New York makes a very clearly defined topographic feature, specially where transected by drainage ways. As is well known it is the rock which is the cap and occasion of the falls at Niagara and of the upper falls of the Genesee river at Rochester, and, though modifying the contour between these points, only its lower parts project freely as exposure or lie under slight drift cover. This mass of dolomites, which is not less than 100 feet in thickness between Niagara Falls and Rochester, is at bottom at first comparatively pure and hard, but becomes more and more dolomitic and less resistant[3] toward the top. The overlying soft shales, gypsum beds and "platten" limestones of the true Salina have been so worn down by obsequent drainage that south of the Niagara escarpment, which is largely constituted of only the lower layers of the Lockport dolomite series, the

[1] See also Pal. N. Y. 1859. 3 : 30.

[2] N. Y. State Cab. Nat. Hist. 20th Rep't. 1868. p. 306 (rev. ed. p. 348).

[3] That is, more yielding to meteoric agency, because the purer the dolomite, in this section, the more completely is it of fragmental origin.

ground is continuously low, much filled with detritus and specially swampy. The northern reaches of the Oak Orchard swamp, extending from near Churchville, Monroe co. on the east, across Orleans county, are excavated in the Salina shales and have the dolomite series (Guelph and upper Lockport) for a floor. Hence it is not altogether strange that, during the years of geologic study which have elapsed since 1843, extremely little has been seen of the strata buried in this almost undissected region.

In 1892 Albert L. Arey brought to the attention of the geologic section of the American Association for the Advancement of Science in session in the city of Rochester, his discovery of a fine series of fossils from this horizon at the top of the Lockport dolomites in and about that city. Some of these were obtained from the uppermost layers in a quarry then being worked in the southwest part of the city and known as the Nellis quarry; at present writing these workings are abandoned. More were derived from occasional excavations for municipal improvements made in the southern part of the city, affording an opportunity for collecting which may sometime recur but which is beyond the control of the geologist. This fauna was subsequently the subject of study by its discoverer, who published a brief account of it in the *Proceedings* of the Rochester Academy of Science [1892. 2:104-7].

These organisms proved to be for the most part preserved in nodules of white chert, of which they have frequently formed the nuclei, but in which more often they had become irregularly involved in the process of segregation. The shells themselves are largely replacements in chalcedonic silica and preserve with fine accuracy and in a manner altogether unusual for paleozoic fossils the important exterior surface ornament. This mode of preservation makes them extraordinarily interesting subjects. In the brief paper cited Mr Arey has brought the fauna as then known to him into comparison with the species of the Canadian Guelph and the published lists of fossils from the Chicago and Racine limestones, and elicits therefrom the very close similarity in general composition of the Rochester and Guelph faunas and the striking contrast between the former and the faunas of the Rochester shale and Lockport limestone. The paper concluded with a list of 15 species identified by the author as common to the Canadian and Rochester Guelph.

It would be impracticable for any investigator to obtain access to these species except by such personal consideration as that shown us by Mr Arey who has availed himself of transitory opportunities not likely to return. As the Nellis quarry is no longer productive, and the student can hardly wait for possible further city excavations into this interesting horizon, we have endeavored, with the important Arey collection as a nucleus, to further exploit this interesting fauna throughout western New York.

The natural sections of the dolomite series in Monroe county are very few, incomplete and unsatisfying. To the series of sections made as a result of searching all the water courses and trenchings, we shall presently refer; as none of them expose the strata with which we are now concerned, we can correlate them most satisfactorily after consideration of the developments given in the following.

Section of the dolomites at Shelby, Orleans county

While zigzagging across the Niagara cuesta in 1901 in the search for this Guelph horizon, the writers discovered a finely extended outcrop of the dolomite series along Oak Orchard creek, from 1 to 1¾ miles south of Shelby village, in Shelby, the southwestern township of Orleans county. Oak Orchard creek, a few miles to the south of this place, receives the Erie canal feeder or drainage channel from Oak Orchard swamp, and from that point the artificial and natural water courses are combined. To effect this function, the bed of the creek has been depressed by excavation of the natural rock section to a depth of 8 to 10 feet, and an immense amount of material thrown on the banks in most favorable situation for examination. The stratigraphic section here stretches along the creek for about 2 miles, and has been briefly sketched in a previous publication.[1]

At the base of the falls at Shelby are

[1] N. Y. State Paleontol. Rep't 1901, p. 521.

1 An exposure of normal Rochester shales, above which lie

2 Sixty feet of hard, dark gray dolomites, full of small cavities bearing druses of dolomite and calcite, but with few or no fossils; only parts of this series are exposed (Lockport limestone);

3 Two feet of porous dolomite, the cavities being vermicular or having the aspect of small tubes (Lockport limestone);

4 Three feet of dark gray dolomite. This is the *lower Guelph bed.* It contains a fairly profuse fauna, of which Trematonotus alpheus is the leading element, but Monomorella noveboracum the more exclusive species (Monomorella bed). Both are highly abundant and occur in extraordinarily fine specimens. Of other species the stratum contains: Poleumita crenulata, Coelidium macrospira, Lophospira bispiralis, Cyrtoceras orodes, Poterioceras sauridens, Protophragmoceras patronus, Trochoceras desplainense, T. costatum, etc.;

5 Eight feet of gray dolomite with few fossils, and these characterizing the Lockport fauna: Zaphrentis bilateralis, Enterolasma caliculus, Stropheodonta profunda, Orthothetes subplanus and a few others. This mass is capped by a thin bed of shaly limestone containing a profusion of small fossils, among which are: Cladopora multipora, Halysites catenularius, Lichenalia concentrica, Dalmanella elegantula, Orthothetes subplanus, Leptaena rhomboidalis, Camarotoechia neglecta, Rhynchotreta cuneata americana, Whitfieldella nitida oblata, Spirifer crispus (typical Rochester shale form), Cornulites arcuatus, Dalmanites sp., Calymmene cf. niagarensis, Proetus sp. This association is characteristic of the Rochester shale and lower Lockport limestone. Over this bed lies a thin layer of chert nodules without fossils.

6 Twenty-four feet of similar dark gray dolomite with fossils extremely rare and of the same character as those below (Lockport limestone).

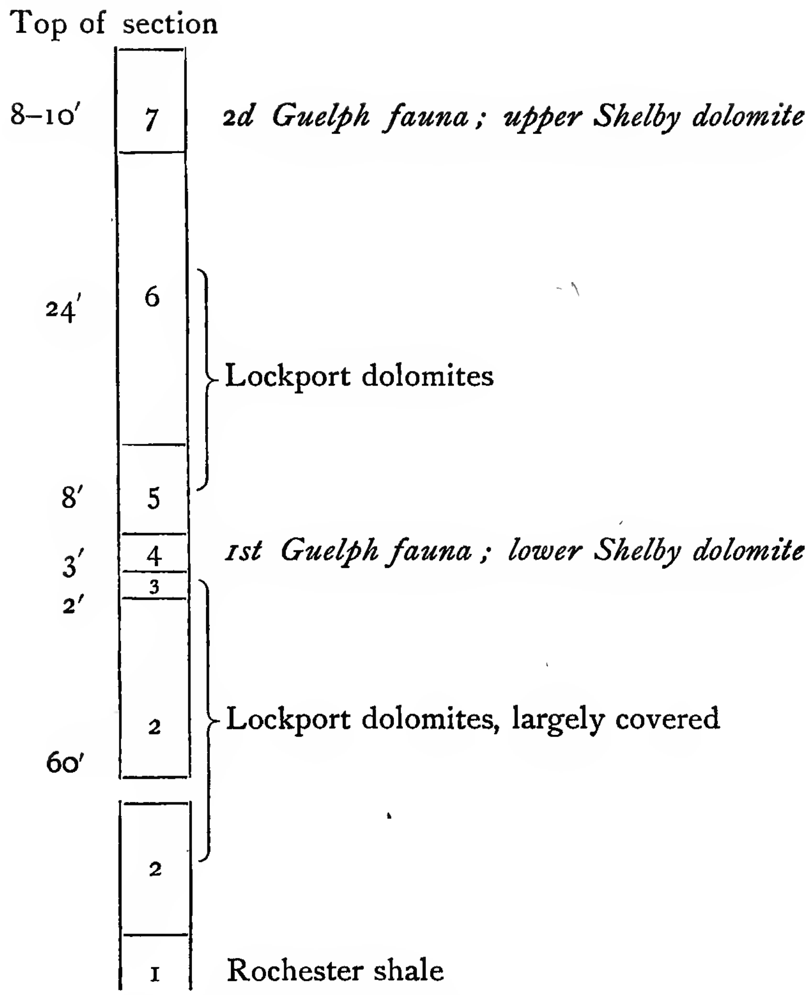
7 Eight to 10 feet of gray dolomite, bearing white chert nodules most

abundant in the lower part and containing *inter alia*, Trochoceras desplainense, Orthoceras trusitum, Coelidium macrospira, Trochonema cf. fatuum, Trematonotus alpheus, Cornulites arcuatus, Poleumita scamnata, P. sulcata, Eotomaria galtensis, Spirifer crispus, Leptaena rhomboidalis, Pterinea subplana, P. undata, Stromatopora galtensis, Diaphorostoma niagarense, Calymmene niagarensis, Proetus sp. This we shall term the *upper Guelph bed*, and shall have occasion to observe that its fauna is more nearly parallel to that at Rochester than the lower or earlier appearance of the Guelph in this section.

This is the southernmost exposure on Oak Orchard creek; and it appears that in the general planing of the country by ice and water any harder beds above would have in some degree at least, resisted erosion and left some trace of themselves in the well channeled way of this stream to the south.

It seems fair to conclude, therefore, from this section supplemented by similar evidence in Monroe county, that overlying beds, with the possible exception of a few feet of dolomite, were the soft shales and thin "platten" limestones of the Salina, and hence that the upper Guelph horizon, lithologically, topographically and faunistically here terminates the dolomite period.

This section is represented in the following diagram.



A significant feature of this occurrence is the double appearance of the Guelph fauna. Its earlier manifestation is after the lapse of 63 feet of Lockport dolomite; it retreated and reappeared after 32 feet more of these Lockport dolomites with their characteristic species, had been deposited. Here it closes the dolomite episode, and the Lockport species have finally withdrawn. We designate these appearances of the fauna as the lower and upper Guelph faunas or, as the local development of the fauna is predicable and carries an impress of distinctive nature, as the *lower* and *upper*

Shelby faunas, contained in the *lower* and *upper Shelby dolomites*. It is furthermore specially noteworthy that of these two manifestations of the fauna, the lower is the purer Guelph, that is, is freer from complications with species occurring in the Lockport dolomites. In the upper bed, however, the presence of such Lockport species is much more pronounced. On the other hand, the intervening Lockport dolomites are wholly free from any evidences of the Guelph species; though decidedly meager in fossils, yet these are all proper to the horizon in which they occur. Thus the overlapping faunas are relatively free of complication and intermixture. We note again, as just stated above, that it is not the lower and purer Guelph congeries that appears in the Rochester section; on the other hand, it is the later association, containing a number of Lockport limestone species, that agrees better in composition with this more eastern development.

We are thus presented with conclusive evidence of an invasion of the Guelph fauna from the west into western New York, while the Lockport dolomites were being deposited and at about the middle of the period of their formation; this immigration was of brief duration, failed to acquire a lasting foothold, withdrew without reaching far if at all east of Orleans county; it thereafter returned with some unimportant modification in composition, penetrated as far east as Monroe and Wayne counties, while the previous occupant of the field withdrew, not to return.

At the close of the descriptions of the New York Guelph species we have given tables showing the distribution of the fossils and bringing out the difference in the composition of the early and late appearance of the fauna in the Oak Orchard creek section and the relation of these manifestations to the fauna in Monroe county. For that place we reserve all further discussion of the affinities of the congeries to extralimital expressions of the Guelph fauna.

Niagara county

The rock exposures at Niagara Falls show 120 feet of limestone and dolomite currently referred to the Niagaran formation. We have been unable to determine the existence of the Guelph fauna in the vertical section here afforded, though the unfavorable exposure may still veil its presence, but we are satisfied that the careful analysis of this section recently made by Mr Luther locates with precision the horizon which at Shelby so much more favorably expresses its contents. To elucidate these stratigraphic relations we here give the detailed section of the dolomites presented in the cut of the Gorge Railway, ½ mile north of the east end of the bridge, supplemented at the top by a temporary exposure made by the Ontario Power Co. on the Canada side.

25′	7	Brown dolomites exposed at Goat island and Three Sisters islands with summit near head of rapids. Full of cavities and with Stromatopora, Halysites. Weathers very scraggy. Uppermost bed (4′) sandy
10′	6	Car barn of Gorge Railway; not exposed
8′	5	Brown, thin bedded dolomites with rough surface and black partings
12′ 6″	4	Thin bedded dolomite, fine grained and very hard. Continuous bed of chert nodules near top; *probable horizon of upper Shelby fauna*
19′	3	Compact drab dolomite; few cavities. *Horizon of lower Shelby dolomite near top*
17′ 6″	2	Smooth, thin bedded dolomites with Stromatopora; at top, Enterolasma, Favosites
28′	1	Compact light brown dolomite
		Rochester shale

The basal layer of the series (1) is quite homogeneous, though the lower part is schistose. The same stratum is seen at Lockport along the banks of the canal beginning a little west of the locks in the city and extending continuously toward the southwest for a mile. Farther west near Gasport it is quarried at the top of the banks of the ravine south of the village and in a ravine south of Middleport. The layer may be differentiated at the falls in Oak Orchard creek.

Stratum 2 is composed of varying proportions of hard, dark gray, subcrystalline limestone and irregular beds of unstratified bluish hydraulic material, giving the whole a dappled appearance. It is dark blue when fresh but weathers a very light gray. It is also known in the canal south of Lockport and in the creek 2½ miles southwest of Gasport. Stromatoporas are common in it. The horizon can be recognized at Shelby from the piles of material just west of the village.

Stratum 3 is a compact, light brown dolomite of uniform texture. At Niagara Falls there are small corals (Enterolasma caliculus, Favosites) in the lower part. From the character of the rock and that of the overlying stratum we regard this as the horizon of the lower Guelph fossils at Shelby. There the subdivision into separate beds is more pronounced and the fossils are restricted to a 3 foot layer; this subdivision of the stratum is also shown at Lockport where the layer is the highest and most southern one exposed on the canal.

Stratum 4 is finer, harder and lighter colored than the layers above and below and is filled with cavities. Near the top is a continuous row of chert nodules which are bluish when fresh but become white on long exposure. This layer is nearly in a plane with the crest of the American and Horseshoe falls. Fossils are extremely scarce but the exposure is unfavorable for examination. Poleumita scamnata occurs here, a species not elsewhere found except in the chert nodules of the upper Shelby and Rochester horizon. This fact indicates that this chert layer represents the *upper Guelph horizon* which would, thus, be separated from the lower horizon by an interval of 20–25 feet, considerably less than at Shelby.

Above stratum 5, consisting of brownish dolomites in thin layers having black partings, there is a covered interval of 10 feet (6), which is followed by a 25 foot mass (7) of rough geodiferous dolomite in thick and thin layers. This is exposed in the cut of the Gorge road south of the car barn, at the south of Goat island and on the Three Sisters. This rock contains numerous fossils; Stromatopora, Halysites, Favosites (diffusely branching form) Spirifer crispus, Trematospira (which is common in the Guelph of Iowa), Coelidium macrospira, Pterinae subplana.[1]

The association indicates a mixture of Lockport and Guelph species, though there is nothing in it which militates against its construction as a Guelph fauna, as, in fact, a facies of the fauna somewhat removed in space from the reefs about which the true Guelph was centered. We may note that Professor Hall[2] described and figured specimens from "limestone below the cliff at Niagara Falls"—evidently loose—as Cyrtoceras? subcancellatum and Gomphoceras? sp. Both are identified with specimens from the Rochester shale but this identification seems erroneous in the former and dubious in the latter case. These fossils are quite distinctly of Guelph habit and it is probable that both were derived from this upper layer. We may properly regard the layer of chert nodules below as presenting the first appearance of the Guelph (i. e. the upper) fauna in this section and in this case may conceive the thickness of 45 feet of dolomite above this layer as imperfectly or not at all represented at Shelby.

The actual measurement of the dolomite section at Niagara Falls is 13 feet more than on Oak Orchard creek and this difference is largely if not wholly at the top of the former. It is not now possible to say how much of the section has been planed off in either place or what part of the difference is to be ascribed to the thinning of the formation eastward. That a portion of the top of the section throughout this region is concealed, is indicated by borings. Deep wells in the Niagara region are stated to show about 100 feet of limestones above the exposure,[3] but it is altogether uncertain that this is to be accepted as correct or what part of such alleged increase can be ascribed to the dolomite series.

[1] These fossils have been chiefly collected on Goat island by Gilbert van Ingen.

[2] Pal. N. Y. 2: 290, pl. 61.

[3] Grabau. N. Y. State Mus. Bul. 45, p. 114.

Other manifestations in Orleans county

In the townships of Barre and Clarendon lying between Shelby township and the west boundary of Monroe county, outcrops of the dolomites are seldom shown. Except at Clarendon village almost the entire surface of the dolomites has been planed down and forms the floor of the basin in which lie detached northern parts of the Oak Orchard swamp. The lower element of the series is exposed at several places near the northeast corner of Barre. At Clarendon village the exposure shows the lowest layers (1, of the Niagara section) in and above the falls; in the ridge south of the village strata 2 and 3 are exposed. No trace, however, of Guelph fossils has appeared here. About 40 feet above the base of the dolomites there appears a cherty layer, similar to, perhaps identical with that in Niagara county; in the latter section the elevation of the layer above the Rochester shale is 75 feet.

One and one half miles east of Barre Center and on the ridge south of Clarendon are found the rough layers appertaining to division 7 of the Niagara section, and the more even grained, sandy dolomites which cap the section near the rapids of the Niagara river, are quarried at Honest Hill, 3 miles south of Clarendon.

In all the section exposed at Clarendon no trace has been found of Guelph fossils; the lower Guelph fauna as expressed at Shelby is absent and the horizon of the upper fauna is not clearly exposed. South of the line of outcrop of these upper rough dolomites the country is dotted with boulders of this origin, made rougher and more jagged by the action of decomposing agencies.

Monroe county

Allen creek section. Directly south of Rochester, an interrupted section of the dolomites is made by Allen creek, a stream of many branches, traversing the town of Pittsford, flowing north and discharging into the Irondequoit river. (1) The lowest exposure is beneath the large culvert through which the stream passes under the New York Central Railroad (Direct road), where 20 feet of rough dolomites are shown. The bottom of this exposure is 350 feet A.T. After a covered interval estimated at about 10 feet, another exposure (2) is seen at Lincoln's Mills, near the crossing of the East avenue road; 25 feet of dark bluish gray dolomite, with drusy cavities and showing specimens of Stropheodonta profunda, are exposed. Estimating a covered interval of 20 feet, a third outcrop (3) occurs on the premises of John Balder, consisting of 5 feet of evenly bedded dolomites overlain by 8 to 10 feet of darker rock with Stromatopora. Above are 2 feet of a peculiarly concretionary layer with many corals of the Lockport limestone and similar to a layer in the Pike quarry section, Rochester. Continuous with this exposure, farther up the creek are (4) 10 feet of dark dolomite with corals; 5 feet of finer, harder and thin bedded rock; 12 feet of dark brown dolomite with Stromatopora, Halysites and Favosites. The summit of the outcrop is about 8 rods east of the Erie canal. Above this section is a covered interval estimated at about 15 feet, and herein probably lies the Guelph horizon of the Nellis quarry, which, as we shall presently note, is above the dolomites in Pike quarry. The exposure next following on the stream (5) is 5 to 6 rods long in the low banks and covers about 8 feet of thin "platten" limestones of the Salina. In the bottom of the Erie canal, 2 miles northwest of Pittsford, 470 feet A. T., and ¾ of a mile from the last named exposure are black shales with interbedded gray "platten" limestones abounding in Salina crustaceans. Exposure 5 has an elevation at the bottom of 485 feet and hence lies above the Salina shales referred to. We may fairly conclude that these Salina black shales lie immediately above the covered Guelph horizon.

The total thickness of the dolomites here according to the section given, is about 120 feet.

Brighton. At a rock cut, 1 mile east of Brighton on the Direct road (New York Central Railroad) are 15 feet of brown dolomites with Stromatopora and Favosites. The exact horizon of this layer in the Lockport dolomites is not altogether clear.

Rochester and vicinity: *Pike quarry*, Frost avenue and Summer street. The section where best exposed is as follows, beginning at the bottom, which is the surface of the water in the quarry:

1	Brownish gray to black scraggy dolomite with drusy cavities. Stromatopora and Favosites abundant. (*See* Allen creek section, no. 4)	2 feet
2	Compact unbroken dolomite	5 "
3	Dark brown dolomite like 1	3 "
4	Dark bluish gray dolomite, weathering brown; compact	10 "
5	Brown sandy dolomite in layers 2 to 4 inches thick. Heavier layer at top. Stromatopora and Zaphrentis bilateralis	6 "

This section is clearly all of Lockport dolomite.

Nellis quarry, McLean street. The highest part of this locality is 1200 feet west and 600 feet south of Pike quarry, and this rock section runs 15 feet higher than in that section. The white chert nodules from which Mr Arey obtained many of the Guelph species before workings here were abandoned, are all in the upper part of this additional thickness.

The rapids, Genesee river. The exposure here is 25 or 30 rods long and includes about the same section as Pike quarry. The Guelph horizon with white chert is not exposed.

Lauer quarry, town of Gates, 2 miles west of the Rochester city line. The lower part of the section exposes 15 feet of dolomite with Favosites, Stromatopora and Enterolasma caliculus (Lockport). The highest part of the quarry gives 3 feet additional, which may rise to the Guelph horizon, but no satisfactory evidence is at hand. The elevation here is 550 feet A. T. The quarry is not now operated.

Newman quarry, 1¼ miles north of Lauer quarry and 3 miles west of Rochester city line; town of Gates; 30 to 35 feet above the preceding. At the south end of the quarry the section is from the bottom.

1 Compact bluish dolomite, with Enterolasma caliculus (Lockport) - - - - - 4 feet

2 Dark grayish brown dolomite with white chert nodules. This layer has furnished Trematonotus alpheus, but fossils are very scarce. (Guelph or upper Shelby horizon) -

Wayne county

The original occurrence of Guelph fossils in New York, was, as we have already noted, from the bottom of the Erie canal near Newark. Professor Hall has stated that these remains (a mere handful of depauperated shells) were thrown out with the Salina marls, the rock containing the fossils preserving "the celluliferous structure and characteristic color of the argilaceous limestone of that formation."[1] Newark lies on the Salina shales which are shown to a depth of not less than 200 feet in well sections in the city.[2] The canal (9 feet deep) passes through the city in an east-west course which it retains for several miles. The nearest outcrop of the dolomite is at Fairville, 6 miles due north. This outcrop may be near the middle of the series and the dip of the beds is south 30–50 feet to the mile. It would thus appear that Professor Hall's specimens must have come from a high horizon, even within the Salina shales wherein was represented a brief, ill conditioned return of Guelph species.

Southern Ontario — the section at Hamilton

The composition of the Niagara escarpment, which is finely continued along Lake Ontario (Hamilton bay) just south of the city of Hamilton, has been carefully studied by Colonel C. C. Grant of that place, who has published various data in regard to it. Dr J. W. Spencer also some years ago studied this region stratigraphically and described some of the fossils therefrom. From these sources we gather that the section here is the following, beginning at the top.

---

[1] N. Y. State Cab. Nat. Hist. 20th An. Rep't, p. 305 (rev. ed. p. 347).

[2] The section of a well put down at Alloway, 3 miles south of Newark, showed 580 feet of Salina shales to the top of the dolomites. [*See* Prosser. Am. Geologist, June 1900, p. 353]

1 The Barton beds (Spencer). Summit formation, mostly dark dolomite with interbedded shale and soft hydraulic layers, the latter considerably employed in the manufacture of cement -	87	feet
2 Magnesian silicious beds filled with irregular nodules of light or white chert - - - -	20	feet maximum
3 Blue dolomite - - - - - -	5–6	feet
4 Rochester shale - -	17.6	feet

For our immediate use we need not carry the section further down, though the outcrop of the cuesta extends well into the Medina, as on the Niagara river. To return to 1: these heterogeneous strata, consisting of shales, soft waterlimes and hard dolomites (Barton beds[1]) contain discrete faunas. In the hydraulic layers are Atrypa reticularis, Enterolasma caliculus, while the dark dolomites bear a distinct association. With the aid of Colonel Grant and by the study of his collection and that of the Hamilton Scientific Association, we are able to cite these as characteristic species: Orthothetes subplanus, Leptaena rhomboidalis, Orthoceras bartonense Spencer, a Dawsonoceras identical with D. annulatum. More important however are the following, each of which has been seen by Colonel Grant in but a single specimen: Pleurotomaria perlata,[2] Coelidium macrospira, Trochoceras like T. waldronense from the Waldron. The first two of these are of distinctively Guelph character, and P. perlata has not been found outside of that fauna. Colonel Grant finds that the upper layer of these Barton beds, whenever stripped of soil, is everywhere deeply scored by glacial shearing and believes that some part of the dolomites has been thus carried away. Hence we get in these Barton beds, a clue to or suggestion of the true Guelph fauna, which we may well believe

[1] The employment of this term, so well known and long established in the English Tertiary nomenclature, recalls how nearly Professor Hall came to duplicating the same English nomenclature by introducing the terms Galt and Ludlowville.

[2] It is apparently this species that has been described by Spencer as P. clipeiformis from this upper horizon at Hamilton. [Univ. Mo. Bul. 1. 1884. p. 57, pl. 7, fig. 6]

was more fully developed in the later deposits removed by glacial erosion.

Summary

We may briefly summarize the evidence from these sections thus:

The more prolific development of the Guelph fauna in the lower Shelby dolomite on Oak Orchard creek does not extend so far eastward as Monroe county and has as yet been observed only at the original locality.

The Guelph fauna of the upper Shelby dolomite, which is largely involved in chert nodules, appears under similar conditions both at Shelby, about Rochester, and in the Niagara Falls section.

It is to be noted that, while the white chert segregations are in some measure an index of the upper Guelph horizon, those which contain fossils have proved to be in an exceedingly small ratio to the number present. The experience of Mr Arey in the exposures about Rochester showed that these fossils were to be had only by very great diligence and watchfulness, and it seems probable that they will always be of rarity. The dolomite containing these silicious nodules weathers freely to sand, retreating from about the nodules, which thus become loosened and set free, so that the rough, scraggy dolomitic blocks with which the surface of the country is freely covered, specially in the towns of Ogden and Sweden, Monroe co., seem to us to be in part at least derived from this upper Guelph horizon.

We conclude that the episode of the Lockport dolomites, which was virtually the closing sedimentation phase of the true marine Siluric, embraces representations of two quite distinct faunas; (1) the essential or normal fauna of the time and place, the immediate successor of, and derivative from the profuse Rochester shale (Niagaran) fauna, that is to say, the peculiar and appropriate fauna of the Lockport stage; (2) at least two, perhaps three manifestations of the typical Guelph fauna which has entered this province from the west. These are embedded in the dolomites and interbedded with the layers containing the other fauna. They represent a distinct organic facies from the other, and the relations of both are those of mutually encroaching faunas of adjoining provinces without alteration of sediment and sea.

In New York, therefore, both Lockport and Guelph faunas pertain to the period of the Lockport-Shelby dolomites.

FAUNA OF THE GUELPH DOLOMITE IN WESTERN NEW YORK

ANTHOZOA

TETRACORALLA (HEXACORALLA?)

ZAPHRENTIS Rafinesque. 1820

Zaphrentis cf. racinensis Whitfield

Plate 1, fig. 2, 3

Cf. Zaphrentis racinensis Whitfield, Geology of Wisconsin. 1882. 4:277, pl. 14, fig. 1, 2

Four casts of the interior of the calyx of a supposedly turbinate coral were found among the Rochester material, one of which had been identified by Mr Arey with Zaphrentis racinensis. We have a few specimens also from the upper horizon at Shelby. Professor Whiteaves records[1] that he had corals from various Canadian localities in a similarly poor state of preservation, and these he regarded as possibly identical with Z. racinensis Whitf. That species itself was founded on internal casts of cups only, from the Racine limestone, and, while our specimens show the same number of septal impressions as those and also agree therewith in the development of the septal fossette and the mode of contraction of the calicular cavity, they uniformly attain only about half the size of Z. racinensis, the latter having a calyx twice as deep as that from Rochester. While it would be hazardous to identify these corals from such casts only, dissimilarity in size does not impugn their usefulness for correlation. It is not probable that the casts represent specimens of Z. (Polydilasma) turbinata Hall,[2] from the Lockport limestone of New York, as that species is characterized by the duplication of its septa about the outer walls and the abrupt depression of the cup about half way from the outer margin to the center, which would give to the casts a cylindric interior and a saucer-shaped superior part.

---

[1] *Op. cit.* 1895. p. 49.

[2] Pal. N. Y. 1852. 2:112, pl. 32, fig. 2a-h.

In the upper Guelph of Shelby was collected a single specimen which possesses a rapidly widening corallum, narrow, thin septa and a deep cup; on account of these characters, it has also been referred to Zaph. racinensis rather than to Zaph. turbinata.

ENTEROLASMA Simpson. 1900

Enterolasma cf. caliculus Hall (sp.)

Plate 1, fig. 1

Streptelasma calicula Hall, Paleontology of New York. 1852. 2:111, pl. 32, fig. 1a-k

Of somewhat more frequent occurrence than the foregoing in the Guelph at Rochester are casts of a smaller turbinate, rapidly expanding zaphrentid, slightly curved toward the apex. These in exterior appearance suggest identity with Streptelasma caliculus Hall. Unfortunately in nearly all specimens the internal structure has been destroyed by dolomitization, but a single specimen has afforded in thin section, evidence of a pseudolamella consisting of the involved vermiform projections of the septa suggesting the convolutions of the intestines. Simpson[1] has united under the generic name Enterolasma, species presenting this peculiar divergence from the structure of Streptelasma, assuming the S. strictum Hall, of the Helderbergian, as the type of the genus. Two other species of Niagaran age have been referred by this author to the genus, viz Petraia waynensis Safford and Streptelasma radicans Hall, the former from Perry county, Tenn., the latter from Waldron Ind. Enterolasma waynense differs from E. caliculus in the coarser and more prominent costae and the sharper concentric striae. It is also proportionally more slender. These are but slight differences, which are not pronounced in the Guelph species. Enterolasma radicans has a more irregular growth and a broad base of attachment.

This characteristic dwarfed coral has not been observed in either the lower or upper Guelph beds at Oak Orchard creek, while it was found to be

[1] N. Y. State Mus. Bul. 39. 1900.

abundant in the dark crystalline limestone directly underlying the upper Guelph chert nodules.

DIPLOPHYLLUM Hall. 1852

Diplophyllum caespitosum Hall

Diplophyllum caespitosum Hall, Paleontology of New York. 1852. 2:115, pl. 33, fig. 1a-r

Cyathophyllum pelagicum Billings, Geol. Sur. Canada. Paleozoic Fossils. 1862. 1:108; Catalogue of the Silurian Fossils of Anticosti. 1866. p. 34

Diphyphyllum caespitosum Nicholson, Paleontology of the Province of Ontario. 1875. p. 59

Diphyphyllum caespitosum Lambe, Ottawa Naturalist. 1899. 12:240

Diphyphyllum caespitosum, Geol. Sur. Canada. Contrib. Canadian Paleontology. 1901. v. 4, pt 2, p. 158

Several fragments of coral stocks from Rochester show aggregate simple, cylindric coralla of somewhat varying diameter. Most of these coralla are so weathered or dolomitized that the interior structure is lost; one stock which was better preserved, afforded sections showing that the coral has the internal structure described by Hall for the Niagaran species D. caespitosum, viz a deep calyx; below this an internal zone with tabulae and septa, and a wide marginal zone with septa and numerous dissepiments, which give this zone a cellular appearance. In mode of growth also this form agrees with D. caespitosum. It is not common in the chert nodules of the Guelph horizon.

Observations. The generic relations of this species have been variously interpreted by different writers. Hall erected for it the genus Diplophyllum, citing as differentials the characters of the distinctly separated central and marginal areas of the cell, and mentioned its apparent relationship to Diphyphyllum Lonsdale, without stating the differences between the two. Latterly, Diplophyllum has been considered a synonym of Diphyphyllum; and Rominger,[1] who has been followed by Lambe, united under Diphyphyllum both Eridophyllum and Diplophyllum, because of

[1] Geol. Sur. Michigan. 1876. 3:120.

similarity in mode of growth, admitting however three different modifications in their structure. In the first of these, consisting exclusively of Siluric forms, the demarcation of the outer and inner area is very obscure, and the septa reach to the center of the cells; in the second the septa are confined to a narrow outer zone, and the zones are not separated by an intermediate wall; and the third has a distinct secondary wall separating the inner and outer zones, and this the septa never transgress. Diplophyllum caespitosum, by the development of the septa which reach the center, falls under the first group; the second is that comprised under the generic term Diphyphyllum; and the third is equivalent to Eridophyllum. The last two genera have usually been recognized by European writers, and Frech has stated that Diphyphyllum was based on corals of the Carboniferous limestone, quite distinct from Eridophyllum, and a question may therefore arise as to the propriety of employing the term Diphyphyllum so as to include Diplophyllum.

Diphyphyllum has been considerably misunderstood. Edwards and Haime[1] united it with Lithostrotion, at the same time creating the similar genus Eridophyllum, which on account of its internal wall was compared with Acervularia. De Koninck and Dybowski, however, later defined the genus Diphyphyllum as characterized by the presence of an internal wall with regular tabulae within it and by the feeble development of the septa. The group defined by these characters is identical with Rominger's second modification except that this author describes this group as without internal wall. Other writers on Diphyphyllum contend that the internal wall is never but slightly developed. Frech[2] states that, on account of the internal walls in Diplophyllum caespitosum, Hall's comparison of that species with Diphyphyllum was erroneous, and that it is much more nearly related to Acervularia. It is also distinctly stated that the septa in Diphyphyllum are feebly developed, while in Diplophyllum they are quite strong and reach the center.

---

[1] Polyp. Foss. Terr. Paleoz. 1851. p. 446.

[2] Lethaea Palaeozoica, 1: 350.

Mr Lambe, who has undertaken a revision of the Canadian corals, united Diplophyllum and Eridophyllum under Diphyphyllum, which is characterized as possessing no "inner wall"; and Diplophyllum caespitosum is said to have "dissepiments arching upward, between the septa, against the outside wall, generally in a single series, their outer edges, as seen in transverse section, assuming the appearance of an inner wall situate less than 1 mm from the wall proper." This appears to us to confirm the presence of an inner wall in D. caespitosum, as the inner wall of the other genera, where it can be said to be typically developed, such as Lonsdaleia and Acervularia, consists also of a single or terminal series of strongly developed upward arching dissepiments. We must, therefore, as long as the term "inner wall" is used loosely, consider D. caespitosum as possessing this structure. It would seem to us that the term should be restricted to that inner wall which is often formed by the lateral thickening of the septa, in like manner as the pseudotheca.

From sections of Diplophyllum caespitosum, of Eridophyllum verneuilianum, the type species of that genus, and of E. simcoense, given by Lambe in the paper above cited, it becomes apparent that the internal wall of Eridophyllum, or walls (for in E. verneuilianum occur two series of dissepiments) are also constructed as in Diplophyllum, and that the difference between the two genera can at present be based only on the different development of the septa, while the difference assumed to consist in the failure of the septa to transgress beyond the inner wall in Eridophyllum is not valid. To this difference may be added the presence of the characteristic radiciform expansions in Eridophyllum. Diphyphyllum differs from the two latter genera by its very feebly developed septa, which do not reach the internal wall, and by its different geologic range. While these distinctions in the three genera may be only of degree, the groups denoted by them differ also in geologic age, Eridophyllum being essentially a Devonic and Diphyphyllum entirely a Carbonic genus.

Diphyphyllum caespitosum occurs, according to Billings, as early as the Anticosti group of Anticosti; it is common in the Lockport dolomite of New York, and is reported from the same horizon in Ontario (Thorold); in Wisconsin it ranges from the Mayville beds, through the coral and Racine beds into the Guelph horizon.

HELIOPHYLLUM Hall. 1849

Heliophyllum sp. indet.

Plate 1, fig. 4, 5.

A single internal cast of a small calyx found in the Guelph of Rochester shows distinctly the impression of the denticulations on the septa, which in the present state of our knowledge are regarded as characteristic of Heliophyllum. Though a considerable number of Siluric species have been referred to this genus, the specimen in hand is not sufficiently complete for identification.

TABULATA

FAVOSITES Lamarck. 1816

Coral stocks of Favosites belong to the most common fossils of the Guelph dolomite. The different coralla show considerable variation, indicating the presence of several species.

Favosites niagarensis Hall

Favosites niagarensis Hall, Paleontology of New York. 1852. 2:125, pl. 34A bis, fig. 4a-h

Favosites gothlandica Whiteaves (in part), Paleozoic Fossils. 1895. v. 3, pt 2, p. 50

Favosites niagarensis Lambe, Contrib. Canadian Paleontology. 1899. v. 4, pt 1, p. 71

This is one of the commonest of the species in the white chert nodules at Rochester and the upper Guelph of Oak Orchard creek. The specimens are for the most part subspheric, attain the size of the fist and are composed of corallites which are seldom larger than 2 mm in diameter, and average considerably less, specially in immature growth. The tabulae are regular and flat, but vary in the intervals between them in different specimens, from .3 mm in one to 1.5 mm. On account of the incrustation of thickened walls, the pores and spines can rarely be observed; one was found to possess two rows of alternating pores on the sides. The presence of numerous spines is indicated by pits on the internal casts of cells. These spines are arranged in three or four rows corresponding to as many septa on each side.

It is safe to consider forms with these characters as identical with F. niagarensis.

Observations. Whiteaves,[1] in his description of Favosites gothlandicus from the Guelph at Galt, Hespeler, Elora and Fergus, regards Favosites niagarensis Hall as a synonym of that species, but remarks that there are no examples of the typical form of F. gothlandicus with large corallites, among the Guelph organisms of the survey museum, and that he has seen but a single specimen thereto. On the other hand Mr Lambe, in the *Revision of the Madreporaria Perforata and the Alcyonaria*[2] describes F. niagarensis and F. gothlandicus separately, but only F. gothlandicus as occurring in the Guelph of Ontario. Milne-Edwards and Haime also regard F. niagarensis as synonymous with F. gothlandicus, but at the same time give a diameter for the corallites which is greater than that of the Guelph specimens. Hall expressly stated that his species was distinguished by the size of the cells, and also usually formed small spheroidal masses, characters with which these Guelph specimens are in accord.

Favosites hisingeri Edwards & Haime

Favosites hisingeri Milne-Edwards & Haime, Polypiers Fossiles des Terr. Paleoz. 1851. p. 240, pl. 17, fig. 2a, 2b

Astrocerium venustum Hall, Paleontology of New York. 1852. 2:120, pl. 34, fig. 1a-j

Astrocerium parasiticum Hall, Paleontology of New York. 1852. 2:122, pl. 34, fig. 2a-i

Astrocerium pyriforme Hall, Paleontology of New York. 1852. 2:123, pl. 34A, fig. 1a-e

---

[1] Paleozoic Fossils, v. 3, pt 2.

[2] Contrib. Canadian Pal. v. 4, pt 1, p. 7.

Favosites venusta Nicholson, Paleontology Prov. of Ontario. 1875. p. 65.

Favosites venustus Rominger, Geol. Sur. Michigan. Fossil Corals. 1876. p. 22, pl. 5, fig. 3

Astrocerium venustum Whitfield, Geology of Wisconsin. 1882. 4:270, pl. 13, fig. 8–10

Favosites hisingeri Whiteaves, Paleozoic Fossils. 1882. v. 3, pt 2, p. 51

Several specimens from the dolomite at Rochester and the upper Guelph at Oak Orchard creek differ materially from other species in size of the corallites, and, while they are uniform in this regard, they vary among themselves. They form depressed, hemispheric or flat, though massive expansions. The cells vary from .5 mm to 1.5 mm in diameter, and are prismatic. Long septal spines, reaching nearly to the center of the corallites, are arranged in longitudinal rows. The number of rows of pores has not been positively determined. The tabulae are thin, flat, horizontal, closely arranged, from .5 to 1 mm apart.

This form is well known from the Niagaran and Guelph formations and has a wide distribution.

Favosites gothlandicus Lamarck

Favosites gothlandica Lamarck, Histoire des Animaux sans Vertèbres. 1816. 11:206

Favosites favosa? Hall, Paleontology of New York. 1852. 2:126, pl. 34A bis, fig. 5a-e

Favosites gothlandica Billings, Geology of Canada. 1863. p. 305, fig. 302; Catalogue of the Silurian Fossils of Anticosti. 1866. p. 32

Favosites gothlandica and favosa Nicholson, Paleontology Prov. of Ontario. 1875. p. 51, 52

Favosites gothlandica Nicholson, Paleontology of Ohio. 1872. 2:224

Favosites favosus Rominger, Fossil Corals. 1876. p. 20, pl. 4, fig. 1–4*a*, pl. 5, fig. 2

Favosites gothlandica Whiteaves (in part), Paleozoic Fossils. 1895. v. 3, pt 2, p. 50

Favosites gothlandica Lambe, Contrib. Canadian Paleontology. 1899. v. 4, pt 1, p. 3, pl. 1, fig. 1

With this species has been identified a fragment of a very coarse type of Favosites from Rochester. The calyxes of this specimen average between 2 and 3 mm in width, the tabulae are in the main closely arranged and the cell walls strong; the mural pores are provided with a distinct rim, as observed by others, are much larger than those of specimens referred to F. niagarensis, are arranged in three rows and set closer together than in other species. The marginal depressions of the tabulae observed in F. gothlandicus by Mr Lambe are also easily observable in this specimen. Septa have not been noticed. The walls of the corallites are striated concentrically in several places, indicating the growth lines.

To all appearances this is the same form as that described and figured by Hall as F. favosa? Goldf. from the Niagara limestone at Milwaukee [*op. cit.*]. F. favosus has been currently considered as a synonym of F. gothlandicus. Whiteaves, Lambe and Milne-Edwards and Haime do not recognize that species.

Favosites forbesi Edwards & Haime

Favosites forbesi Edwards & Haime, Polypiers Fossiles des Terr. Paleoz. 1851. p. 238

Favosites forbesi Edwards & Haime, British Fossil Corals. 1855. p. 238, pl. 60, fig. 2a–g

Favosites forbesi Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 50

Favosites basaltica Lambe (in part), Contrib. Canadian Paleontology. 1899. v. 4, pt 1, p. 8

Both at Rochester and at Shelby fragments have been obtained which differ noticeably from the other specimens in the small size of the corallites, which average not quite 1 mm in diameter. Interspersed between these are less numerous, almost circular, somewhat larger corallites. The walls are rather thin, the tabulae irregularly disposed, the pores apparently arranged in two rows and the interior of the cells provided with horizontal scales or squamulae.

It would seem to be a specimen of like character that was identified by Nicholson[1] as coming from Hespeler. In regard to the occurrence of this species, Dr Whiteaves remarks that it is not included in any of the

[1] Pal. Ontario. 2d Rep't. p. 56.

lists of fossils from the Guelph formation in the *Geology of Canada* and that he has failed to recognize it in any of the later collections received by the survey.

A comparison of the specimens from New York with the original description and figures by Edwards and Haime leaves no doubt that, if their species is valid, these may appropriately be referred to it, for they show the difference in size of cells and the average cell diameter given by those authors.

Mr Lambe, however, has lately[1] expressed the view that the specimens determined by Nicholson as F. forbesi are identical with F. basalticus Goldfuss, from which Edwards and Haime had separated it first. These authors themselves, state that there occur all transitions between the two sizes of cells, and, as this difference in our specimens is much less marked, there seems to be good reason for doubting the validity of that species (F. forbesi). In fact, Mr Lambe describes F. basalticus Goldfuss as subject to many variations in outward form and in the size and shape of the corallites. As, however, the dimensions for the corallites are given by him as varying from 2 mm, or even less, to 4 or 5 mm, while in the Guelph specimens, as in those described by Edwards and Haime, the diameter of the two kinds of cells does not quite average 1 and 2 mm; and as Mr Lambe does not cite F. basalticus from the Guelph beds but only from the Onondaga limestone of Ontario, it seems preferable still to refer these specimens to F. forbesi E. & H. Both Nicholson [*op. cit.*] and Frech[2] mention as an additional descriptive feature of this species the less sharply subcylindric form of the cells, a very marked feature of the specimens from Rochester and Shelby. The difference in the size of the cells is reported as most marked in young specimens, but becomes obliterated with progressing growth.

---

[1] Contrib. Canadian Pal. v. 4, pt 1, p. 8.

[2] Lethaea Palaeozoica, 1:422.

CLADOPORA Hall. 1852

Cladopora multipora Hall

Cladopora multipora Hall, Paleontology of New York. 1852. 2:140, pl. 39, fig. 1a-g

Favosites? multipora Nicholson, Paleontology of Ontario. 1875. p. 53

Cladopora multipora Lambe, Contrib. Canadian Paleontology. 1899. v. 4, pt 1, p. 29

This form, with the characters assigned to it by Hall and by Lambe, is quite common in the upper Shelby layer, occurring in casts in the compact dolomite which present only the tube fillings, while in the nodules the cell walls are retained. Hall reports the species from the lower part of the Lockport limestone at Lockport, and Lambe from the Niagaran of Lake Temiscamingue, Quebec; it has not been cited from the Canadian Guelph. Whitfield lists an undetermined species of Cladopora from the Guelph of Wisconsin.

The lower Shelby bed frequently contains indistinct masses of a Cladopora, which may be also referable to this species.

HALYSITES Fischer. 1813

Halysites catenularius Linne (sp.)

Tubipora catenularia Linné, Systema Naturae, ed. 12. 1767. p. 1270

Catenipora labyrinthica Goldfuss, Petrefacta Germaniae. 1826. 1:75, pl. 25, fig. 5

Halysites catenularia Edwards & Haime, British Fossil Corals. 1855. p. 270, pl. 64, fig. 1a-c

Catenipora escharoides Hall, Paleontology of New York. 1852. 2:127, pl. 35, fig. 1a-i

Halysites catenulatus Billings, in Logan's Geology of Canada. 1863. p. 305, fig. 303

Halysites catenularia Nicholson, Paleontology Prov. of Ontario. 1875. p. 51, fig. 24a, b

Halysites catenularia Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 47

Halysites catenularia Lambe, Contrib. Canadian Paleontology. 1899. v. 4, pt 2, p. 68

Specimens of this species occur in the white flint nodules at Rochester, and also in the dark dolomite, the latter in a condition altogether similar to that in which they are abundantly found throughout the upper layers of the Lockport dolomite series. The species is also common at the upper Guelph horizon near Shelby falls. In the size of the corallites and shape of the meshes the forms approach that described by Goldfuss as Catenipora labyrinthica, but the latter is considered by Whitfield[1] as a variety of Halysites catenulatus, while Whiteaves regards it as synonymous with the latter, and Lambe asserts that transitions are observable to the forms with large corallites and meshes.

Halysites catenularius, with its varieties has a very wide vertical and horizontal distribution and in Canada occurs both in the Guelph and Niagara beds.

Halysites agglomeratus Hall (sp.)

Catenipora agglomerata Hall, Geology of New York; report on fourth district. 1843. table 22, fig. 2

Catenipora agglomerata Hall, Paleontology of New York. 1852. 2:129, pl. 35 bis, fig. 2a-g

Halysites agglomerata Nicholson, Paleontology Prov. of Ontario. 1875. p. 51, fig. 24c, d and p. 66

Halysites agglomeratus Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 48

Numerous fragments consisting of rather long straight chains composed of nearly round, rather large corallites have been observed at Rochester and in the upper Shelby dolomite. Hall termed forms with this character Catenipora agglomerata. Nicholson reports the species from the Guelph of Ontario; while Lambe [*op. cit.* p. 67, 68] believes that the corallum of H. catenularius adopted the agglomerata mode of growth when its lateral expansion was interfered with or restricted, and asserts that both oval and circular corallites are found in the same corallum. These fossils are too scantily represented in the Rochester material to permit any conclusion in regard to the relation of the species in question.

[1] Geol. Wisconsin. 1882. 4:271.

There have also been observed in this material a few fragments consisting of alternating rows of large corallites with smaller rectangular ones. This variation has been reproduced by Lambe [pl. 3, fig. 2] and is regarded by him as belonging to Halysites catenularius, his specimen coming from the Niagaran of Ontario.

SYRINGOPORA Goldfuss. 1826

Syringopora infundibulum Whitfield

Plate 1, fig. 6–9

Syringopora infundibula Whitfield, Geol. Sur. Wisconsin. Annual Report. 1877. p. 79

Cystostylus infundibulus Whitfield, Geology of Wisconsin. 1882. p. 274, pl. 14, fig. 7

Cystostylus infundibulus Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 2

Cystostylus infundibulus Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 49

Syringopora infundibula Lambe, Contrib. Canadian Paleontology. 1899. v. 4, pt 1, p. 53

A considerable number of nodules of the upper Shelby Guelph are composed of a Syringopora, identical with the above species originally described by Whitfield from the Racine limestone at several points in the vicinity of Wauwatosa and Milwaukee Wis. Whiteaves subsequently reported the species from the Guelph of Hespeler, Elora and Durham.

The material in hand consists of medium sized, apparently irregular coralla, aggregations of subparallel, straight or somewhat flexuous corallites, which have an average diameter of 3 mm and are from 3 to 6 mm apart. The corallites appear externally as transversely wrinkled, sometimes abruptly thickened tubes, which multiply by lateral budding and are connected by transverse, hollow connecting processes, three or four of which are often given off radially in different directions at the same level.

The spiniform septa and funnel-shaped tabulae, characteristic of the genus, are distinctly shown in natural sections.

The writers share Mr Lambe's doubt whether this species will prove distinct from the longer established species, S. verticillata Goldfuss, the more as Rominger, in his very elaborate description of the latter,[1] points out that it is very variable in the size of the tubes and their mode of growth. The dimensions of the two species, as given by these authors, do not differ materially; the critical difference therefore rests only in the more verticillate arrangement of the connecting tubes of the one species, which, as the Shelby material suggests, may take place at the same level in one place and at different levels in other portions of the corallum, so that the latter species may be based on an extreme variation.

Should Syringopora infundibulum prove to be a synonym of S. verticillata, the form is not restricted to the Guelph but also extends down into the Lockport limestone, from which S. verticillata was described, Goldfuss's types having come from the Niagaran of Drummond island.

The only Syringopora which is described from the Niagaran of New York is S. multicaulus Hall, which is said to occur in the Lockport limestone. It appears from the original drawings of that species, that its corallites are smaller than those of S. infundibulum, and the connecting processes must have been very far apart.

HYDROZOA

STROMATOPORA Goldfuss. 1826

Stromatopora galtensis Dawson (sp.)

Plate 1, fig. 13

Coenostroma galtense Dawson, Life's Dawn on the Earth. 1875. p. 160
Coenostroma galtense Dawson, Quart. Jour. Geol. Soc. 1879. 35:52
Cf. Stromatopora constellata Hall, Paleontology of New York. 1852. 2:324
Stromatopora galtensis Nicholson, Monograph on British Stromatoporidae. 1891. p. 173
Stromatopora galtensis Whiteaves, Paleozoic Fossils. 1895. v. 2, pt 3, p. 52

Both at Rochester and in the upper horizon at Shelby occur broad, flat masses with distinct astrorhizae on the surface but with the interior mostly dolomitized. These fossils are very similar to Stromatopora

[1] Geol. Sur. Michigan. 1876. v. 3, pt 2, p. 80.

constellata Hall of the Coralline (Cobleskill) limestone, but the latter has the astrorhizae on monticules, a feature not shown in the Rochester specimens.

Sir William Dawson, in *Life's Dawn on the Earth*, p. 160, describes and figures a form from the Guelph which shows such astrorhizae without monticules, and the same closely laminated interior. Sections obtained from the Rochester specimens show that the mass is first divided into "latilaminae," then again in closely arranged laminae, through which pillars pass continuously. On the basis of these structures the specimen is considered a true Stromatopora, and as showing no noticeable differences from Dawson's Coenostroma galtense. The latter was regarded by Nicholson as probably identical with Str. typica Rosen. This author also states that Coenostroma constellata (Hall) Spencer[1], from the upper Niagaran of Hamilton Ont., does not appear distinguishable from C. galtense Daws.

This species forms numerous large concentric masses in the upper Guelph of Oak Orchard creek. A good specimen exhibiting the astrorhizae in fine preservation was also obtained from the dark crystalline limestone directly underlying this layer and associated with Enterolasma caliculus in abundance. In the lower bed occur very frequently cavities of large size, which are either entirely vacant or filled with a more or less loose mass of small, white, dolomite crystals. The shape of these cavities and the occasional retention of one or two concentric layers indicate that they originated from the dissolution of masses of Stromatopora.

CLATHRODICTYUM Nicholson & Murie. 1878

Clathrodictyum ostiolatum Nicholson

Plate 1, fig. 10–12

Stromatopora ostiolata Nicholson, An. and Mag. Nat. Hist. 1873. ser. 4. 12:90, pl. 5, fig. 1, a

Stromatopora ostiolata Nicholson, Paleontology Prov. of Ontario. 1874. pl. 1, fig. 1, 1a; 1875, p. 63

[1] Univ. State of Missouri. Bul. 1. 1884. p. 48.

Clathrodictyon (Stromatopora) ostiolatum Nicholson, Monogr. British Stromatoporidae. 1886. pt 1, p. 14

Clathrodictyon ostiolatum Nicholson, An. and Mag. Nat. Hist. 1887. ser. 5. 19: 11, pl. 3, fig. 1-3

Clathrodictyon ostiolatum Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 52

The great majority of the stromatoporoid bodies found in the dolomite of Rochester and in the upper Shelby horizon are small, often incrusting nodular masses with very fine and close lamination, a smooth or finely granulate surface and conic oscula, the latter a characteristic feature of Clathrodictyum ostiolatum. In the specimens under observation they are however not arranged distinctly, as described by Nicholson. Where the specimens are weathered, they display the characteristic nipple-shaped prominences of botryoidal appearance. Thin sections show that the specimens belong to the genus Clathrodictyum as defined by Nicholson and Murie, specially clear being the succession of calcareous laminae with intermediate vertical props or dissepiments, which do not penetrate the laminae, and the "marked off cellular compartments."

This species has hitherto been recognized only in the Guelph of Ontario.

A section presenting the same structure was observed among the museum collection of slides from a specimen ticketed as coming from the Coralline limestone at Schoharie. This section also displays distinctly "the internal cylindrical masses, each composed of laminae concentric with a long axis," observed by Nicholson in C. ostiolatum, as the internal continuation of the conic oscula. It seems, therefore, that this species is common to both the Guelph and the Coralline (Cobleskill) limestone.

BRACHIOPODA

CRANIA Retz. 1781

Crania (sp.)

Plate 4, fig. 6

An imperfect upper valve with subcentral beak and squamose concentric striae has been obtained in the white chert at Rochester but is not specifically identifiable.

MONOMERELLA Billings. 1871

Monomerella noveboracum sp. nov.

Plate 2, fig. 1–6; plate 3, fig. 1–7; plate 4, fig. 38

Shell large, thick; brachial valve subovate; pedicle valve elongate, subovate in marginal outline, the greatest width at midlength or sometimes a little in front of it, thence tapering with convex sides to a bluntly triangular erect umbo; the brachial valve broader, blunter and more curved than the pedicle valve. Pedicle valve gently convex, almost straight in profile; brachial valve strongly convex, with the greatest prominence posterior to the middle. The surface ornamentation consists of conspicuous growth lines.

Pedicle valve. Cardinal area large, broad, flat, elongate triangular, slanting obliquely inward and divergent from that of the brachial valve; subdivided longitudinally into a broad, flat, depressed median area (pedicle groove) bounded by lateral ridges and broad, smooth areal borders. Median area higher than broad, crossed by coarse, lamellose growth lines. Supracardinal slope narrow, very oblique and incurved; cardinal faces narrowly triangular, curving outward, merging into a prominent and very broad cardinal buttress, which extends nearly the entire length of the platform. Hinge transverse, much depressed. Platform well developed, extending about half the length of the valve, linguate, widening slightly anteriorly; front obliquely and obtusely angular. Umbonal chambers in most specimens very deep, wide mouthed and broad. Platform vaults not developed. Crescent distinct below the hinge line; lateral and terminal parts readily distinguishable, the latter more impressed. Transverse scars forming an oval impression between terminal crescents and platform. Platform scars finely and obliquely striated; extending apparently the full length of the umbonal chamber. Umbo-lateral scars not distinguished. A broad, low ridge extends from the anterior edge of the platform to the front margin of the valve.

Brachial valve. Shorter by nearly one third than the pedicle valve, broadly ovate, with a low, rotund beak, and transverse hinge which is strongly raised in the middle. Umbonal cavity simple, deep and broad. Platform very large, moderately elevated, extending three quarters the length of the valve, with V-shaped anterior margin, and rounded, projecting antemedian point; slightly excavate on its anterior walls, often to the extent of forming shallow platform vaults. Anterior septum a low, broad ridge, more prominent than in the pedicle valve. Crescent appearing as a well defined impression on the cardinal slope, its sides and ends curving forward and being broader and less distinct. Transverse scars distinct, subcircular depressions. Umbo-lateral scars rather faint and small, lying at the sides of the umbonal cavities. Both median and anterior scars of the platform sharply defined, depressed below the lateral scars, which are obliquely striate.

Horizon. Lower Shelby dolomite, Oak Orchard creek.

This large and ponderous shell has been found only at the locality cited, but is there in very great abundance; it is surpassed in number of individuals only by Trematonotus alpheus and Poterioceras sauridens. Some of the specimens are impressions of the exterior of the shell.

This species is in many respects closely related to M. prisca Billings, whose characters have been described by several authors,[1] though nothing is yet known of its exterior. So obvious is this relationship that M. noveboracum is evidently a local, more prosperous development of that widespread Guelph species. It is, however, sufficiently different to necessitate distinction. It is larger, the specimens attaining a length of 80 mm and a width of 65 mm; the umbonal cavities are, in most specimens, absolutely and relatively much longer, some attaining a length of 35 mm; the umbo of the pedicle valve however is less acutely, but more broadly tapering; the cardinal area, pedicle surface and areal borders are therefore relatively broader. The platform of the brachial valve extends farther anteriorly, and the anterior septa of both valves extend as broad distinct

[1] *See* Billings, Paleozoic Fossils. Nicholson Pal. Ontario. Whiteaves. Davidson. Hall & Clarke, Pal. N. Y. v. 8, pt 1.

ridges to the anterior margin. In size this form rivals M. durhamensis Whiteaves, which however is readily distinguished by its extremely large and prominent beaks in both valves. In some features the species is still more closely related to M. walmstedti Dav. & King than to M. prisca. Monomerella walmstedti is a species from the corresponding beds of Gothland, which has a similar development of the umbo and cardinal region, but possesses a more convex umbo in the pedicle valve. Davidson points out the close relationship of that species with M. prisca. Monomerella noveboracum shows relationship also, in the character of its brachial valve, with M. kingi Hall & Clarke, from the Niagaran dolomites of Hawthorne Ill.[1] This Shelby species is the only representative of the family Trimerellidae yet found in the State of New York.

DALMANELLA Hall & Clarke. 1892

Dalmanella cf. elegantula Dalman (sp.)

Plate 4, fig. 9

For synonomy of Orthis elegantula see Hall & Clarke, Paleontology of New York. 1892. v. 8, pt 1, p. 207, and Davidson, Monogr. British Silurian Brachiopoda.

Some small and incomplete specimens of immature individuals found at Rochester and in the upper Guelph at Shelby suggest affinity with the specific type of Dalmanella elegantula in the relative convexity of the two valves and the character of the surface sculpture so far as retained.

The presence of casts of the interior of two species of Orthis in the Guelph of Ontario is mentioned by Whiteaves; and it is also cited from the Guelph beds at Cedarburg Wis.[2]

---

[1] *See* Pal. N. Y. v. 8, pt 1, pl. 4D, fig. 2.

[2] Geol. Wisconsin, 2:379.

Dalmanella cf. hybrida Sowerby (sp.)

Plate 4, fig. 7, 8

Orthis hybrida Sowerby, in Murchison's Silurian System. 1839. p. 630, pl. 13, fig. 11

Orthis hybrida Hall, Paleontology of New York. 1852. 2: 253, pl. 52, fig. 4a-c; and authors generally

A single depauperated ventral valve with the characters of this species has been observed in the chert nodules at Rochester. Orthis hybrida is found at various outcrops of the Racine beds of Wisconsin, but has not been elsewhere identified in typical Guelph rocks.

LEPTAENA Dalman. 1828

Leptaena rhomboidalis Wilckens

For synonymy *see* Schuchert, United States Geol. Sur. Bul. 87, p. 240

Under the name L. depressa, Hall[1] reports this species as common in the Rochester shale and rare in the Lockport limestone. A single small specimen has been obtained from the lower Shelby dolomite. As this cosmopolitan shell is not mentioned from the Guelph of Canada or Ohio, in Wisconsin has been reported only from one locality of that formation, and is entirely absent from the upper horizon at Shelby and Rochester, it evidently found very uncongenial conditions in the Guelph basin.

SPIRIFER Sowerby. 1815

Spirifer crispus (Hisinger) Hall

Plate 4, fig. 10-20

Spirifer crispus Hall, Paleontology of New York. 1852. 2: 328, pl. 74, fig. 9a-h

The Spirifers occurring in the upper Shelby horizon both at Rochester and Oak Orchard creek present features of considerable interest and significance. They naturally fall into two groups, one of small and broad forms, of which numerous specimens have been observed, the other of larger and relatively longer form, occurring in but restricted number.

The smaller of these is identical in expression with the Sp. crispus described by Hall from the Coralline (Cobleskill) limestone. All the

[1] Pal. N. Y. 2: 258.

specimens before us from Rochester and Shelby, as well as those described from the Coralline limestone of eastern New York, agree in having the plications obsolete, while they distinctly show the fine concentric striae with minutely setose edges, characteristic of that species. Hall expressly states that these Coralline forms possess no distinctive features from the Niagaran specimens of this very variable species, and he therefore had "no hesitation in referring the specimens from the Niagara and the Coralline limestone to the same species." At the same time it seems that there is, in the progress of this species, a decided tendency toward the development of smooth forms, as is evinced by the replacing of the strongly plicated shells of the Rochester shales by the smooth forms in the Coralline and the Guelph dolomites.

In the upper horizon on Oak Orchard creek a few faintly ribbed specimens indicate the derivation of the smooth mutation from the typically costate form. But they also contrast strongly with the highly plicate forms found abundantly in a fossiliferous limestone layer in the Lockport limestone above the lower Shelby bed and among which there are found no smooth specimens. In the lower fauna Spirifer is entirely absent.

A similar smooth expression of Spirifer crispus in the dolomites of the Manlius horizon has been recently observed by A. W. Grabau in western New York and described as Spirifer eriensis.[1] Dr Grabau emphasizes the very close relation of his form with the Coralline (Cobleskill) limestone variety of Spirifer crispus for which he has proposed the varietal term corallinensis. These smooth varieties of the species thus extend to the top of the Siluric.

The larger form is too robust to be considered a variety of Sp. crispus. It is also distinguished by the subtriangular outline, and the long extended beak of the pedicle valve. The sinus is extremely shallow and can hardly be characterized as flanked by folds. Parts of the shell adhering to the cast exhibit concentric imbricating lines. A comparison with Sp. bicostatus at once suggests itself, but the form from the Guelph dolomite is still larger than the typical forms of that species, has the extremities

[1] Geol. Soc. Am. Bul. 11. 1900. p. 366. pl. 21, fig. 2a, b.

more angular and lacks the distinct folds on either side of the sinus. In these features, differential from Sp. bicostatus, it agrees with a large form which is described and figured by Hall from the Coralline limestone as "Spirifer sp."[1] and is stated to be closely allied to Sp. crispus but differing in size. This agreement extends even to four of the five very low costae observed on the casts from the Coralline limestone of Schoharie. The form from the Guelph dolomite [see plate 4, fig. 21, 22] unites the characters of Sp. bicostatus with this unnamed Spirifer. Sp. bicostatus in New York is only known from its original locality, Vernon Center in Oneida county, in the eastern extension of the Lockport limestone. It seems, therefore, probable that this group of forms is restricted to the Guelph dolomite, the eastern extension of the Lockport limestone in the center of the State, where the stratigraphic relations are not fully known, and to the Coralline limestone.

Whiteaves[2] states that the characters of two ventral valves from the Guelph at Durham Ont. are so similar to those of Sp. bicostatus, as described and figured by Hall, that it is possible these should be referred to that species rather than to Sp. plicatellus. This species and its variety, radiatus, replace Spirifer crispus in the western Racine and Guelph beds, from which the latter has not been reported.

WHITFIELDELLA Hall & Clarke. 1892

Whitfieldella nitida Hall

Plate 4, fig. 32-37

Atrypa nitida Hall, Geology of New York; rep't on fourth dist. 1843. table of organic remains 13, fig. 5

This is the most common brachiopod in the higher horizon of the Guelph dolomite at Shelby and at Rochester. Most of the examples are relatively small, in this feature approaching more nearly the New York Niagaran than the Waldron, Indiana, specimens. One exhibits lateral folds, an occurrence at times observable in the Waldron shell.

---

[1] Pal. N. Y. 2: 327, pl. 74, fig. 7, 8a-d.

[2] Paleozoic Fossils, v. 3, pt 2, p. 62.

Whitfieldella nitida Hall is not reported from the Guelph limestone of Canada. It is there replaced by W. hyale Billings (sp.) which is said to be abundant at all localities. The Rochester specimens are distinctively different from the latter, which is broader shouldered, has its greatest width more posteriorly and is less convex. The majority of them however have a broader outline than the typical Lockport specimens, a feature in which they approach W. nucleolata Hall, the Coralline limestone representative of the genus, but they still differ from the latter in not having a distinct sinus and indentation of the anterior margin. Hall[1] makes the interesting statement that these broader forms occur in the Lockport limestone of eastern Wayne county and in Cayuga county, that they have not the full development which the same species has in the shale at Rochester, and that they are not easily distinguished from the less characteristic specimens of W. nucleolata. The forms from the Guelph dolomite here considered seem to agree most closely with these eastern shells from the Coralline limestone.

Whitfieldella hyale is reported by Whitfield from the Wisconsin Racine and Guelph beds, while W. nitida is mentioned only from the Racine beds. As the latter species has not been cited from the Guelph of Ohio it appears to be present in that formation only in New York. It is entirely absent from the lower horizon at Shelby.

CAMAROTOECHIA Hall & Clarke. 1892

Camarotoechia (?) neglecta Hall (sp.)

Plate 4, fig. 28–31

Atrypa neglecta Hall, Paleontology of New York. 1852. 2: 274, pl. 57, fig. 1a-p

Rhynchonella neglecta Hall, N. Y. State Mus. 28th An. Rep't. 1879. p. 162, pl. 26, fig. 1–6

Rhynchonella neglecta Beecher & Clarke, N. Y. State Mus. Mem. 1. 1889. p. 37, pl. 4, fig. 3, 6–8

Characteristic specimens of this species are quite common in the white chert of the Rochester and the upper Shelby dolomite. They seem to

[1] Pal. N. Y. 2: 329.

agree more closely with the shell as it occurs in the Rochester shales of New York than with the representatives of the species at Waldron Ind., the latter having the plications less blunt and the sinus more pronounced.

The species has a wide distribution in the Niagaran beds, and is listed from some of the Guelph localities in Wisconsin. It has not been found in the Canadian Guelph. These specimens do not approach Rhynchonella pisa Hall & Whitfield, the only species of the genus recognized by Whiteaves in the Guelph fauna of Ontario [*op. cit.* 1895. p. 63].

Camarotoechia (?) **indianensis** Hall

Plate 4, fig. 26, 27

Rhynchonella indianensis Hall, Albany Institute. Trans. 1863. 4: 215

Rhynchonella indianensis Hall, N. Y. State Mus. 28th An. Rep't. 1879. p. 163, pl. 26, fig. 12–22

Rhynchonella indianensis Beecher & Clarke, N. Y. State Mus. Mem. 1. 1889. p. 42, pl. 3, fig. 17–28

This species is represented by a few specimens from the Rochester and Shelby horizons.

It, as well as C. (?) neglecta, is decidedly more common in the chert nodules of the upper Shelby dolomite than at Rochester. In the lower Shelby bed it is still less frequently observed.

Camarotoechia (?) indianensis occurs freely in the Niagaran at Waldron Ind., and at Louisville Ky., but has not been recorded in the Niagaran beds of New York.

RHYNCHOTRETA Hall. 1879

Rhynchotreta cuneata americana Hall

Plate 4, fig. 23–25

Atrypa cuneata Hall (non Dalman), Geology of New York; rep't on fourth dist. 1843. table of organic remains 13, fig. 3, 4

For synonomy *see* Hall & Clarke, Pal. N. Y. v. 8, pt 2, p. 185

In the upper Guelph of the Oak Orchard creek section a single normal specimen of this shell was obtained, exhibiting the cuneiform outline, concave cardinal slopes and angular plications curving outward toward the lateral margins. The plications are not quite as prominent as in the typical Rochester shale specimens.

This shell is widely distributed in the Niagaran of North America, where it occurs in the Rochester shale, Waldron and Osgood beds; but it seems to be absent from the higher beds of the Niagaran, and has not been observed before in the Guelph. Its appearance, though extremely rare, in the Guelph of Oak Orchard creek, is hence worthy of notice.

LAMELLIBRANCHIATA

MYTILARCA Hall. 1870

Mytilarca eduliformis sp. nov.

Plate 5, fig. 8-10

Shells rather small, valves ovate acuminate, very narrow at the beaks, with slightly concave anterior margins, broadly rounded at the base and at the postlateral extremity, the posterior cardinal margin being straight. Beaks narrow, subacute and directed forward. Surface elevated along the umbonal ridge which runs from the beaks to the antelateral curve. From this ridge the surface is abruptly incurved and almost vertical. Posteriorly the slope is very much more gradual, and the ridge loses its prominence over the basal region. The ornament is not well preserved, but patches of the shell show fine concentric lines without other modification.

Dimensions. This description is based on two specimens, one of which retains the valves in normal juxtaposition. The valves have a length of 20 mm and a width at three fourths their length of 15 mm.

Observations. This shell has a noteworthy resemblance in form and contour to a small example of the living Mytilus edulis. It is provisionally referred to the genus Mytilarca, though some generic distinction may eventually be found between this and the typical upper Devonic representative of the genus. The only American Upper Siluric species which has heretofore been referred to Mytilarca is the M. sigillum Hall from the Niagaran at Waldron Ind.

Mytilarca eduliformis is from the white chert at Rochester.

Mytilarca acutirostrum Hall

Plate 5, fig. 11, 12

Ambonychia acutirostra Hall. N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 336, pl. 14, fig. 2

Ambonychia acutirostra Hall. N. Y. State Mus. 28th An. Rep't. 1879. p. 171, pl. 7, fig. 12

Several internal casts of this shell, rather below medium size, were obtained from the lower bed at Shelby. They are characterized by their full, relatively long valves with produced, acute beaks, straight, short cardinal line, straight and slightly convex anterior margin which extends almost the whole length of the valve, very convex basal and less rounded, almost straight and oblique posterior margin, which forms an obtuse angle with the short wing of the posterior cardinal region. The umbo is very prominent and convex; from it a slightly elevated and distinct umbonal ridge extends to the anterobasal angle. Thence the valve slopes evenly toward the posterior margin, and more abruptly toward the anterior margin. No muscular impression has been observed on the somewhat incrusted casts. The impression of a distinct, narrow ligamental area, extending the full length of the cardinal line, and of two oblique lateral teeth at the extreme posterior end of the cardinal line are noticeable.

Observations. This form differs from the foregoing both in size, and in its slightly convex anterior margin. We have identified these shells with Ambonychia acutirostrum, a species which was described by Hall from the limestone of the age of the Niagaran group, near Milwaukee. In the 28th report of the New York State Museum it is said to be associated, in Wisconsin and Illinois, with Ambonychia aphaea, described from Wauwatosa Wis. and Bridgeport Ill. Professor Whitfield[1] cites the species from the Racine beds of Racine, Greenfield, Waukesha and Wauwatosa, and from the Guelph beds of Cedarburg, it being the only Guelph lamellibranch mentioned besides Megalomus canadensis. It has not been reported from the Canadian Guelph.

---

[1] Geol. Wisconsin, 2: 372–79.

Hall referred his species with doubt to Ambonychia. Ulrich[1] refers the form to Mytilarca, a view which is verified by the evidence of lateral teeth.

Mytilarca acutirostrum is, as indicated by Hall, very similar to Myalina mytiliformis Hall from the gray Clinton limestone of New York. From the latter species M. acutirostrum was said to differ in its more acute beak and relatively greater width. In regard to width our specimens are intermediate between the two species, but in the character of its beak it is more like the western Guelph form. Foerste[2] has described still another Clinton form as Mytilarca mytiliformis, but as Hall's Ambonychia mytiliformis is a Mytilarca [p. 560 of same paper] the species should be renamed (Myt. foerstei *nom. propos.*).

PTERINEA Goldfuss. 1826

Pterinea subplana Hall (sp.)

Plate 5, fig. 4

Avicula subplana Hall, Paleontology of New York. 1852. 2:283, pl. 59, fig. 3a, 3b, 3c

Internal casts from the Rochester chert and the upper horizon at Shelby indicate a depressed right valve with long straight hinge line, beak subanterior and not prominent, slightly projecting above the hinge line. The ear is short and apparently rounded, the posterior wing is much extended, obliquely truncated and set off from the body of the valve by a low and broad depression. A long narrow cartilage pit extends from the beak three fourths the length of the posterior cardinal line and parallel to it. Surface with concentric lines.

The left valve shows a greater convexity and similar outline.

Avicula subplana is a Rochester shale species which has not been reported from the Guelph of Canada or the Interior.

---

[1] Geol. Sur. Minnesota, v. 3, pt 2, p. 494.

[2] Geol. Ohio, 7:559.

Pterinea undata Hall (sp.)

Plate 5, fig. 6

Avicula undata Hall, Paleontology of New York. 1852. 2:283, pl. 59, fig. 2

A single cast of the left valve. This, in its oblique form, short hinge line, prominent umbo, and much elevated, rounded umbonal ridge, agrees closely with this shell as described by Hall from the Rochester shale. The concentric undulations are also indicated on the cast.

We are not aware that this species has been obtained in either the Canadian or western Guelph. The specimen described is from the upper Shelby dolomite.

CONOCARDIUM Bronn. 1835

Conocardium sp.

Plate 5, fig. 7

Several small Conocardia, poorly preserved, have been noted in the Guelph at Rochester. These indicate a shell somewhat similar to the little known C. ornatum Winchell & Marcy[1] from the Niagaran dolomites of Illinois, but seem to lack the sharp ornamentation of the umbonal ridge. This ridge is greatly elevated, and the body of the shell is short, so that both anterior and posterior slopes are steep, but the former is much the more abrupt and is concave. The surface of the posterior slope bears nine to 10 ribs with five to six on the anterior.

Whiteaves mentions the frequent occurrence of a small Conocardium in the Guelph at Durham and thinks it probably an undetermined species, but gives no clue to its characters.

MODIOLOPSIS Hall. 1847

Cf. **Modiolopsis subalata?** Hall

Modiolopsis subalatus? Hall, Paleontology of New York. 1852. 2:285, pl. 59, fig. 7

A somewhat incomplete cast of both valves, from the upper Guelph at Oak Orchard creek, exhibits the characteristics of the Rochester shale

[1] Boston Soc. Nat. Hist. Mem. 1. 1866. p. 111, pl. 2, fig. 15.

specimens, which were identified with qualification by Hall with the Clinton form of his species. It differs to some extent in possessing a slight depression extending forward from the umbo, which is not mentioned in the description of M. subalata.

GASTROPODA

BELLEROPHON Montfort. 1808

Bellerophon shelbiensis sp. nov.

Plate 5, fig. 13–19

Bucania stigmosa? (Hall) Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 34, pl. 5, fig. 3, 3a; pl. 8, fig. 4

Not Bucania stigmosa Hall, Paleontology of New York. 1852. 2:92, pl. 28, fig. 8, 8a-e

Dr Whiteaves has figured from the Guelph of Galt internal casts of a symmetric shell which he refers to as Bucania stigmosa? Hall. With regard to these he says:

These agree perfectly with similar but better preserved casts from the Niagara formation at Grimsby Ont., in the museum of the survey, which have been identified with B. stigmosa by E. Billings, but in the absence of any knowledge of the shell of the Galt specimens their determination must be regarded as doubtful.

A considerable number of similar casts from Shelby leaves no doubt that this form is well distinguished from Hall's Clinton species, Bucania stigmosa, for, besides attaining a size thrice as large, it distinctly differs in the cross section of its whorls, which are more convex on the dorsal and more deeply concave on the ventral side, the whorls embracing somewhat more than in the Clinton species.

Diagnosis. Shell somewhat below medium size, having an average diameter of 15 mm and rarely attaining more than 25 mm; consisting of about three volutions which increase but slowly in size; whorls embracing about one third of the hight, lowly subtriangular in cross section, with a dorsal carina which, bearing the slit-band, becomes more prominent as growth advances. The sides are convex, full or evenly rounded in young stages, becoming more gently convex in later growth, abruptly sloping to the umbilicus, which appears relatively large on internal casts but as indicated by casts of the exterior was actually very small, the shell being considerably thickened along the umbilical edge. Aperture but little expanded laterally, broadly triangular reniform, outer lip with a shallow sinus, inner lip not observed. Surface ornamentation not sufficiently known, apparently consisting only of growth lines.

Horizon. Lower Shelby dolomite.

As Whiteaves reports this species from the Guelph at Galt and from the Niagaran formation at Grimsby Ont., it suggests itself that also in Canada this form may appear in an early manifestation of the Guelph fauna, as in New York. From B. tuber Hall, the only other species of Bellerophon described from the Niagaran, B. shelbiensis differs in the laterally more expanded aperture and the deeper sinus of the outer lip. We have no record of the occurrence of other species of true Bellerophon in the American Niagaran; and, in view of the large representation of the genus in the Lower Siluric and Devonic, it is evident that the facies in which this genus flourished in Niagaran time has not yet been brought to notice.

Though this shell was identified by Billings and Whiteaves with a species of Bucania, we feel justified in referring the form to Bellerophon. In the differentiation of Bellerophon and Bucania, the character of the surface sculpture is considered by various writers (de Koninck, Waagen, Koken) of critical importance; and this feature is not clearly exhibited in the Shelby material, but the character of the umbilicus, and of the section of the whorls is distinctly bellerophontid. The umbilicus has been described above; and the section is not flat on the dorsum and angulated at the edge, as in the generic type of Bucania, but rounded and embracing with the edges. All through the literature of paleozoic gastropods the distinction of Hall's genus Bucania from Bellerophon has been involved in much uncertainty and doubt. Professor Hall did not originally define the genus sufficiently to avoid misconception. It seems evident that, as suggested by Koken and Ulrich, Hall used B. expansa as type of his genus, but, as he described B. sulcatina as the first species of the genus, this had to be taken as typical, and B. expansa has been construed as a species of Roemer's later genus, Salpingostoma. De Koninck and Waagen, in the endeavor to define the genus more clearly, based it on the presence of revolving lines. Koken, who intimates that Hall when defining the genus evidently had before him species of the subsequently established genera, Salpingostoma and Trematonotus, bases the genus on B. sulcatina and defines it by its flat dorsum, wide umbilicus, slightly expanded peristome and coarse, wrinkled revolving lines, crossed and interrupted by transverse lamellae. He also includes in this genus the Devonic and Carbonic species bearing these characters, and is followed in this view by Clarke, who has described a Devonic Bucania.[1] Hall, on the other hand, states[2] that there are no Bucanias younger than the B. profunda (which is a Trematonotus) of the Helderbergian, so that there obviously exists a considerable difference between Hall's and Koken's conceptions of Bucania. Lindström, in his work on the Silurian Gastropoda of Gothland, does not recognize the genus at all, but unites it with Bellerophon, on the ground that it has the wide aperture in common with most of the Bellerophons, and that the wide umbilicus and the spiral striae are not of enough importance to be of value as generic distinctions. The claim of Fischer[3] and Lindström, that Hall ultimately abandoned the generic term Bucania and reunited the form with Bellerophon, seems to be based on a misconception, as Hall, in *Paleontology of New York*, v. 5, states only that the B. devonica is probably not Bucania, and that this genus does not enter the Devonic.

In contrast with Lindström's extreme conservatism, Ulrich places Bellerophon and Bucania in different families, the Bellerophontidae and Bucaniidae. He recalls Koken's observation as to the differences in the aperture and surface sculpture between the "Sulcatina typus" and the Devonic and Carbonic species, and holds the opinion that Bucania, in its restricted sense, is "strictly a Silurian genus and possibly not even repre-

[1] Paleozoic Faunas of Parà.

[2] Pal. N. Y. v. 5, pt 2.

[3] Manuel de Conchyliologie, p. 854.

sented in the upper Silurian." The spirally ribbed later species are united by this author under a new generic term, Bucanopsis. As these forms do not differ from Bellerophon in other features than the cancelation of the surface, the genus is placed among the Bellerophontidae. To Bucanopsis are referred the well known Hamilton species Bell. leda and B. lyra. If our Guelph species should prove to be ornamented with spiral lines, it would also be referable to Bucanopsis.

TREMATONOTUS Hall. 1868 (emend.)

Trematonotus alpheus Hall

Plate 5, fig. 20-23; plate 6, fig. 1-9

Tremanotus alpheus Hall, separately printed in advance for N. Y. State Cab. Nat. Hist. 18th An. Rep't. 1865. p. 43

Tremanotus alpheus Hall, N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 347, pl. 15, fig. 23, 24

Tremanotis alpheus McChesney, Chicago Acad. Sciences. Trans. 1859. v. 1, pl. 8, fig. 4a, b

Bellerophon (Bucania) perforatus Winchell & Marcy, Boston Soc. Nat. Hist. Mem. 1866. v. 1, no. 1, p. 108

Tremanotus alpheus Whitfield, Geol. Sur. Ohio. v. 2, Paleontology, p. 145, pl. 8, fig. 1

Tremanotus angustatus Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 70

Not Bucania chicagoensis McChesney, Description of New Species of Fossil from Paleozoic Rocks of Western States (advance extr. Chicago Acad. Sci. Trans. v. 1). 1859. p. 69, pl. 8, fig. 5a, b (plate published at a later date)

Probably Bucania angustata Hall, Paleontology of New York. 1852. 2:349, pl. 84, fig. 7a-d

Of this remarkable type of symmetric gastropod structure, three specimens have been observed in the material from the Guelph horizon at Rochester, one from Newman's quarry, one among the fossils from the same horizon (upper Shelby) at Oak Orchard creek and not less than 100 internal and external molds in the collection from the lower Shelby bed. Two of the Rochester specimens are in a fair state of preservation, and most of the lower Shelby examples are excellently preserved, much better than are the originals of the species, as they retain the surface markings and the apertural expansion in neanic, ephebic and gerontic conditions. They permit, therefore, the addition of some important facts to the description of that species.

Description. Shell subdiscoid, involute; whorls three to four; in section subcircular to roundly elliptic, with inner groove, the outer whorl being impressed on the inner. The aperture has a flaring lip, which is turned outward by rather abrupt curvature till it stands at right angles to the axis of the body whorl and is then reflected. This lip attains, in one specimen, in its longer axis, a length of 65 mm, and in its minor one a length of 50 mm. The inner lip was folded back over the last whorl to such an extent that it covered about one third of it.

Most transverse sections of the shell show symmetric enrolment of the whorls, but a few, undisturbed in their growth, evince indications of asymmetry in early growth. This condition, however, has not been demonstrated a normal feature.

The degree of involution seems to have been subject to some variation, as there is some difference in the specimens in the width of the umbilicus at full growth. In the great majority, however, the volutions embrace sufficiently to make the umbilicus relatively small. The whorls are abruptly convex around the umbilicus.

The surface ornamentation consists of about 20 coarse flat topped revolving ridges, on each side from keel to umbilicus; these are separated by equally wide furrows with generally a smaller rib between them. The ribs have a somewhat irregular undulating course, periodically swelling and contracting, giving the surface a peculiarly irregular appearance. These irregularities are caused by intersection with incised concentric lines, beyond which the revolving ribs appear out of position. The ribs are also intersected by broad, transverse folds, which curve obliquely backward across the whorls. These are most distinct near the umbilicus and become faint near the dorsal keel. On the outside of the peristome the ribs become quite abruptly coarser; and in gerontic specimens they change, on the outer lip, into broader, less keeled ribs, and the smaller intercalated ribs disappear entirely, so that in such individuals the peristome bears a very distinct ornamentation. Casts of the interior surface of the shell demonstrate that the latter was almost entirely smooth, and bore no other traces of the highly sculptured surface ornament than occasional very faint, low, revolving undulations or obscure indications of the transverse ribs.

The transverse folds by which the surface sculpture is crossed, are apparently the results of the repeated production and absorption of the expanded mouth. The development of the latter at more or less frequent intervals is a noteworthy difference from the earlier Siluric forms referred by Ulrich to the genus Salpingostoma F. Roemer,[1] the fundamental distinction, however, being in the character of the perforations on the slit-band, which in Trematonotus are elliptic, with everted margins, while in Salpingostoma the perforation is a single long and continuous but inclosed slit.

In T. alpheus the perforations are located on an elevated, narrow, dorsal keel, which does not extend on the peristome, but is there followed by a depression extending to the margin of the outer lip. To the keel corresponded a deep groove on the inside of the shell. The groove and perforations disappear where the inner lip of the peristome reclines on the penultimate volution, and closes the perforations. The number of perforations left open varies from six to nine.

Dimensions. A large specimen with gerontic characters measures from the outer edge of the aperture to the dorsal side of the early part of the ultimate volution, 75 mm. The major diameter of the aperture was about 57 mm and the vertical diameter of the shell 51 mm.

Observations. The genus Tremanotus (*recte* Trematonotus Fischer) was erected by Hall as above cited for this species, the original specimens being from the Chicago limestone. Professor Hall had earlier described from the Guelph formation at Galt Bucania angustata,[2] a species

[1] The type of this genus, S. macrostoma, is a middle Devonic shell. It is yet to be demonstrated that the Trenton shells which have been referred to it are congeneric with this species.

[2] Pal. N. Y. 1852. 2:349, pl. 84, fig. 6a, b.

based on internal casts in a rather inferior state of preservation. Dr Whiteaves holds this fossil to be identical with T. alpheus, and while this is probably true, conclusive evidence of the exterior and apertural characters of the Canadian Guelph specimens still fails us, and we have no recourse except to continue the recognition of the term here adopted. It has been contended that McChesney's name, Bucania chicagoensis, has priority over T. alpheus, the description having been published in advance of that of the latter, but it was unaccompanied by illustration at its first description, and the original figure shows it to be a much larger and more widely umbilicated shell. On the same plate with this figure are others referred by McChesney to T. alpheus.

Whiteaves was inclined to believe that all three may be found identical with T. dilatatus Sowerby, because Billings had identified a specimen from the Niagaran of L'Anse á la Vieille on the Bay of Chaleurs, and another from "Division 2" of the Anticosti group, with that species. A comparison of our material with Sowerby's excellent figures and McCoy's more complete description convinces us that the form in hand is distinct from the Ludlow and Wenlock species, for, while the dimensions and the surface sculpture appear to be alike in the two, the whorl section is markedly distinct. This is evinced by the flat dorsum of the whorls and the broad but low cast of the aperture in Sowerby's figure, and by McCoy's statement[1] that the section of each whorl is twice as wide as long. In the specimens of T. alpheus from Shelby, the proportion of width to hight is, in the inner volutions, as 3 : 2, in the ephebic volution however, only as 5 : 4. This volution is, therefore, relatively much higher than in the English form. In this character our material agrees fully with Hall's type of T. alpheus. On the other hand, the single specimen which served as representative of this species in Hall & Whitfield's description of its occurrence in Ohio,[2] possesses lower volutions, it being described as having the lateral diameter of its whorls nearly double that of the dorsoventral

[1] British Paleozoic Fossils, p. 309.

[2] Pal. Ohio, 2 : 145.

diameter. It is also much more widely umbilicated and the outer volutions embrace the inner ones for about one half their width. As the large series of New York specimens are quite uniform in their relatively high volutions, it seems to us that the specimen from Genoa O., represents another type and approaches Trematonotus chicagoensis McChesney, which (in its restricted definition) possesses only low volutions and a very wide umbilicus.

Trematonotus alpheus is very nearly related to T. longitudinalis Lindström, which has cylindric volutions, a like surface ornamentation and an equal degree of umbilication. It differs however in having a relatively much greater expansion of the lateral peristome and shorter outer lip; and T. alpheus does not exhibit the distinct dorsal ridge of the outer lip in continuation of the slit band, and the corresponding sinuation of the margin of the outer lip. Lindström regarded his species most nearly related to T. trigonostoma Hall & Whitfield, evidently because only incomplete casts of the more closely related T. alpheus, had been figured at the time of his study.

The peculiar preservation of the majority of the specimens as molds is evidently the same as in the Gothland material, for the principal figure given by Lindström illustrates the same mode of preservation. Failure to properly interpret this figure led Koken to the misconception that it represents the inside of the aperture, and he has stated,[1] in his elaborate research *Ueber die Entwickelung der Gastropoden vom Cambrium bis zur Trias*, that Trematonotus has on the aperture internal folds, which show no relation to the outside sculpture. Our material shows how easily this misconception could arise. The wrinkled sculpture is actually that of the outside of the aperture, and the inside of the aperture was nearly smooth.

We need not emphasize here the significance of the discovery of this species in New York at a horizon corresponding to its occurrence in Canada and Illinois. We fail to find the form cited among the Guelph fossils of Wisconsin; among the Racine fossils, however, there is listed

[1]Neues Jahrb. Beilagebnd. 1888–89. p. 386.

Bucania angusta[1] (in error for angustata), which probably is a synonym of T. alpheus, as stated above. Hall also[2] mentions the occurrence of Bucania angustata at Racine, stating that the specimen is indistinguishable from the species occurring at Galt. The early appearance of this form in the Racine beds of Wisconsin seems to us quite significant in view of the abundant appearance of T. alpheus in the lower Shelby dolomite.

DIAPHOROSTOMA Fischer. 1885

Diaphorostoma niagarense Hall (sp.)

Plate 10, fig. 14–16

Platyostoma niagarensis Hall, Paleontology of New York. 1852. 2: 287, pl. 60, fig. 1a–v

Two very young specimens from Rochester and four equally small ones from the upper Guelph at Shelby, exhibit in profile, shape of volutions, aperture and surface markings, the characteristic features of D. niagarense. The largest of these specimens possesses a broad, shallow depression on the middle of the body whorl, where the growth lines are distinctly sinuate.

This form occurs in various exposures of the Rochester shale within the State of New York, and also in more robust development at Waldron Ind. It is not reported from the Guelph formation, nor has it been recognized from the Coralline limestone of eastern New York.

POLEUMITA nom. nov.

In 1876 Munier-Chalmas introduced[3] the generic term Oriostoma (–Horiostoma) for certain French Lower Devonic shells which have been more fully explicated by Oehlert and Barrois. Lindström,[4] after comparison of the Gothland shells with the French species regarded both congeneric, admitting however a dissimilarity in the abundant presence

[1] Geol. Wisconsin, 2:375.

[2] N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 346.

[3] Jour. de Conchyliologie, 16 : 103.

[4] The Silurian Gastropoda and Pteropoda of Gotland.

of opercula among the Swedish shells, which have not been observed with typical species of Horiostoma — an argument to which little weight can be given. Horiostoma, however, was described as having the final whorl free about the aperture though only for a short distance, a feature which is not specifically noted by Lindström for the Siluric species. Koken has expressed[1] the belief that there is a palpable difference in the typical Horiostoma (H. konincki Oehlert) and the species referred by Lindström to that genus, and regards the former as related to the capulids, while the latter are derivable by easy stages from Euomphalus. Koken has proposed to denominate the Swedish Horiostomas by the term Polytropis de Koninck, introduced for Carbonic shells in 1881. As this name however was employed by Sandberger in 1874 for an entirely different group of Gastropods, its use is not permissible.

Koken has not made out a very forcible argument for the distinction of these genera; and our impulse is to array the species from the Guelph which we are about to discuss, under Munier-Chalmas's genus. Admitting however the dependability of Koken's inferences, there remains no place here for the term Polytropis which he has applied to the Swedish species and which Whiteaves, following that proposition, has also employed for species of the Guelph of Ontario. Hence we have introduced the name Poleumita, basing its characters as a genus on the species which is most abundant in the Guelph horizon at Rochester, P. scamnata.

Poleumita scamnata sp. nov.

Plate 9, fig. 1–8, 10, 12–15

Shell turbinate, with spire more or less depressed, there being in this respect a notable variation among the individuals; whorls five to six, subcircular to subovate in section, very slightly overlapped by succeeding volutions, on the contrary separated by a broad and deep suture, above which the whorls stand up prominently. The form of the whorl does not vary materially with growth, but the suture and its excavated or flattened outer slope become more conspicuous though relatively no larger on the later

[1] Neues Jahrb. für Mineral. Beilageband 6. 1889. p. 425, 477.

whorls. Near the aperture the last whorl is distinctly free from the preceding. Aperture circular, not thickened; umbilicus round and deep. Surface bearing a series of about 20 fine, elevated, flat topped and continuous ridges, of which about 15 are on the outer and upper slope of the whorl. These are separated, except near the suture, by flat grooves of subequal size and wider than the ridges.

The excavated slope to the suture occupies the width of two or three of these intervals, and on this faint traces of the revolving lines may sometimes be observed. On the umbilical surface the revolving ridges are more prominent than elsewhere and more widely separated. At times these ridges appear to be faintly grooved at their summits. All these ridges are crossed by fine, imbricating or tilelike, concentric striae which are caught back at the summits and are most sharply evident in the intervening furrows. These lines are specially noticeable over the sutural slope where they are faintly festooned by the obsolete revolving lines, and again toward the umbilicus. At the aperture of adult shells they are closely crowded.

Dimensions. A typical example of the species measures as follows: hight (apex to lower margin of aperture) 28 mm; basal diameter 31 mm, i. e. a ratio in these dimensions of nearly 1:1. Another example has a hight of 20 mm, basal diameter of 35, a ratio of 4:7, indicating a very depressed spire.

Observations. This beautiful species is the most common of all the gastropods of the Rochester fauna, and also occurs in the upper horizon at Shelby, but has not been found in the lower bed. All the specimens before us indicate remarkable uniformity except in the degree of elevation of the spire. The species is probably related to the shell Whiteaves has identified with Euomphalus (1884),[1] Polytropis (1895) macrolineatus Whitfield, from the Guelph at Elora and Durham, Ont., but differs therefrom in proportions of the whorls, depth of suture and apparently in the character of the ridges of the surface. While we are unable to find closer agreement in the Canadian and New York species, we are disposed

[1] *Op. cit.* v. 3, pt 1, pl. 3, fig. 6.

to believe that the former could hardly with safety be referred to the large, very coarsely ridged shell which Whitfield described[1] as Euomphalus macrolineatus from the dolomites at Manitowoc Wis. In size and surface characters P. scamnata approaches very closely Lindström's Horiostoma lineatum,[2] having the same sculpture throughout, but the latter has its spire greatly depressed and the body whorl attached at the aperture.

Poleumita (?) sulcata Hall (sp.)

Plate 10, fig. 1-4

Cyclonema sulcata Hall, Paleontology of New York. 1852. 2: 347, pl. 84, fig. 1a-d

Trochonema (Pleurotomaria) pauper Hall, New York State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 343, pl. 15, fig. 5, 6, 9

Cyclonema sulcatum Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 18, pl. 3, fig. 5

Polytropis sulcatus Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 89, pl. 13, fig. 9, 9a

The original of this species was a shell from the "Onondaga Salt group, Newark, Wayne co., N. Y." With it were described other specimens obtained by Professor Hall on his visit to the Canadian Guelph localities in 1848. The early illustrations, which are not altogether satisfactory for the requirements of identification among so many similar shells, have been supplemented by the figures given by Whiteaves as above cited. The species appears to be among the rarer gastropods of the Guelph formation, but in the Rochester material we find several examples of it, some of them preserving the detail excellently, and we also have the same species from the dolomites of the upper Guelph at Shelby. Whiteaves has redescribed the species in full, and we find no pronounced disagreement therewith among our shells. Characteristic of it are (1) the notable elevation of the spire, which is considerably greater than the basal diameter

[1] Geol. Wisconsin, 4 : 294, pl. 18, fig. 5, 6.

[2] Silurian Gastropoda, p. 173, pl. 20, fig. 42–44.

and gives the shell the aspect of a true Cyclonema, (2) the deep suture, with broadly excavated outer slope, (3) the differentials of the surface sculpture, which over the body or outer convexity of the whorl consists of fine, subequal, elevated, revolving lines, increasing by intercalation. Near the suture two of these are stronger and wide apart, and on the umbilical surface four are specially emphasized, being larger and more distant than any of the rest. In all, the mature shell carries 20 to 25 revolving lines, which are crossed by fine, crowded and rather indistinct concentric growth lines, most palpable on the final whorl. The final whorl is apparently slightly detached at the aperture as in P. scamnata, but the aperture itself is not well retained in any of our specimens.

There is certainly very little difference in the characters of this species as we now apprehend it and the shell figured by Hall as Trochonema (Pleurotomaria) pauper from the Racine limestone at Racine. There is a striking discrepancy between the description of that species and its illustration which may be due wholly to the fact that the drawing was made from material not accessible when the description was printed. S. A. Miller,[1] for reasons not evident, has ranked this species as a synonym for Pleurotomaria halei Hall, but this is unquestionably erroneous.

Notwithstanding the resemblance of this shell to Cyclonema, we find that it is kept from that association by the presence of a deep though narrow umbilicus, and perhaps also by the coexistence of opercula which Whiteaves has discovered but which have not yet been recorded as occurring in Cyclonema. The apparent detachment of the final whorl at the aperture and the loose coiling evinced by the very deep suture in all these shells constitute another difference from Cyclonema in which the whorls distinctly embrace each other.

---

[1] Cat. Paleozoic Fossils, p. 422.

Poleumita crenulata Whiteaves (sp.)

Plate 9, fig. 9, 11, 16-24

Straparollus crenulatus Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 2, p. 21, pl. 3, fig. 8a, b

Polytropis crenulatus Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 91

Dr Whiteaves states that he had but two specimens of this species in the collections from the Guelph at Durham, and from these he drew his description. In the Arey collection are upwards of 30 specimens, which show that the species is specially characteristic of this eastern development of the Guelph. About half as many have been collected in the lower bed at Shelby but none at all obtained from the upper Guelph horizon, where P. scamnata was found in considerable number. This abundant material does not qualify the very clear and full description of the species given by Whiteaves, which we here reproduce. Our larger series, however, shows that wider variations exist in the elevation of the spire and surface sculpture, as the few specimens from Durham would indicate.

Shell turbinate, compressed vertically, hight one third less than the maximum breadth; whorls three to four [5]; spire short, about one third the entire hight, somewhat conical, its volutions being obliquely rounded; suture excavated; body whorl compressed vertically both above and below, ventricose and inflated in the middle; umbilicus about one third the diameter of the base, very deep and exposing all the inner whorls up to the apex; mouth nearly circular but narrower above and very slightly emarginated or indented by the penultimate whorl; outer lip apparently thin and simple, convex above and obliquely convex below. Surface marked by a few narrow and not very prominent spiral ridges which are crossed obliquely by numerous flexuous crenulated raised ridges or lamellae. On the outer half of the body whorl there are about seven or eight of these spiral ridges, four above and either three or four below the middle. The upper ones, one of which is placed very close to the periphery, are distant and rather clearly defined, but the lower ones are close together and extremely indistinct. These latter two are exclusively confined to the outer portion of the base, and disappear altogether before reaching the umbilical margin. The crenulated raised lines, however, which cross the whorls obliquely, are as strongly marked in and around the umbilicus as they are on the central and upper portions of the body whorl, and they are much more numerous as well as more closely disposed than the spiral ridges.

While a few examples show the same ratio of spire to body whorl (2 : 3) as that given by Whiteaves, many of the specimens from Rochester have a decidedly more elevated spire, which sometimes nearly equals in hight the diameter of the body whorl. The surface sculpture oscillates between the entire development of the revolving ridges and the suppression of the transverse ridges, and the reverse, but mostly consists of quite regular, coarse, sinuous and squamose transverse ridges.

Dimensions. An average well preserved shell has a hight of 30 mm and a basal diameter of 39 mm.

Observations. There is no likelihood of confounding this with any other described form. The general type of surface is of the same plan as that of P. scamnata, but the sparseness of the revolving ridges and the greater prominence of the concentric markings are pronounced. The species is clearly of the same generic character as P. scamnata, but here we fail to observe on any specimen evidence of the detachment of the body whorl at the aperture.

COELIDIUM nom. nov.

Coelidium macrospira Hall (sp.)

Plate 7, fig. 2–8; Plate 10, fig. 13

Murchisonia macrospira Hall, Paleontology of New York. 1852. 2:346, pl. 83, fig. 5

Murchisonia loganii Hall, Paleontology of New York. 1852. 2:346, pl. 84, fig. 4a, 4b

Murchisonia macrospira Billings in Logan's, Geology of Canada. 1863. p. 339, fig. 334

Murchisonia macrospira Nicholson, Paleontology Prov. of Ontario. 1875. p. 70, pl. 3, fig. 9

Murchisonia macrospira Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 27, pl. 4, fig. 7, 7a

Murchisonia logani Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 80

Murchisonia macrospira Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 81

In describing the fossils which he had collected from Galt and vicinity, Professor Hall applied the name Murchisonia loganii to a turritiform specimen of the internal cast, showing in part the rounded whorls, 11 or 12 in number, and partly exposing the inner surface of the whorls. At the same time he applied the name M. macrospira to an external mold of moderately large size and of similar angle to M. loganii but presenting whorls simply and rather sharply angulated by the peripheral slit band. It has been questioned by Whiteaves whether any distinction between such bodies can or should be made. On consideration of the material representing these shells in the Rochester and Shelby collections, in most cases clear cut internal casts present rounded whorls save in the mature growth of the shell, such casts of the later volutions preserving the angularity at the periphery. At times however this obscurity of angulation on the cast is manifested on all whorls. It therefore seems probable that but a single species is represented by these two names, and of these it is M. macrospira which should be employed, as this is the name given to the external mold on which the species characters are best expressed. The species is represented by a number of specimens from Rochester, a large example from the upper Shelby dolomite and several small specimens from the lower horizon.

The illustrations here given show the angularity of the lower whorls, on which the slit band stands out prominently at the periphery, being narrowly convex, with elevated, thin margin not rising to the hight of the surface of the band. Of the whorls, which may be 10 in number, the last four show this angularity with increasing distinctness, but the earlier whorls even when well preserved present only a rounded surface. The slit band lies almost centrally on the whorl, but the overlap by later growth makes it appear below the middle except on the final whorl. The slope on the upper part of the whorl to the slit band is more direct and less convex than below. The concentric surface lines slope directly backward about the periphery but show a curvature on the umbilical surface. The apical angle is from 20° to 25°. The direction of the suture is quite transverse; form of aperture not observed. Umbilicus narrow but open to the apex of the shell.

The term Coelocaulus was introduced by Oehlert in 1888 for Devonic species of these Murchisonias; and Murchisonia logani has, on the basis of Hall's original figure, been referred to that genus by Ulrich.[1] The name was however preoccupied by Hall for a genus of Bryozoa; but recognizing the usefulness of the distinction intended, we have suggested the term here employed, Coelidium. Coelidium is pretty clearly distinguished from forms referred to Hormotoma by the more depressed whorls (when round), the less oblique suture and extended aperture and the perforate axis.

Coelidium macrospira, originally described from the Guelph of Ontario, has also been recognized among the fossils of the Guelph beds of Wisconsin.

Coelidium cf. **vitellia** Billings

Plate 7, fig. 9, 10

Murchisonia vitellia Billings, Paleozoic Fossils. 1865. 1: 156, fig. 138

Murchisonia vitellia Nicholson, Paleontology Prov. of Ontario. 1875. p. 3, fig. 6

Murchisonia vitellia Whiteaves. Paleozoic Fossils. 1895. v. 3, pt 2, p. 80

In the material from Rochester is a single incrusted shell of a rather large species of this genus with relatively short and stout spire presenting an apical angle of 45° to 50°. Through the incrustation of the surface the whorls show a low carination, and the vertical section which reveals the open axis of the shell also indicates the angularity of the whorls at the position of the slit band. This specimen bears six volutions. It is a shorter and stouter shell than C. macrospira, and, of the various species of Murchisonia with Coelidium characters which have been described from the Guelph fauna, this approaches most closely to Billings's species M vitellia from Galt, both in the angle of the spire and the number and form of the whorls.

[1] Geol. Sur. Minnesota. Paleontology. 1897. v. 3, pt 2, p. 1019.

EOTOMARIA Ulrich. 1897

Eotomaria durhamensis Whiteaves (sp.)

Plate 10, fig. 17

Pleurotomaria durhamensis Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 24, pl. 4, fig. 2

Pleurotomaria durhamensis Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 77

Two internal casts in a not very favorable state of preservation, the larger composed of a spire of five whorls, have been found in the dolomites of this horizon at Rochester and are referred to this species on account of the slow increase of the whorls, the acuminate character of the apex, the obliquely flattened upper side of the whorls and the indication of the former presence of a deep umbilicus. The description of P. durhamensis was based on a single specimen, and that of P. galtensis, which is allied to it but differs in its more depressed spire, on not many more; Whiteaves has suggested that the former may prove to be only a variety of the latter. The difference is however a persistent one.

This and the P. galtensis are here referred to the genus Eotomaria, one of the divisions erected by Ulrich for forms heretofore comprised under Pleurotomaria, a genus which, it is asserted by that author, when restricted to forms agreeing closely with the original type is not found in the Paleozoic.

Eotomaria areyi sp. nov.

Plate 8, fig. 2

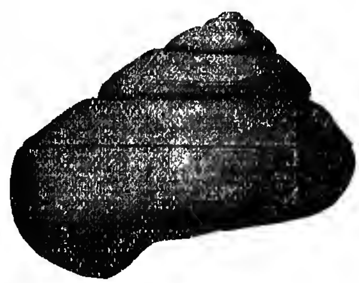
This is a large and robust shell bearing somewhat the expression of P. galtensis Billings,[1] but its proportions are larger. stouter and distinct in certain other details.

Shell depressed conic, broader than high, the thick spire being but slightly elevated; apical angle between 85° and 90°; whorls five, increasing slowly in size; suture not deeply impressed, as the upper surface of the whorls slopes gradually to the preceding ones; but on the casts there is a

[1] Geol. Sur. Canada. Paleozoic Fossils. 1862. 1:154, fig. 136. *See* Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 75, pl. 11, fig. 7.

deep furrow along the suture line. The upper slope of the early whorls is moderately convex, but assumes a gently sigmoidal contour on the body whorl, the upper part being gently convex, the lower concave, markedly so directly above the slit band. This band forms a rather narrow groove with projecting sides a little above the middle of the whorl; on the casts it appears as a quite prominent ridge, and passing on the spire a little above the suture line. Periphery of whorls slightly convex, nearly vertical, umbilical surface strongly convex; umbilicus small, only about one sixth of the diameter of the base of the shell; surface marked by fine crowded growth lines, which curve strongly backward at the slit band but on the under side converge directly toward the umbilicus; aperture not observed.

There is no satisfactory evidence of revolving ridges on the surface.



Dimensions. The best preserved example has a hight of 38 mm, basal width of 47 mm. Another, an incrusted specimen, has a hight of 43 mm, a basal width of 47 mm.

Our Rochester material has afforded but two examples of the shell, which we find to differ from the still imperfectly known P. galtensis, not alone in size, but also (1) in the thick and depressed spire, (2) in the profile of the whorls, which are less acute than in P. galtensis and have a different curvature of surface, (3) in the distinct umbilication of the shell, Whiteaves having stated that P. galtensis is imperforate. A still more depressed and broader shell of apparently this group of species is P. (Eotomaria) halei Hall[1] from Racine Wis. and Bridgeport Ill., and

[1] *See* N. Y. State Cab. Nat. Hist. 20th An. Rep't, p. 364.

in the opposite line of variation to an acuminate spire is P. (Eotomaria) laphami Whitfield[1] from the Niagaran at Ashford Wis.

Eotomaria kayseri sp. nov.

Plate 7, fig. 1; plate 8, fig. 1

The presence of still another species of the genus in the Guelph of Rochester is indicated by two internal casts, one of them pretty well preserved. These are of relatively large size, with stout whorls, apical angles about 75°, spire elevated, three whorls preserved. The suture is deeply impressed, the whorls overlapping not quite to the periphery. Surface of the whorls full, expanded, prominent on the slit band, which is narrow and elevated and bounded above by a similar ridge in close juxtaposition. On the outer whorl the surface slopes rather directly from suture to periphery or may be slightly concave between the peripheral ridge mentioned and another low ridge just outside of the suture. The lower or basal surface is evenly and moderately convex, not ventricose. The exposed parts of the earlier whorls are quite regularly convex, though showing evidence of the revolving ridges. The shell appears from the cast to have been distinctly umbilicate, though the umbilicus is quite narrow.

The hight of the best preserved shell (allowing for the apical whorls) is 53 mm; width across the base 48 mm.

Eotomaria galtensis Billings (sp.)

Plate 10, fig. 10–12

Pleurotomaria galtensis Billings, Paleozoic Fossils. 1862. 1:154, fig. 136

Pleurotomaria galtensis Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 75, pl. 11, fig. 7

Specimens referable to this species, were collected in the upper and lower Guelph of Oak Orchard creek.

Both show the characteristics of the internal and external casts on which Billings based the description of his species, viz depressed conic profile corresponding to an apical angle of about 100°, nearly flat upper side of

[1] Geol. Wisconsin. 1879. 3:296.

the volution, angular margins and the rather depressed lower side. The impression of the exterior verifies the observation of Whiteaves as to the external characters of this species and exhibits a nearly flat or only very gently convex upper slope, a vertical carination near the base of the upper whorls and a slit band, appearing as a spiral ridge which is concave on the apical and convex on the umbilical side. A difference from the exterior view given by Whiteaves exists in the position of the slit band, which lies below the mid-hight of the last volution. In the original drawing by Billings it lies at mid-hight, so that there is evidently slight variation of this feature. The surface is described by Whiteaves as having been apparently smooth; the specimen in hand shows only faint recurving growth lines on the shell fragments of the upper side of the whorls.

LOPHOSPIRA Whitfield. 1886

Lophospira bispiralis Hall (sp.)

Plate 10, fig. 6-9

Pleurotomaria bispiralis Hall, Paleontology of New York. 1852. 2:348, pl. 84, fig. 2a, 2b

Pleurotomaria bispiralis Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 74

This species was described from a single specimen obtained by Professor Hall at Galt; and Whiteaves reports that it is not otherwise known except in the reidentification of the species by Billings. The recorded examples are known to be poorly preserved, but the original, which was an external mold, shows quite distinctly features presented by three very good examples from the Rochester localities. The original description of the species is as follows: "Volutions about four or five, rapidly increasing from the apex, subangular, and marked above and on one side by thin, sharp carinae or spiral elevated lines." It is evident, on comparison with the better material in hand, that the spiral elevated lines here referred to represent the narrow slit band, which is very prominent on the periphery. The early whorls bear a sharp keel halfway between the suture and periphery, but on the final whorl this becomes quite obsolete. Present material allows a more precise definition of the characters of the species than could be given by its author.

Diagnosis. Shell of medium size, turbinate conic, a little higher than broad; spire elevated, hight greater than the basal diameter of the body whorl; apical angle 60°, base imperforate (?); suture deeply impressed, increasing outward in obliquity; earlier whorls overlapped by the later for one half the interval between the slit band and the base; volutions about five, subangular, slit band narrow with elevated margins, at or just above the middle of the whorl. The body whorl has a gently convex, almost direct slope from the suture to the slit band, but is convex and subventricose below the periphery. On the earlier whorls the depression of the upper surface is more pronounced, and the concavity is divided by a sharply developed keel or single ridge. A narrow, rather obscure and nearly vertical band runs along the suture. Surface marked by fine, irregularly concentric lines which cross the carina without interruption but are directed backward and are caught up at the slit band. On casts the carina and the slit band are indicated by rather low, rounded ridges.

Aperture unknown.

Observations. The angularity and prominence of the whorls in this species show its close approach to forms of Murchisonia having the expression of M. hespelerensis Whiteaves, and in this respect it is in harmony with Pleurotomaria durhamensis, these two species differing chiefly in the degree of elevation of the spire.

Besides the larger specimens from Rochester six smaller ones were obtained from the lower Shelby layer, and these distinctly exhibit the keel of the upper side of the whorl and the spiral elevated lines of the slit band. The upper Shelby dolomite has furnished no examples of the species.

HORMOTOMA Salter. 1859

Hormotoma whiteavesi sp. nov.

Plate 8, fig. 5-9

Shell long, slender, terete and acuminate, its entire length being nearly four times the diameter of the body whorl. Apical angle 18°–20°.

Volutions 9–10. These are but slightly overlapped, their exposed surfaces thus being quite regularly convex; the upper slope is slightly flattened or depressed to the obscure slit band. The sutural slopes are deep, the suture itself narrowly impressed, the edge of the lower whorl being slightly depressed against the whorl above. Umbilicus covered. Aperture oblique or subfusiform in outline. Inner lip somewhat thickened, outer lip with a deep linguiform emargination at its upper third. This is the edge of the slit band, which is a gently depressed sulcus without sharp margins, at which the surface lines are bent deeply backward. This band is evident on all whorls even on internal casts as an obscure flattening modifying the contour of the shell. The surface bears a multitude of fine and crowded, somewhat irregularly concentric lines, which are profoundly reflexed at the slit band but seem to be continuous over that area. On the lower slope of the body whorl is evidence of a second revolving band, which does not, however, effect any change in the direction of the concentric growth lines. This is a feature which is well defined only in a single specimen other examples, whether exteriors or internal casts, not showing it.

Dimensions. The most complete example before us has a length of 85 mm, a width at the base of 28 mm. A large specimen, incomplete at the apex, had a probable length of 100 mm and a basal diameter of 30 mm.

Observations. This graceful and striking species is one of the most abundant organisms in the Guelph horizon at Rochester. The Arey collection contains 25 or 30 specimens which are either internal casts in white chert or retain the shell more or less completely in pulverulent white silica with dolomitic interiors. The species has also been obtained in the upper Shelby horizon.

Shells of similar character to this have been already described from the Guelph fauna. Dr Whiteaves has given figure and description[1] of an internal cast having similar outline and contour to H. whiteavesi though of smaller size, and this he has identified with the Loxonema magnum

[1] Paleozoic Fossils. 1884. v. 3, pt 1, p. 17; 1895. pt 2, p. 87.

Whitfield from the Guelph dolomites of Carlton township, Wisconsin.[1] This so called Loxonema, however, is a species of large proportions (Whitfield states that the probable length estimated from the two whorls which constitute the original specimen was fully 8 inches), rather square shouldered whorls and so far as known, smooth surface. The fine preservation of the Rochester specimens does not justify the reference of them to either Loxonema or to this species provided it prove a Loxonema. We have little doubt that the Guelph shell figured by Whiteaves (specimens are from Galt, Hespeler and Elora) as Lox. magnum is specifically identical with, if smaller, than the New York specimens of Horm. whiteavesi, and we propose therefore the change of name here adopted, taking however as the type specimens of the species those we have here figured.

The generic term Hormotoma which was introduced by Salter for Murchisonias of terete form and rounded whorls has been quite generally placed by authors back among the synonyms of Murchisonia. Lindström so treats it and at the same time employs the term Loxonema for shells in which among the longitudinal sinuous lines are extremely fine and crowded.

MACROCHILINA Bayle. 1880

Macrochilina sp. indet.

Plate 10, fig. 18

This is a very diminutive shell from the Rochester Guelph, with subequally rounded oblique whorls, three in number, the last rapidly increasing in hight, but all relatively narrow. In these respects it is unlike the various species described (mostly by Billings) as Holopea from various Canadian localities of the Guelph. The surface so far as preserved appears to be smooth and without slit band.

---

[1] Geol. Wisconsin, 4:317, pl. 24, fig. 1.

TROCHONEMA Salter. 1859

Trochonema cf. fatuum Hall

Plate 10, fig. 5

Trochonema (Eunema) fatua Hall. N. Y. State Cab. Nat. Hist. 20th An. Rept. 1867. p. 345, pl. 15, fig. 7, 8

The upper Shelby dolomite has afforded a single imperfect example, comprising parts of the ultimate and penultimate whorls which bear the expression of the species cited above, showing a very broad peripheral band with raised margins and somewhat depressed surface, a direct slope above this band which is about as wide as the band itself, and a gently convex surface beneath. Faint concentric lines may be seen on the surface of this cast.

The original of this species is described from the Racine dolomites at Racine Wis. It is also cited[1] as occurring in the Guelph at Cedarburg Wis., but it is not recorded in the Canadian Guelph.

EUOMPHALUS Sowerby. 1812

Euomphalus fairchildi sp. nov.

Plate 8, fig. 3, 4

Shell of medium size, discoidal, with the apex of the spire depressed below the summit of the body whorl and lying almost in a horizontal plane. Volutions four to five; all in contact, but no impressed zone is formed, and at or near the aperture the body whorl seems to become almost detached. On the cast these volutions are free. Whorls oval in section, one third higher than wide; outer slope depressed convex and broad, upper side obscurely subangular, lower more broadly rounded; aperture apparently oval, not thickened, with a broad emargination on the upper side; umbilicus wide, exposing all the whorls.

Surface covered with sharp and fine, rugose concentric lines, which curve forward over the broad peripheral surface of the whorls and make a

[1] Geol. Wisconsin, 2: 380.

rather sharp and deep retral curve at the summit of the whorl, indicating the position of the apertural notch.

Dimensions. Two specimens, both of which were collected at Rochester, have a greatest width of 38 mm, and the body whorl near the aperture has a hight of 18 mm.

Observations. No species of similar habit and expression has been described from the Guelph fauna. Billings's two species, Straparollus hippolyta and S. daphne, from the dolomites at Galt are small shells with elevated spires; S. mopsus Hall[1] from the Racine limestone at Racine is smaller and has cylindric volutions; its surface markings are not known; S. niagarensis Hall & Whitfield[2] has revolving ridges on the whorls. The resemblance of the species is however extremely close to certain expressions of E. gotlandicus Lindström.[3] Lindström has maintained that individuals of a given species of Euomphalus may have their whorls contiguous throughout or be evolute in varying degree. Hence to this species, E. gotlandicus, he has referred a series presenting all phases in the unwinding of the whorl, thus embracing within the same species the conditions typical of both Euomphalus and Eccyliomphalus. With the involute expression of this species the agreement of E. fairchildi is so close as fully to justify identification were the evolute condition of the species eliminated, for this is not expressed in any of the specimens before us. We are however disposed to follow Lindström's valuation of the genus Euomphalus and have hence employed the designation in preference to Mr Ulrich's equivalent construction of the later term Eccyliomphalus and the common and freer employment of Straparollus, in which the whorls are impressed and the evolute condition less complete.

Named for H. L. Fairchild, professor of geology, University of Rochester.

---

[1] N. Y. State Cab. Nat. Hist. 20th An. Rep't, p. 342, pl. 15, fig. 21, 22.

[2] Pal. Ohio. 1875. 2: 144.

[3] The Silurian Gastropoda and Pteropoda of Gotland, p. 139, pl. 13, fig. 19–31, specially fig. 20–22

CEPHALOPODA

ORTHOCERAS Breyn 1732

Orthoceras trusitum sp. nov.

Plate 10, fig. 25, 26; plate 13, fig. 1–10

Shell straight, thick, regular, slender, tapering at an angle of 10°; of moderate size, diameter of largest fragment 38 mm, transverse section circular or subelliptic. Septa closely arranged, regularly and moderately concave, their depth approximately equaling that of the camerae; about 6 mm distant at the largest diameter, 3 mm distant when the shell has a diameter of 25 mm, 2.2 mm when the latter is 15 mm and about 1 mm at the apical end. The sutures are not straight, have a broad saddle on the ventral side but on the opposite side are nearly transverse. Siphuncle very small (3 mm where the diameter of the chamber is 26 mm), tubular and ventrocentren. The living chamber shows the same degree of tapering as the septate portion of the shell. The aperture has not been observed. The surface is usually entirely smooth, but when well preserved shows a very faint and fine longitudinal striation. In the largest specimen observed these lines are 1.5 mm apart and consist of broad flat ridges with narrow furrows between.

One of these specimens was labeled by Mr Arey, Orthoceras selwyni Billings. This is probably the specimen so listed in the provisional enumeration of fossils given by the discoverer. While it is true that the specimens under consideration have the same apical angle and depth of camerae as Billings's measurements of that species indicate, the siphuncle of O. selwyni is moniliform, with discoid inflations between the septa, and lies at a short distance from the ventral margin. According to Whiteaves the original specimen of this species is a very imperfect cast and the species therefore incompletely characterized.

There is some justification for comparing these specimens to O. scammoni McChesney. The somewhat complicated synonymy of this form given by Whiteaves shows that it has passed under various names, as

O. columnare and O. angulatum Hall, and has even been described under four different names by McChesney himself. A comparison with the descriptions and figures given by these authors indicates that that shell has the same rate of tapering as O. trusitum and the same small cylindric ventrocentren siphuncle. The septa show about the same convexity but in all the figured specimens are farther apart than in O. trusitum.

The surface sculpture of O. angulatum and O. scammoni is described as consisting of angular, equidistant, longitudinal ribs about one line distant when the shell is an inch in diameter. Such ribs are not observable in any of the New York specimens.

In the collection from Rochester is a single short fragment which has a much slower rate of tapering (6°), the siphuncle is relatively large and only 1 mm distant from the ventral margin at a diameter of 8 mm, and the septa are very closely arranged, 1.5 mm apart at the same diameter. It is possible that this specimen represents the apical part of O. selwyni, though there is too little known of this specimen on the one hand and that species on the other, to assert the identity positively.

Orthoceras trusitum is represented by a large number of fragments (upward of 30) from the Rochester Guelph and is of relatively frequent occurrence in the lower Shelby dolomite. In the upper Shelby bed it is rarer.

Orthoceras rectum Worthen

Plate 12, fig. 9

Orthoceras rectum Worthen, Geology of Illinois. 1875. 6:504, pl. 26, fig. 3

Orthoceras crebescens Hall & Whitfield, Geology of Ohio. 1875. 2:148, pl. 9, fig. 2

Worthen's original description of this species is the following:

Shell of medium size, very gradually tapering, septa moderately concave, two of the intervals being a little less in width than the diameter of the shell. Length of specimen with 12 septa preserved, 8.87 inches, length of outer chamber about 3 inches. Surface markings and siphuncle unknown.

This shell seems to be nearly related to O. crebescens of Hall, but differs from that species in its much less tapering form, and in the proportional width of the septa.

Worthen gives "the Niagara limestone" of Joliet Ill. as horizon and locality of his species.

Before us is a fragment retaining 10 camerae from the lower Shelby bed, which differs from the associated O. crebescens in the same respect as indicated above for O. rectum. It expands so slowly that its apical angle is only about 5°, and the camerae are so deep that the diameter is but a little larger than the combined depth of three camerae. While the latter are therefore still somewhat shallower than those of the type specimen of O. rectum, the difference is so small that it is well within the limits of individual variation. The section of the Shelby species is subcircular, and the siphuncle is centren.

In the same year in which Worthen differentiated O. rectum from O. crebescens, Hall and Whitfield described and figured a specimen from the "limestones of the Niagara group" at Cedarville O., which they referred to O. crebescens, but which, in the differential characters cited above, tallies quite closely with the lower Shelby specimen. Hall and Whitfield also noted the difference in the depth of the chambers between the Ohio and the original Wisconsin specimens of O. crebescens, but did not consider it sufficient for separation. The additional difference in the rate of expansion brought out by the figure of the Ohio specimen and its description, in which it is said to taper "gradually and moderately," while the types of O. crebescens are stated to taper "rapidly," seems to have been overlooked in the comparison of the forms. The constancy of the combined appearance of these differences in the Illinois, Ohio and New York specimens and the very distinct habit resulting from them, fully warrant their recognition as of specific importance.

Orthoceras crebescens Hall

Plate 10, fig. 24, 27, 28; plate 11, fig. 2-5

Orthoceras crebescens Hall. N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 354, pl. 19, fig. 1-3

Orthoceras crebescens Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 37

Orthoceras crebescens Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 98

Not Orthoceras crebescens Hall & Whitfield. Geol. Sur. Ohio. Paleontology. 1875. v. 2, pt 2, p. 148, pl. 9, fig. 2

Among the orthocerata of the lower Shelby dolomite is a small group of specimens which contrast with the others by their large dimensions, and specially the greater depth of the chambers. These must be the relics of the giants in the cephalopod fauna that populated the lower Guelph coral reef. They are all casts of the interior.

Diagnosis. Conch straight, thin, of large size, the living chamber of one specimen attaining a diameter of about 70 mm, gradually expanding (angle 9°), cross section circular or subcircular; surface smooth, faintly striated longitudinally; sutures transverse with a distinct (ventral?) lobe, camerae very deep, the sutures lying 9 mm apart in one specimen where the conch has a diameter of 40 mm, and in another where the diameter is 50 mm; septa evenly concave and very deep, the depth being about equal to the depth of the camerae; siphuncle centren or nearly so, large, nummuloidal in the mature stage, where it passes the septum, about one sixth the diameter of the conch; living chamber possessing the same rate of expansion as the septate portion, repeatedly slightly constricted; aperture apparently nearly straight. One cast retains faint longitudinal ridges, with flat interspaces.

Horizon. Lower Shelby dolomite. No specimens have been obtained in either the upper bed at Shelby or Rochester.

Our material agrees in all essential features with the type specimen described by Hall from the Racine limestone, Wisconsin. In vol. 2, *Geology of Wisconsin*, the species is listed as occurring in the Waukesha, Racine and Guelph beds; in the Racine beds at the greatest number of localities, so that we may conclude that it reached its acme there and survived only sparsely in the Guelph, where it has been found occasionally at Hespeler and Elora, though in greater number in the lower Shelby dolomite.

The series of orthoceracones from the lower Shelby bed contains a fragment, consisting of seven chambers, which appears to be a portion of the apical part of the conch of O. crebescens, which has hitherto not been observed. It agrees with that species and differs from the other associate orthoceratites by its slender form, very deep camerae, their depth being nearly half the width of the conch, and the very large siphuncle, which occupies nearly half the interior space of the conch. This siphuncle, however, is but very slightly expanded, and the cast of the siphuncular cavity is completely cylindric. As the siphuncle of other species is known to become nummuloidal only in late growth stages, the difference between the siphuncles of this small conch and those of the large conchs of O. crebescens is not thought to militate against a reference of the same to that species.

DAWSONOCERAS Hyatt. 1883

Dawsonoceras annulatum Sowerby, var. **americanum** Foord

Plate 10, fig. 19–21; plate 11, fig. 1

Orthoceras annulatum Sowerby var. americanum Foord, Cat. Fossil Cephal. British Museum. 1888. p. 56, 57

The wide variation in the expression of the ornament among specimens which have been referred to O. annulatum Sowerby and have likewise been described under a variety of other names, now renders exceedingly difficult the accurate determination of specimens of this type, specially when the species are represented by only fragmentary parts. It is evident from the study of the long list of annulated orthoceracones of the late Siluric, and has been specifically pointed out[1] by one of the writers in the case of certain lower Siluric shells of similar type, that the ontogenic progress of the ornament in the annulate and longitudinally striate shells is quite uniform, and it may be summarized thus: The annuli are a quite

[1] Minnesota Paleontology, v. 3, pt 2, p. 787.

primitive feature appearing in the early growth stages (cf. Kionoc. darwini) with their greatest relative strength. With continued shell growth they become broader, less distinct and in progressed shells entirely obsolete even before adult growth is attained. The longitudinal lines, however, which develop before the early annuli, remain with the obsolescence of the latter, for a time the principal feature of the exterior. Contemporaneous with both of these surface features there develops a concentric lineation, which also may become more conspicuous with the suppression of the annuli, in some species becoming a prominent cancelating feature, even entirely replacing the longitudinal ribs. Among species which have been described from the American Upper Siluric the following express various conditions of this combination of surface characters: O. undulatum Hall, O. annulatum Sowerby var. americanum Foord, O. medullare Hall, O. nodocostatum McChesney, O. cadmus Billings, O. virgatum Sowerby, O. laphami McChesney. This statement does not impugn the differential specific values of certain of these forms, but, as all of them have been described from incomplete cones, it is clearly impossible with present knowledge to decide on the specific values involved. Generic characters among these late Siluric species are consequently highly obscured and uncertain, and the genera of this group proposed by the late Professor Hyatt pass into each other, as do the specific characters. Hyatt has proposed to term species which retain the annuli throughout growth with concentric undulating lines or frills, Dawsonoceras (D. annulatum Sow. = O. undulatum Hall). Shells having the longitudinal ridges conspicuous and obscure annuli in senile growth are termed Kionoceras; a condition in which the annuli of early growth become later obscured, with corresponding increase in the prominence of the longitudinal lines, are Spyroceras, while a development of spines or nodes at the intersection of annuli and longitudinal ridges constitutes the character of Thoracoceras.

We find among the material from Rochester several small specimens of sharply annulate cones which we refer to Dawsonoc. annulatum var. americanum Foord, employing that author's distinctive designation for American expressions of Sowerby's specimens. These specimens doubtless represent early growth stages; one has 15 sharply developed somewhat sinuous annuli in a length of 23 mm, another 10 in a length of 16 mm, a third 24 in a length of 45 mm. The annuli are separated by rather deeply concave depressions not always of equal width. Fine sharp longitudinal striae, often clearly in two series, cross the surface, and these are cancelated by much finer and obscure concentric lines. Nothing that would indicate the modification of those characters in later growth has been observed. Several large specimens, exceeding an inch in diameter and possessing strong, rounded annulations, were obtained from the lower Shelby bed. None were found in the upper horizon.

Dr Whiteaves has reported the presence of this species in the Guelph at Hespeler and Elora, where it seems to be rare and the surface characters are not specially noted. It is also cited in the *Geology of Wisconsin* among the Racine and Guelph fossils. Professor Hall[1] knew it only from the lower beds at Waukesha and near Wauwatosa, Wisconsin. Its occurrence at Yellow Springs and Cedarville O., is recorded by Hall and Whitfield in *Paleontology of Ohio*, 2:148. It is therefore evident that this species rises from the lower Niagaran shales, where it is most common, into and through the higher Niagaran beds in New York as well as in the west.

Orthoceras bartonense is a shell from the Barton beds or highest member of the Niagaran series at Hamilton Ont., which has been described by J. W. Spencer[2] as distinct from D. annulatum in having the annular crests marked "by swelling waves (giving a nodular appearance on the margin)." This is the same variation which McChesney described as O. nodocostatum[3] but which Hall seems to have correctly estimated[4] as identical with O. annulatum.

[1] N. Y. State Cab. Nat. Hist. 20th An. Rep't, p. 351.

[2] Mus. Univ. Missouri. Bul. 1884. 1:60, pl. 7, fig. 7.

[3] Descr. Paleozoic Fossils. 1860. p. 94.

[4] N. Y. State Cab. Nat. Hist. 20th An. Rep't. expl. pl. 20.

KIONOCERAS Hyatt. 1883

Kionoceras darwini Billings (sp.)

Plate 10, fig. 22; plate 11, fig. 6; plate 12, fig. 1-8

Orthoceras darwini Billings, Paleozoic Fossils. 1862. 1 : 161 (not figured)

Cyrtoceras myrice Hall & Whitfield, Geol. Sur. Ohio. 1875. v. 2, pt 2, Paleontology p. 149, pl. 8, fig. 9

Orthoceras darwini Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 38, pl. 6, fig. 2, 2a

Cyrtoceras myrice Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 39, pl. 6, fig. 3, 3a

Orthoceras darwini Foord, Cat. Fossil Cephal. British Museum. 1888. pt 1, p. 76, fig. 8

Orthoceras darwini Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 100

Among the Rochester specimens of this species is one which is excellently preserved and shows the surface features probably better than any which have been recorded. There are sharp, angular, longitudinal ridges, between each pair of which normally lies a smaller ridge. These ridges of the first and second order are separated by equal furrows. Concentric lineation does not appear on this specimen but is shown on the later growth of a larger individual. Toward the apical end of the shell are quite well marked transverse annulations. These, as in many other species of this generic type, are completely obscured in later growth. The gentle cyrtoceran flexure of the cone is clearly indicated in the best of the specimens. The sipho is subcentral and the section is nearly circular, with the concave side slightly flattened.

No examples of this pretty and characteristic species have been obtained in the upper Shelby bed, but the lower dolomite has furnished a number of well preserved specimens, two of which are remarkable for their dimensions, which indicate a size considerably larger than hitherto recorded. One of these is preserved as a mold of the exterior and attains a length of 158 mm, with both ends imperfect. This retains the same slight curvature exhibited by the smaller specimens. Another is a cast of the interior of the living chamber and of 10 septa, which shows but very slight curvature and traces of the longitudinal surface ornament. This specimen shows a marked gerontic character in the uniformly closer arrangement of the last septa and therefore furnishes an indication of the mature size reached by this species. Its living chamber has a diameter of 48 mm and a length of 51 mm. The aperture is partly preserved and appears to have been slightly curved. The chambers show the same depth (about 5 mm) as in Billings's type specimen of Orth. darwini, the conchs of both having a like width. The sutures have a broad, low saddle on the concave side. While two of the smaller specimens bear only uniform longitudinal ridges, the larger conch is provided with low annulations throughout its entire length. In the best preserved young specimens from the Rochester Guelph these annulations appear only in the earlier stages, and it thus appears that the large individual preserved this infantile character into the ephebic stage. The three factors of the surface ornamentation follow evidently in the same order as observed by Clarke in annulated and lineated Trenton forms and above referred to, viz longitudinal ribs, annulations, transverse striae, but with this difference, that the annulations here never attain any strong development and soon disappear, while the longitudinal ribs appear to persist throughout life and become in the ephebic stage complicated with the concentric lineation, which, however, does not attain such prominence as in the mature stage of Dawsonoceras annulatum or in the Trenton forms mentioned.

Dr Whiteaves gave the first illustration of the original of K. darwini and points out its identity with Hall & Whitfield's Cyrtoceras myrice described at a later date from the dolomites at Yellow Springs O. Billings's original was from the Guelph at Hespeler, and other specimens originally identified by Dr Whiteaves with Cyrtoc. myrice are from Durham. This species is, hence, to be considered a typical Guelph form. Its connection with the longitudinally ribbed or cancelated, slender orthoceratites, so common in the Racine beds whence it probably descended, is very close, specially with Orthoceras angulatum (Wahlenberg) Hall,[1] which is

[1] N. Y. State Cab. 20th An. Rep't. 1867. p. 353.

described as possessing the same number of longitudinal ribs within the same space, the same cancelation in some parts, but has somewhat deeper camerae, tapers slightly faster and is perfectly straight. This species is said by Hall to be identical with the numerous species of longitudinally ribbed Racine forms erected by McChesney, and also with Hall's O. virgatum (?) and O. cancellatum from the Rochester shale of New York. Whiteaves identifies the latter species with Orthoceras cadmus Billings, which has been described from the Niagaran at Grimsby Ont.

Kionoceras medullare Hall (sp.)

Plate 10, fig. 23

Orthoceras medullare Hall, Geol. Sur. Wisconsin. Report of Progress. 1859.

Orthoceras medullare Hall, N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 353, pl. 20, fig. 1, 2

Orthoceras medullare (?) Meek & Worthen, Geol. Sur. Illinois. 1875. 6:504, pl. 26, fig. 1

Orthoceras medullare Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 37

This species is represented in our collections by a single mold of the exterior from the lower Shelby dolomite. The ornamentation of this fragment, which belonged to a conch having a diameter of about 30 mm, consists of sharp, longitudinal striae, alternately stronger and finer; these are crossed by transverse lines, arranged slightly closer than, and equal in prominence to, the finer, longitudinal striae. Seven of these longitudinal lines may be counted in 10 mm. The character of this ornamentation, the relative distance and strength of the striae, is that ascribed to O. medullare, and we, therefore, provisionally identify the Shelby species with that.

Hall described Orth. medullare from "limestone of the Niagara group at Waukesha and Wauwatosa, Wisconsin." In the lists of fossils of Wisconsin, given in *Geology of Wisconsin*, v. 2, Kion. medullare is cited only from the Waukesha and Racine beds, but not from the Guelph. Meek and Worthen doubtfully refer to the species a specimen from the Niagara at Joliet Ill. Whiteaves reports the species in the Guelph at Elora Can.

Cyrtoceras arcticameratum Hall

Plate 15, fig. 1, 2; plate 16, fig. 1-7

Cyrtoceras arcticameratum Hall, Paleontology of New York. 1852. 2:349, pl. 84, fig. 7a-d

Cyrtoceras arcticameratum Billings, in Logan's Geology of Canada. 1863. p. 340

Cyrtoceras arcticameratum Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 103

This species was very briefly characterized by Hall in the following words: "Elongated, slender, gradually tapering and gently incurved; septa numerous; slightly convex; section transversely oval, siphuncle dorsal." The original specimens from Galt were not very good. Billings cites Galt and Hespeler as localities, but Whiteaves states that he has seen no specimens of the species. It has also been recognized in the Guelph at Cedar burg Wis.[1]

In the Rochester material there are several examples, one of excellent quality, which present characters agreeing with Hall's diagnosis and figures, and these are specially marked by their long, slender and gently arcuate cones, in which the outer ventral curve is about 87° and the inner 69°. The section is nearly circular in early growth but later becomes broadly oval.

The living chamber is long, somewhat swollen in the middle, broadly contracting to the aperture, which has straight lateral margins. Septa from 2 to 3 mm apart, slightly concave and nearly transverse, broadly flexed forward ventrally. Siphuncle small and ventral.

Surface smooth, only fine concentric lines being visible. These become squamous toward the aperture and all recurve ventrally at the hyponomic sinus.

Dimensions. The most complete of these examples has a length measured on the outer curve of 95 mm. This covers most of the living chamber, which is 29 mm long. Width of living chamber dorsoventrally 21 mm, of aperture 16 mm, of lower end of specimen 9 mm.

[1] Geol. Wisconsin, 2:380.

Cyrtoceras orodes Billings

Plate 15, fig. 3–11

Cyrtoceras orodes Billings, Paleozoic Fossils. 1865. 1 : 162 (not figured)
Cyrtoceras orodes Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 103, pl. 14, fig. 7–9

Several specimens of this species presenting a very slightly curved and rapidly tapering shell with nearly circular section, have been obtained from the lower Shelby horizon and at Rochester. The original, which was not figured by Billings, and two specimens of better preservation have been described and figured by Whiteaves.

The New York specimens are of moderate size, tapering rapidly (one increasing from 11 to 19 mm in 39 mm; another from 12 to 28 mm in 60 mm), very gently curved, of nearly circular section, becoming somewhat flattened dorsoventrally in late growth. Billings describes the dorsoventral diameter as being slightly the greater, which is true of earlier growth, while the outline of the section of the type specimens given by Whiteaves is circular. The septa are closely arranged; in the smallest specimens from 1.5 mm apart at the smaller end to 4.5 mm at the larger. The septa are but slightly concave, their depth being no more than 2 mm. The sutures run nearly straight across the shell; they show a very short, blunt lobe over the siphuncle on the ventral surface, and a very faint, broad lobe over the dorsal surface. The siphuncle is situated close to the ventral side and is not expanded between the septa.

The surface appears to have been smooth, the inner shell larger and, as shown in one specimen, bearing some fine, longitudinal furrows.

The species has not been collected in the upper Guelph of Oak Orchard creek, while in the lower bed both young and adult specimens were found, the former exhibiting well the rather rapid expansion of the conch, and the latter retaining part of the living chamber and a number of the youngest camerae. In a large example the living chamber becomes greatly contracted toward the aperture in about the same degree as a specimen referred by Whiteaves[1] with some doubt to this species. This contraction may be here a gerontic character, as it has been claimed by Pompeckj and Hyatt that numerous cephalopods constrict their apertures in gerontic stages.

Cyrtoceras cf. **brevicorne** Hall

Plate 13, fig. 11, 12

See Cyrtoceras brevicorne Hall, N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 356, pl. 18, fig. 8, 9

A small, rapidly expanding cyrtoceracone from the Rochester collection, though quite incomplete, seems to agree with Cyrtoceras brevicorne Hall in the rapid expansion of the shell. In a length of 16 mm it expands from 5 to 12 mm in diameter. The section is oval, broadly rounded on the ventral and more acutely on the dorsal side. The inner curvature is slight. Septa shallow, curving strongly downward on the venter. The siphuncle is small and situated close to the ventral margin. The chamber of habitation is not preserved in the specimen. The surface is smooth or covered with fine concentric growth lines, which show a broad and deep posterior curve on the venter.

The original specimens of this species were from the dolomite at Racine Wis. The form has not yet been observed in either the Canadian Guelph or the Niagara beds of New York, but is reported from several outcrops of the Racine beds in Wisconsin.[2]

In the lower Guelph bed at Shelby has been found a short conch, which in its extremely rapid expansion and curvature agrees with Hall's figured specimen of Cyrtoceras brevicorne, but fails to show the difference in convexity of the dorsal and ventral sides. Its section is, on the contrary, perfectly circular.

---

[1] *Loc. cit.* pl. 14, fig. 9.

[2] Geol. of Wisconsin, 2 : 376

Cyrtoceras bovinum sp. nov.

Plate 16, fig. 8, 9; plate 18, fig. 5, 6

Large, robust, rapidly tapering, gently and regularly curved cones. In the most complete the arc of outer curvature is 165 mm long and its chord 135 mm, the inner curve 115 mm long, its chord 98 mm. Section transversely oval, more rounded in the apical parts, but very broad and flattened and even slightly depressed medially on the venter.

Septa closely arranged, from 2.5 to 4.5 mm apart; gently concave; suture transverse with a low median backward turn or lobe on the venter. Siphuncle subventran, moderately large, slightly contracted at the septa. Living chamber long, not constricted as far as the specimens indicate.

Surface covered with only fine, concentric growth lines, which combine to form low bands or festoons. All the internal casts of this species bear a highly characteristic roughened surface, caused by the excoriation of the inner shell layers indicating a thick shell. All surface lines make a broad backward curve on the venter but are apparently transverse on the dorsum. The shell is traversed longitudinally by very faint, fine and unequal, somewhat undulating lines and grooves. These, however, are shown only on two fragments which seem to have somewhat less curvature than the others.

This species is represented by six or seven specimens from the Guelph at Rochester, which show that it is by much the largest cephalopod in the fauna at that locality. As a species it seems distinct from any that have been described, in size, cross section and breadth of venter as well as in surface characters.

CYRTORHIZOCERAS Hyatt. 1900

Cyrtorhizoceras curvicameratum sp. nov.

Plate 17, fig. 1-10

Diagnosis. Conch a cyrtoceracone of moderate size, gently arcuate, curvature of apical part not known; expanding slowly, adult living chamber having a length of 35 mm, widening from a basal diameter of 37 mm to an apertural diameter of 45 mm. Camerae very shallow, the sutures being only 3.5 mm apart, where the major diameter of the conch is 43 mm; deeply concave, the deepest place dorsad of the center, bent forward strongly in the ventral and slightly in the dorsal region. Depth of septum of living chamber 8 mm; sutures transverse, with a higher, but narrow, rather sharp ventral, and lower, broader dorsal saddle, straight on the sides; transverse section oval, compressed laterally, the venter narrower than the dorsum, major and minor diameters in one narrow specimen 39 and 30 mm, in another broader, 44 and 36 respectively; siphuncle small, 4.5 mm wide at the perforation of the septum, where the latter has a major diameter of 44 mm, apparently empty, expanding to its double diameter in the camerae, situated propioventran; living chamber short, retaining the curvature and expansion of the septate portion, aperture not constricted, its lateral margins low, convex, the dorsal margin provided with a broad and lower sinus and the ventral margin with a narrower and somewhat deeper hyponomic sinus situated on the arched external side (exogastric shell); surface not known, the internal casts being smooth and the molds of the external surface obscured by coating of crystals. A coarse ornamentation was evidently absent.

Locality. Lower Shelby dolomite.

Observations. From Cyrtoceras cancellatum Hall, the only form of the New York Niagaran showing some superficial similarity, Cyrt. curvicameratum is readily distinguished by being laterally compressed and not dorsoventrally as the latter. In the rich cephalopod fauna which has become known from the western Niagaran, there are Cyrt. fosteri Hall and Cyrt. dardanus Hall, both clearly related to this species. Cyrtoceras fosteri Hall, described[1] from the "Niagara limestone" near Chicago, possesses a similar transverse section, curvature of sutures and like depth of chambers, but differs in having the venter relatively narrower and the ventral saddle of the sutures higher. Cyrtoceras dardanus Hall, occurring in the Racine beds at Waukesha and Wauwatosa Wis., a form with similar curvature and expansion, is

[1] *Report of Progress* of Geological Survey of Wisconsin for 1860, p. 41.

described[1] as having the dorsal and ventral sides equally rounded, and it also possesses deeper camerae.

This species, C. curvicameratum, is considered a typical representative of the genus Cyrtorhizoceras Hyatt[2] on account of its uncontracted living chamber, open aperture and the character of its dorsal and hyponomic sinuses, its laterally compressed form, the well developed ventral and dorsal saddles of the sutures and the small siphuncle. The genus is described as beginning in the Lower Siluric, where the generic type, Cyrtorhizoceras minnesotense Clarke (sp.), a small form of the western Trenton, occurs, and as extending into the Upper Siluric. It appears that this genus, a very primitive group of cyrtoceracones, is still well represented in the Niagaran, for several of the western species of Cyrtoceras evidently pertain to it.

GYROCERAS de Koninck. 1844

Gyroceras farcimen sp. nov.

Plate 18, fig. 1-4

Diagnosis. Conch robust, strongly curved, very slowly expanding, number of volutions unknown; transverse section circular, the dorsal and ventral sides not appreciably different in curvature, no impressed zone observable; camerae moderately deep, septa 8 mm distant, where the diameter of the shell is 28 mm; sutures transverse, nearly straight, a small saddle at the outer side of the arch; siphuncle submarginal, at the outer side its character not known; living chamber very long, extending for one half a volution or more, continuing with the curvature of the septate portion; aperture not known; surface smooth.

Locality. Lower Shelby dolomite.

Observations. There are only three cephalopods with gyroceran volutions known from the Niagaran; G. farcimen may be readily distinguished from G. abruptus Hall, of the Indiana Niagaran, by its very gradual expansion and the position of its siphuncle, from G. americanum

[1] *Report of Progress* of Geological Survey of Wisconsin for 1860. p. 43.

[2] Zittel-Eastman. Textbook of Paleontology. 1900. p. 529.

Billings, by the fact that the latter is annulated and from G. bannisteri Winchell & Marcy,[1] from the western Niagaran, for the same reason.

POTERIOCERAS McCoy. 1844

Poterioceras sauridens sp. nov.

Plate 14, fig. 1–19

The most common and one of the most characteristic cephalopods of the lower bed at Shelby is a small breviconic cyrtoceracone, different in important characters from all other forms reported from the Guelph or so called Niagaran horizons. A single specimen somewhat crushed dorsoventrally was also obtained at Rochester.

Diagnosis. Shell small, fusiform, somewhat abruptly tapering and relatively but little curved; in a specimen with a length of 48 mm the outer arc has a hight of 19 mm; the inner of 4 mm, measured from a chord connecting the extremities. The shell is slightly asymmetric, and seen from the ventral side, the apex is turned a little to the right. It is somewhat compressed dorsoventrally, in its mature parts the dorsoventral diameter being one tenth shorter than the lateral; the dorsum is almost flat or but slightly rounded, while the ventral side is well rounded, its section in most specimens being part of a circle. The ventrolateral slopes are evenly rounded, while the dorsolateral are quite abrupt. In the apertural part the section is entirely circular, the flattening of the dorsal side not appearing till about the neanic stage of the shell. The living chamber is remarkably short; its length rarely attains that of the diameter of the last septum; this chamber is widest at about one third of its length, whence it contracts on the ventral and lateral sides, toward the aperture to such a degree that the dorsoventral diameter of the aperture becomes slightly the smaller. The outline of the aperture is simple, with a shallow hyponomic sinus and a broad, low dorsal saddle. The shell around the aperture is thickened, so that on the very frequent casts of the living chamber, there appears a ringlike depression just within the margin.

[1] According to Hall, N. Y. State Mus. 20th An. Rep't, supplementary note, p. 393, this is a Trochoceras.

Septa transverse, closely arranged, those of the ephebic stage being about 3 mm apart on the ventral, 2 mm on the dorsal side; shallow, with a low saddle on the venter. Siphuncle ventral near the margin (propioventran Hyatt), tubular in the nepionic part, becoming slightly nummuloidal in the following stages. Surface with fine concentric lines which are recurved on the venter, where they are crossed by obscure longitudinal ridges.

The species can not have attained a large size, for, among all the specimens, none has been found to have a diameter of the living chamber above 30 mm, this being the measurement of the largest specimen observed which possesses distinct gerontic characters in the shallow later camerae. Numerous specimens of average size with but two thirds of this measurement, show the same gerontic features, and should therefore be regarded as representing the normal size. An entire specimen whose living chamber has a diameter of 18 mm, measures 54 mm along the ventral side.

Horizon and locality. Rare in the Guelph horizon at Rochester, but very common in the lower Shelby dolomite; one doubtful specimen has been taken from the upper Shelby horizon.

Observations. The large representation of this species has allowed a full elucidation of its characters; and it is also possible to attempt a generic reference more exact than to Cyrtoceras in its broad and common application. The genus Cyrtoceras, as restricted by Hyatt, while including similar exogastric, breviconic cyrtoceracones, with flat dorsum and elevate venter, is defined as having the aperture contracted to a T-shaped opening, and a large, nummuloidal siphuncle. Thus restricted, the generic term is only applicable to Devonic forms, on which it was originally based, but we have not been able to apply the term in this meaning because of lack of evidence. Hence our use of the name in the foregoing is to be regarded in a broad sense as covering species not at present referable with greater exactitude. The genus Oncoceras, which is suggested by the short, abruptly terminated septal part and the contracted aperture, is restricted to laterally compressed forms of the Lower Siluric, with distinctly nummuloidal siphuncle. It is however clear that this genus is a primitive representative of the genus Poterioceras, as defined by Hyatt, primitive in so far as its aperture is not yet laterally contracted and still possesses a wide open, roundly triangular outline; also primitive in its less developed fusiform shape, which, it appears, does not attain its most typical expression till Carbonic time. This genus, in its restricted sense, was placed by Hyatt (*Genera of the Fossil Cephalopoda*),[1] under the term Acleistoceras, but subsequently was regarded by him as a synonym of Poterioceras; Acleistoceras *nobis* includes brevicone fusiform bodies with partially contracted living chamber. The aperture has a large ventral sinus and a dorsal saddle, and is only slightly smaller in diameter than the living chamber, while the outline is usually subtriangular. The siphuncle remains ventral, and the form in section is an oval with the dorsum broader than the venter.

It appears from the frequent coincidence of shallow ultimate camerae indicating gerontic conditions, with marked contraction of the aperture, that the latter feature alone may indicate gerontic condition rather than specific character. This fact would, in some measure, conform to the statement made by Hyatt, that Oncoceras is a phylogerontic group, one of the phylogerontic characters being the transverse contraction of the living chamber during gerontic age. On the other hand, it was pointed out by Clarke that the expansion of the shell during later growth and a sudden contraction at the close of the swelling near the aperture is a character appearing in the early genera Oncoceras, Clinoceras, Poterioceras and Cyrtoceras (in the old sense), and that in the Devonic species of the orthoceran genus Bactrites this expression of the shell characterizes the growth stage directly succeeding the formation of the protoconch. It is in line with the latter observation that, as Foord remarks, the inflation of Poterioceras is much less conspicuous in the adult than in the young. This author probably refers only to late species of Carbonic age. It would seem to us that we have here a gerontic character indicating early decline of a series of cephalopods taking place remarkably soon after the inception of the cephalopod stock. In considering the small size and slight development

[1] Boston Soc. Nat. Hist. Proc. 22: 277.

attained by the species of these genera, they appear to us as a group of dwarfed forms comparable in their entirety to the small specimens with constricted apertures among later (mesozoic) cephalopods considered as dwarfs by Pompeckj.

One specimen, consisting of a badly crushed living chamber which may belong to this species, was found in one of the geodes of the upper Guelph at Shelby, and another was obtained at Rochester. The latter is probably also somewhat crushed, for its section is very traverse, the dorsoventral diameter of the body chamber being one third less than the transverse diameter. This specimen measures 50 mm on the ventral curve and has an apertural transverse diameter of 20 mm and an apical diameter of 8 mm.

It is a noteworthy fact that, with the exception of one or two specimens, all have retained only the living chamber and a few camerae, the apical parts being gone. It is therefore quite probable that this organism was in the habit of discarding from time to time some of its oldest camerae.

There are no forms in the Guelph or Niagara similar enough to invite comparison with this species or to necessitate distinctive characterization, but Cyrtoceras clitus Billings[1] should be cited here as possessing similar size, like curvature and contraction of the aperture, though still differing in the amount of expansion, this being much more rapid in the apical part of Pot. sauridens.

J. W. Spencer has described and figured[2] the cast of a living chamber as Cyrtoceras reversum. This cast resembles so closely that of the same part of P. sauridens that it doubtless belongs to that species. The author has succeeded however in making a very remarkable fossil out of this fragment, viewing it in a wrong direction and then calling it "reversum." He states: "Its form is rapidly tapering with a considerable curvature, until it ends in a rounded point." This rounded point is, however, the aperture, and the tapering is that of the living chamber toward the aperture. From this misconception arose the other, that "the convex

---

[1] Cat. Silurian Fossils of the Island of Anticosti. 1866. p. 85.

[2] Mus. Univ. Missouri. Bul. 1884. p. 60, pl. 7, fig. 8.

side of the septae is directed toward the body-chamber," a structure which would indeed be quite unique among the Cephalopoda. Cyrtoceras reversum is described as occurring in "the lower beds of the Niagara limestones at lighthouse station on the G. T. R." It may, therefore, occur at a similar horizon as the lower Shelby form.

Poterioceras sp.

Plate 13, fig. 13-16

A single living chamber, found in the lower Shelby dolomite, differs so materially from those of the associated P. sauridens that we are constrained to note it separately. The living chamber is quite evenly rounded and plump, the flattening of the dorsal side but slightly developed. The section of the living chamber and also of the aperture is nearly circular. The ventral and lateral surfaces are regularly and evenly contracted from the middle of the chamber toward the aperture. The siphuncle is marginal (subventral) and highly nummuloidal. The camerae are not preserved, but, judging from the siphuncle, they were shallow and the septa but slightly convex. The cast shows traces of transverse striae, presumably growth lines.

PROTOPHRAGMOCERAS Hyatt. 1900

Protophragmoceras patronus sp. nov.

Plate 19, fig. 1, 2

A very robust, moderately tapering, strongly and regularly curved shell. The arc of the outer curvature is 190 mm long and its chord is 165 mm; the inner curve is about 140 mm long and its chord measures 90 mm. Section in the earlier part of the septate portion broadly elliptic, the major axis being the dorsoventral; the living chamber and mature part of the cone have an oval or roundly triangular section, the outer (ventral) side being very broadly rounded, the inner side narrowly so and the lateral parts nearly flat, sloping to the dorsal ridge.

Camerae very deep, last septa being 21 mm apart on the ventral side and about 8 mm on the dorsal side; sutures transverse with a broad, low saddle extending the full width of the venter. Depth of septum almost half the depth of the camera; siphuncle not retained; living chamber relatively very large, widening at the same rate as the septate portion; aperture not contracted, but open and simple. Surface unornamented, save by closely and regularly disposed, faint growth lines, the course of which indicates the presence of a shallow hyponomic sinus on the convex side of the cone.

Locality. Lower Shelby dolomite, Oak Orchard creek.

Observations. This large species has no equal in size among the curved cephalopods of the Guelph of Canada or the Interior; it compares well in this regard with the large forms to which Barrande applied the terms C. tyrannus and C. rex. Cyrtoceras hercules Winch. & Marcy (= Cyrt. (Phragmoceras) amplicorne Hall) is a large form from the Waukesha and Racine beds of Wisconsin, which possesses a stronger curvature and broader venter. Cyrtoceras bovinum, a smaller, similarly curved species from the Guelph at Rochester, expands more rapidly and has shallower camerae. Phragmoceras nestor Hall, reported as from the Niagaran at Wauwatosa Wis., is readily distinguished from Protoph. patronus by the constriction of its aperture, its shorter living chamber and shallower camerae; from Phragmoceras byronensis Worthen,[1] described from the Niagaran of Port Byron Ill., and which very much resembles the Shelby species in the degree of its curvature and rate of expansion, it differs in the same particulars.

The form of the shell, the degree of curvature and expansion, suggest relationship to Phragmoceras, as was also indicated in Hall's description of C. amplicorne by addition of that generic name in parenthesis. Its open aperture and slightly developed dorsoventral expansion indicate that it represents one of the primitive types of the Phragmoceratidae, for which Hyatt has created the genera Cordoceras and Protophragmoceras. On account of the general similarity of our form with the type of the latter genus, Protoph. murchisoni Barr., which makes itself obvious in the curvation, expansion, situation of hyponomic sinus and ventral position of sutural saddle, we refer the species thereto.

---

[1] Geol. Sur. Illinois, 6: 506.

PHRAGMOCERAS Sowerby

Phragmoceras parvum Hall & Whitfield

Plate 21, fig. 1-8

Phragmoceras parvum Hall & Whitfield, Paleontology of Ohio. 1875. 2: 151, pl. 8, fig. 10

Phragmoceras parvum Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 41, pl. 7, fig. 2

Phragmoceras parvum Arey, Rochester Acad. Sci. Proc. 1892. 2: 107

Phragmoceras parvum Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 105

Of the several species of Phragmoceras which have been described by various authors from American Upper Siluric faunas one, P. parvum, is notable for its small size and the projection of the dorsal horn of the aperture. This species has been described only from internal casts of the chamber of habitation. The original is from the dolomites at Cedarville, Greene co. O., and others identified therewith are from the Guelph at Hespeler. There are before us several fine small examples of Phragmoceras from Rochester which retain in exceptional perfection the exterior surface, the form of the apertural and septate portions, features which for the most part have not been made known of P. parvum.

These shells in their entire condition are unguiform, sloping from a stout chamber of habitation by a gentle curve to an acute apex, the septate portion making about one half the length of the shell. The section of the living chamber is broadly oval, but on the earlier parts the cone is more flattened on the sides. The ventral margin is very broad, the dorsal narrowly rounded and subangular. In expanding upward, the shell becomes rather abruptly swollen at the base of the body chamber, thence, at first gradually, then abruptly, contracting to the aperture, where two lateral flanges of the shell almost meet in a median line, leaving a slitlike opening between. The surface of this almost plane and vertically deflected area slopes upward to the ventrolateral angle, where it is somewhat produced in the form of a rather blunt tube. At the dorsolateral angle the tube is narrower and greatly produced. This latter feature is one of the distinguishing characters of the species.

The septa are slightly but regularly concave, the camerae quite shallow. The siphuncle is ventral and almost marginal on the earlier septa; its position on later septa has not been observed. The surface, not heretofore noted, is ornamented by quite regular, low, broad, concentric ridges separated by narrow interspaces. These make a broad backward curve on the venter, bend upward at the sides, and on the dorsum make a sharply angular, posterior curvature. At the aperture they are not parallel to or concentric with the margins.

Dimensions. A specimen nearly entire to the apex has a length of 50 mm, the greatest diameter (living chamber, not including apertural extensions) being 28 mm.

Locality. Upper Guelph horizon, Rochester.

TROCHOCERAS Barrande. 1847
(SPHYRADOCERAS Hyatt)

Trochoceras desplainense McChesney

Plate 20, fig. 3-9

Trochoceras desplainensis McChesney, New Paleozoic Fossils. 1859. p. 68, pl. 6, fig. 1

Trochoceras desplainense Hall, N. Y. State Cab. 20th An. Rep't. 1867. p. 359, pl. 16, fig. 8, 9, 10

Trochoceras desplainense Whiteaves, Paleozoic Fossils. 1884. v. 3, pt 1, p. 36, pl. 5, fig. 5

Trochoceras desplainense Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 105

The specimens which we identify with this species are of better quality than those which have heretofore been figured and studied, one of them retaining almost in its entirety the living chamber and aperture, another of somewhat smaller size preserving the umbilical aspect of the entire final whorl to the aperture, while still other specimens illustrate the grosser and finer characters of the early surface.

This completeness of the material at hand gives basis for the amplification of the characters of the species which have heretofore been drawn solely from the immature conditions of the shell.

Shell dextral, forming a low torticone of about two and one half volutions, not quite one half of the last volution being occupied by the living chamber. The volutions expand and coil downward very gradually, so that the apex of the shell and the upper side of the outer chamber lie in almost the same horizontal plane. The section is described by McChesney as being subelliptic with the dorsoventral diameter greater than the lateral, while Hall states that the volutions in these immature examples are "essentially circular." The Rochester specimens are subcircular in the section of the early part of the last whorl but become laterally flattened in later growth, so that in the final stages the cross section is ovate. The ventral side is subacutely and the dorsal obtusely rounded, but the latter is not flattened nor does it bear any trace of an impressed zone. In gerontic specimens the sides become flattened to parallel planes, a fact mentioned by Hall as characteristic of the genus. The siphuncle, which is described and figured by Hall as being central, is centren in the nepionic whorl, becomes however, in the mature stage, as shown by several of the Oak Orchard creek specimens, ventrocentren. The ventral position of the siphuncle is given by Hyatt as a family character of his Plectoceratidae, to which this genus appertains. The siphuncle is small, apparently tubular. The camerae are of slight depth and the septa closely arranged (the final ones 3 mm apart), the suture has a prominent saddle on the venter and a broader and lower one on the dorsum. The lateral lobes are shallow and broad, deepest near the dorsolateral curve.

The surface sculpture consists, in the earlier stages, of angular, oblique ridges, with slightly concave to flat interspaces. These bend strongly forward on the dorsal and backward on the ventral side, thus intersecting the suture lines at a considerable angle. They become faint as growth advances and on the last half or two thirds of the final whorl are obsolescent, in old shells disappearing before septation ceases. Concentric with these ridges and covering both ridges and the intervening sulci, are finer lines which are crossed and cancelated on the early shell by revolving lines of the same size. With the obsolescence of the ridges, the concentric lines retained to the aperture become more and more conspicuous and defined. The revolving lines may also be seen under favorable conditions in later growth.

The living chamber continues in the curve of the volutions, though, in a gerontic stage, it continues in a nearly direct line. The aperture is large, provided with a shallow dorsal and probably a deep ventral sinus.

Localities. Not infrequent in the lower Shelby dolomite and at Rochester; rare in the upper Shelby bed.

This form was first described by McChesney from the "Niagara division" of Joliet and on the Kankakee river, Ill. Professor Hall obtained his specimens from Racine Wis. and Whiteaves reports two specimens from the Guelph at Hespeler. The shell is definitely dextral and is thereby distinguished from the otherwise closely allied form termed Troch. aeneas Hall[1] from the dolomites at Lyons Ia.

The generic term Trochoceras was employed by Barrande in 1847 and independently introduced by Hall in 1852. The former's conception of the generic value is expressed in the species T. optatum Barr. (Etage E), which is very closely allied to T. desplainense, but is a sinistral shell. Hall's type is T. gebhardi Hall of the Coralline limestone, a shell with high spire, smooth whorls and of quite distinct aspect from the group under consideration; it has been made by Hyatt the type of his genus Mitroceras. Hyatt has taken Barrande's Troch. optatum as the type of his genus Sphyradoceras, and we have therefore employed Trochoceras here in the restricted sense ascribed to Sphyradoceras by its author.

Hyatt considers Sphyradoceras as an offshoot of Spyroceras, a genus with, in early growth, longitudinally ridged, and, in later, annulated longicones; and mentions the presence of longitudinal ridges among the generic characters of Sphyradoceras. Our material does not show this last

[1] N. Y. State Cab. of Nat. Hist. 20th An. Rep't, revised ed. pl. 25, fig. 16.

named feature, but it appears that the fine longitudinal lines mentioned above would point to the presence of longitudinal ridges in the neanic stage, as they do in Spyroceras, in which Clarke[1] has shown from Spyroceras bilineatum, that coarser longitudinal ridges, with advancing growth and by interplantation, become changed into more numerous uniform, fine, longitudinal striae. The presence of such fine, longitudinal striae in Troch. desplainense allows us, hence, to infer the presence of longitudinal ridges on the earliest parts of the conch.

Trochoceras costatum Hall

Plate 20, fig. 1, 2

Trochoceras costatum Hall, Geol. Sur. Wisconsin. Rep't Prog. for 1860–1861

Trochoceras costatum Hall, N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1868. p. 360

Trochoceras costatum Hall, N. Y. State Cab. Nat. Hist. 20th An. Rep't. revised ed. 1870. p. 402, pl. 25, fig. 15

With the specimens of Trochoceras desplainense from the lower dolomite at Shelby, are several which are not only sinistral, but also differ from the former in their loose coiling and closer arrangement of costae, sufficiently to warrant their reference to T. costatum, another species reported from the Racine limestone.

Conch a low torticone, slightly asymmetric, but sufficiently to show that it is sinistral, very closely coiled, with wide open umbilicus, expanding moderately; whorl beginning with circular section, becoming within the first volution depressed convex and assuming an oval section; position of siphuncle not determined; surface ornamented by strong annulations, which cross the sides obliquely backward, in the earlier part of the whorl, being slightly curved, with the convexity directed forward, and becoming slightly sigmoidal on the later portion. On the venter they are curved backward. The costae number nine within the first 10 mm of the whorl, and the interspaces increase regularly till there are at the end of the whorl five costae within 10 mm.

---

[1] Geol. Minnesota, v. 3, pt 2, p. 786.

Observations. In describing this species, Professor Hall stated that it differed from T. desplainense in its more numerous and more sharply elevated annulations, which do not increase beyond the point opposite the apparent apex of the shell. As "a conspicuously distinguishing feature," is cited the sinistral direction of the volutions. A comparison of the specimens here described with our material of T. desplainense leaves no doubt as to the greater prominence and closer arrangement of the costae in that species, characters which give a distinctly different habit to the shell. In regard to the sinistral enrolment, Hall deemed it necessary to add an explanatory note, stating that, as in T. desplainense the inner volutions are sometimes a little depressed below the outer, it might perhaps be suspected that T. costatum is an exaggerated condition of the former species, with the inner volutions still more depressed. This, however, is claimed not to be the case, as T. costatum is clearly sinistral. It is added that Barrande described several sinistral forms of Trochoceras and found that "the enrolment is sometimes dextral and sometimes sinistral according to the species, but the dextral forms greatly predominate." In two forms, however, viz T. asperum and T. sandbergeri, Barrande concedes that "we find both modes, varying in individuals." Barrande's descriptions and fine figures of these two species, show that they are but very slightly asymmetric. They belong therefore near the beginning of the morphologic series, which according to Barrande, extends from perfectly symmetric to the highly asymmetric torticones; and it may be inferred that the tendency to become asymmetrically enrolled to the right side had not yet become established in these Bohemian forms. The two sinistral species described by Hall, viz T. costatum and T. aeneas, when compared with the decidedly dextral T. desplainense, are conspicuously less asymmetric, and therefore appear to represent an earlier and less fixed stage. We are disposed to believe that the species of Trochoceras can not be naturally divided into a sinistral and a dextral series, but that, as by far the prevailing number of species and those the most progressed, are dextral and the sinistral are but slightly asymmetric, the general tendency is toward a dextral enrolment, and the sinistral forms represent only early variations. It should be noted also that the late Devonic species are all dextral.

As Professor Hyatt has made no mention of this difference in enrolment, it may be inferred that he did not regard it of special significance. He did, however, at one time[1] separate from Trochoceras in its restricted sense the genera Peismoceras and Systrophoceras, basing these divisions principally on the characters of the aperture, position of siphuncle and section of whorl. From a note in Whiteaves's description of T. desplainense, it seems that Hyatt would have referred that species and evidently also T. costatum to his Peismoceras. In Zittel-Eastman's *Textbook of Paleontology*, however, he has covered these names again under Sphyradoceras, which is here considered a synonym of Trochoceras Barrande, *sensu stricto.*

Trochoceras costatum was described as from the Niagaran limestone at Racine and near Milwaukee Wis. In v. 2, *Geology of Wisconsin* it is only cited by Chamberlin among the species of the Racine limestone, but not among the Guelph forms.

ANNELIDA

CORNULITES Schlotheim

Cornulites arcuatus Conrad

Plate 4, fig. 1-5

Cornulites arcuatus Conrad, Acad. Nat. Sci. Jour. 1842. 8: 276, pl. 17, fig. 8

Three well preserved specimens from the dolomites at Rochester and a greater number from both horizons near Shelby are referable to this species which was described as follows:

Curved, rapidly attenuate; the base of each ring contracted, the upper edge angular.

It is not altogether certain that Cornulites flexuosus Hall (= C. clintoni Hall) from the Clinton, is sufficiently different to permit

[1] Phylogeny of an Acquired Characteristic, p. 500 and 502.

the separation from this species though Professor Hall failed to identify Conrad's species. Another specimen preserved as an internal cast has the body longer and more slowly tapering than the rest, while the rings project more at their lower ends; this may represent a form approaching C. flexuosus.

Most of these specimens are internal casts in part retaining the wall of the tube.

No specimens of Cornulites are reported from the Guelph formation; Conrad's originals came from the Niagaran dolomite in the neighborhood of Albion, Orleans co.

OSTRACODA

LEPERDITIA Rouault. 1851

Leperditia balthica Hisinger, var. guelphica Jones

Plate 21, fig. 9-11

Leperditia balthica Hisinger, var. guelphica Jones, Contrib. Canadian Paleontology. 1891. pt 3, p. 80, pl. 13, fig. 12a, 12b, 13a-c

Leperditia balthica Hisinger, var. guelphica Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 106

Of quite common occurrence in the dolomites at Rochester are specimens of a large Leperditia agreeing in dimensions with the form which Professor T. R. Jones has described under the name given above. These are valves measuring, in the adult stage, from 10-12 mm in length, 5-6 mm in hight, with long straight hinge, both angles of which are salient and beyond which the curving margins of the valves extend for a slight distance. The surface is smooth and quite convex, most so in front of the middle; the anterior slope abrupt, posterior gradual, the eye lobe well defined. These features serve to distinguish it from L. phaseolus Hisinger, var. guelphica Jones (Guelph of Ontario), which is more oblique in outline, with angles not projecting and convexity more regular.

It seems quite possible that on close comparison L. balthica guelphica may be found identical with L. fonticola Hall[1] from

[1] N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 335.

Niagaran dolomites at Fond du Lac Wis., and it is evidently closely related to L. scalaris Jones of the upper or Manlius waterlimes at Buffalo and elsewhere in Western New York.

Leperditia sp. ?

Another large species of this genus is present in the Rochester fauna, but the examples observed are insufficient for its determination. It has narrower and more elliptic valves, rounded extremities and a curving hinge line. It may eventually prove to be the L. phaseolus Hisinger, var. guelphica Jones.

A small Leperditia has been also noticed in the Lower Shelby dolomite.

TRILOBITA

CALYMMENE Brongniart. 1822

Calymmene niagarensis Hall

Plate 21, fig. 12

Calymene niagarensis Hall, Geology of New York; Rep't on Fourth Dist. 1843. p. 182, fig. 3 (p. 101)

Calymene blumenbachii var. niagarensis Hall, Paleontology of New York. 1852. 2:307, pl. 67, fig. 11, 12

Calymene blumenbachii Whiteaves, Paleozoic Fossils. 1895. v. 3, pt 2, p. 107

The material of the Arey collection contains a few separated parts of this species, all of the usual small size prevalent in the Rochester shales of New York, the outcrops at Waldron and quite generally diffused in upper Siluric strata. In the upper layers at Shelby all the specimens observed attain much larger size than these.

Dr Whiteaves reports the species as occurring in the Guelph at Galt. It is also reported by Whitfield from Cedarville O., but does not seem to occur in the Guelph of Wisconsin.

DALMANITES Emmrich. 1845

Dalmanites sp.

A fragment consisting of some thoracic somites and part of the pygidium insufficient however to determine the species was found at Rochester. The surface of both parts is more coarsely granulose than in D. limulurus Green, and a row of coarse tubercles upon the segments indicates relationship to D. verrucosus Hall. The segmentation of the pygidium however is unlike either and the specimen may represent an unknown form.

PROETUS Steininger. 1830

Proetus sp.

Plate 21, fig. 13-16

At Rochester was obtained a single internal impression of a cranidium of Proetus with tapering glabella, quite narrow and convex but not protuberant in front, eyes small and closely appressed to the glabella, anterior border thickened and separated from the glabella by a narrow sulcus. This form may prove to be the species referred to by Hall as Asaphus stokesi Murchison[1] but that is believed to have the anterior end of the glabella more remote from the border as it is described as having "the space between it [border] and the cheeks and glabella depressed in a broad, shallow groove." Proetus corycaeus Conrad is of a somewhat different type of glabellar structure.

The material from Shelby has afforded besides a glabella several small pygidia of a Proetus with highly elevated strongly annulate axis and deeply sloping pleurae with three or four obscure duplicating ribs. These are also features ascribed to P. stokesi Hall.

The relatively frequent occurrence of the specimens of this genus in the eastern Guelph is interesting in view of the fact that no species of Proetus has been elsewhere reported from this fauna.

---

[1] Pal. N. Y. 1852. 2:316.

SYNOPTIC LIST OF GUELPH FOSSILS OF NEW YORK

c = common, cc = abundant, r = rare, rr = very rare

		LOWER SHELBY DOLOMITE	UPPER SHELBY DOLOMITE	ROCHESTER DOLOMITE	OTHER LOCALITIES
1	Zaphrentis *cf.* racinensis *Whitf.*	-	rr	c	Racine beds of Wisconsin, Guelph of Canada
2	Enterolasma *cf.* caliculus *Hall* (sp.)		-	c	Rochester shale, Lockport limestone, Racine limestone
3	Diplophyllum caespitosum *Hall*	-	-	c	Anticosti group, Lockport limestone of New York and Canada, Niagara and Guelph of Wisconsin
4	Heliophyllum *sp. ind.*	-	-	rr	
5	Favosites niagarensis *Hall*	-	cc	cc	Lockport limestone of New York and Niagaran and Guelph of Wisconsin
6	F. hisingeri *E. & H.*		c	c	Niagaran and Guelph of Ontario and West
7	F. gothlandicus *Lam.*	-	-	rr	Anticosti group, Niagaran and Guelph of Canada, Niagaran of New York, Michigan and Wisconsin
8	F. forbesi *E. & H.*	cc	c	c	Guelph of Canada?
9	Cladopora multipora *Hall*	cc	cc		Lockport limestone of New York
10	Halysites catenularius *Linné*		c	cc	Niagaran and Guelph of Canada and West
11	H. agglomeratus *Hall*		r	r	Lockport limestone of New York, Coral beds of Wisconsin, Guelph of Ontario (Nich.)
12	Syringopora infundibulum *Whitf.*		c	-	Racine beds of Wisconsin, Guelph of Ontario
13	Stromatopora galtensis *Dawson*	cc?	c	c	Guelph of Ontario
14	Clathrodictyum ostiolatum *Nich.*		cc	cc	Guelph of Ontario
15	Crania		-	rr	
16	Monomerella noveboracum *sp. nov.*	cc		-	Mon. prisca its closest ally occurs in the Guelph of Canada, Ohio and Illinois

		LOWER SHELBY DOLOMITE	UPPER SHELBY DOLOMITE	ROCHESTER DOLOMITE	OTHER LOCALITIES
17	Dalmanella *cf.* elegantula *Dal.* (sp.)	-	r	rr	Niagaran of New York and Guelph of Ontario and Wisconsin
18	D. *cf.* hybrida *Sow.* (sp.) - - -		-	rr	Niagaran of New York and West, Racine of Wisconsin
19	Leptaena rhomboidalis *Wilckens* (sp.)	rr	-	-	Rare in Guelph of Wisconsin
20	Camarotoechia ? neglecta *Hall* (sp.)	-	c	c	Niagaran, Guelph of Wisconsin
21	C. ? indianensis *Hall* - -	r	c	c	Niagaran of Indiana and Kentucky
22	Spirifer crispus (*His.*) *Hall* var. -		c	c	Niagaran and Guelph of Canada
23	Whitfieldella nitida *Hall*	-	cc	cc	Niagaran of New York, Racine of Wisconsin
24	Rhynchotreta cuneata americana *Hall*		rr	-	Niagaran of New York and West
25	Mytilarca eduliformis *sp. nov.* -	-	-	r	
26	M. acutirostrum *Hall* -	r	-		Racine and Guelph of Wisconsin
27	Pterinea subplana *Hall* -	-	rr	rr	Rochester shale
28	P. undata *Hall* (sp.) - -	-	rr	-	Rochester shale
29	Conocardium *sp.* - - - -	-		r	Conoc. sp. in Guelph of Ontario
30	*Cf.* Modiolopsis subalata *Hall* -		rr	-	Clinton and Rochester shale
31	Bellerophon shelbiensis *sp. nov.*	c		-	Niagaran and Canadian Guelph
32	Trematonotus alpheus *Hall* -	cc	rr	rr	Racine of Wisconsin, Chicago limestone, Guelph of Canada
33	Diaphorostoma niagarense *Hall* (sp.)	-	rr	rr	Rochester shale, Guelph of Wisconsin
34	Poleumita scamnata *sp. nov.* -	-	c	cc	Canadian Guelph
35	P. sulcata *Hall* - - - - -	-	r	r	Guelph of Newark, Wayne co. N. Y., Canadian Guelph
36	P. crenulata *Whiteaves* (sp.) - -	c	-	c	Canadian Guelph
37	Trochonema *cf.* fatuum *Hall* - -	-	rr	-	Guelph of Wisconsin
38	Eotomaria durhamensis *Whiteaves* (sp.)	-	-	rr	Canadian Guelph
39	E. areyi *sp. nov.* - - - - - -	-		rr	
40	E. kayseri *sp. nov.* - - - - -		-	rr	
41	E. galtensis *Billings* (sp.) -	rr	rr		Canadian Guelph

		LOWER SHELBY DOLOMITE	UPPER SHELBY DOLOMITE	ROCHESTER DOLOMITE	OTHER LOCALITIES
42	Lophospira bispiralis *Hall* (sp.)	c		r	Rare in Guelph of Ontario
43	Hormotoma whiteavesi *sp. nov.*	-	r	cc	
44	Coelidium macrospira *Hall* (sp.)	c	rr	c	Guelph of Ontario and Wisconsin
45	C. *cf.* vitellia *Bill.* (sp.) -			rr	Guelph of Ontario
46	Macrochilina *sp. ind.* - - - -			rr	
47	Euomphalus fairchildi *sp. nov.* -	-		rr	
48	Orthoceras trusitum *sp. nov.* - -	c	rr	c	
49	O. crebescens *Hall* - - -	c			Waukesha, Racine and Guelph beds of Wisconsin
50	O. rectum *Worthen* - - -	rr			"Niagara limestone" of Joliet Ill.
51	Dawsonoceras annulatum *var.* americanum - - - -	c		r	Niagaran of New York, Guelph of Ontario
52	Kionoceras darwini *Bill.* (sp.) -	c		c	Racine and Guelph of Wisconsin, Guelph of Ontario, limestone of Yellow Springs O.
53	K. *cf.* medullare *Hall* (sp.) - - -	rr	-		Waukesha and Racine beds of Wisconsin, Niagaran of Joliet Ill. Canadian Guelph
54	Cyrtoceras arcticameratum *Hall* -			r	Guelph of Canada and Wisconsin
55	C. orodes *Bill.* - - - -	r		r	Guelph of Canada
56	C. *cf.* brevicorne *Hall* - - -	rr?		rr	Racine beds of Wisconsin
57	C. bovinum *sp. nov.* - - -			c	
58	Cyrtorhizoceras curvicameratum *sp. nov.*	c			
59	Trochoceras desplainense *McChesney*	c	rr	r	Niagaran of Joliet and Kankakee river, Illinois, Racine of Wisconsin, Guelph of Canada
60	T. costatum *Hall* - - - -	c			Racine of Wisconsin
61	Gyroceras farcimen *sp. nov.*	r			
62	Poterioceras sauridens *sp. nov.* - -	cc		rr	
63	Poterioceras *sp.* -	rr			
64	Protophragmoceras patronus *sp. nov.*	rr			
65	Phragmoceras parvum *Hall & Whitfield*	-	-	r	Guelph of Ohio and Canada

		LOWER SHELBY DOLOMITE	UPPER SHELBY DOLOMITE	ROCHESTER DOLOMITE	OTHER LOCALITIES
66	Cornulites arcuatus *Conrad*	c	c	c	Lockport limestone
67	Leperditia balthica *var.* guelphica *Jones*		-	c	Canadian Guelph
68	Leperditia *sp.*	rr	-	r	
69	Calymmene niagarensis *Hall*		r	r	Niagaran of New York, Guelph of Ontario and Ohio
70	Dalmanites *sp.*	-	-	rr	
71	Proetus *sp.*		r	rr	

Summary

Total species recorded from the Guelph fauna of New York		71
From Shelby		52
From Rochester		52
Common to	upper and lower Shelby horizons	10
"	upper Shelby and Rochester	25
"	lower Shelby and Rochester	14
"	Shelby and Canadian Guelph	26
"	upper Shelby and Canadian Guelph	15
"	lower Shelby and Canadian Guelph	13
"	Rochester and Canadian Guelph	27
"	New York and Canadian Guelph	31
"	Shelby and Niagaran faunas of New York	17
"	Rochester and Niagaran faunas of New York	16
"	New York Guelph and Niagaran faunas	19
"	Shelby Racine, and Waukesha limestones	12
"	Rochester, Racine and Waukesha limestones	8
"	New York and Wisconsin Guelph	13
Species at	Shelby not recorded from Rochester	19
"	Rochester not recorded from Shelby	18

In considering the relative prevalence of the various classes of organisms in these manifestations of the Guelph fauna in New York we observe that the several classes have the following distribution:

	CORALS	BRACHIOPODS	LAMELLIBRANCHS	GASTROPODS	CEPHALOPODS	CRUSTACEANS
Lower Shelby	2+	3	1	4	15	0
Upper Shelby	9	6	2	6	2	3
Rochester	12	7	3	15	10	5

In the lower Shelby horizon the cephalopods prevail, notably in species and profusely in individuals; furthermore of the three brachiopods one is Monomorella noveboracum which extraordinarily abounds and is nowhere else seen; of the four gastropods Trematonotus alpheus is amazingly prolific and Poleumita crenulata is very common. As to the corals we have every reason for believing that, originally abundant, their skeletons have been largely destroyed by diagenesis.

In the upper Shelby-Rochester horizon, there has been less destruction of the corals, and the gastropods and cephalopods are prevailing species though not rising to such individual development as in the earlier appearance.

Comparing this condition with the relative development of these classes in the typical Guelph fauna of Ontario as given by Dr Whiteaves we find a corresponding prevalence of gastropods and cephalopods; the lamellibranchs are few in species (nine in a total fauna of 133 species) but one of these is the ponderous Megalomus canadensis which is extraordinarily abundant at definite horizons. The brachiopod species rise to 24 but it is a noteworthy fact that throughout this fuller representation of the Guelph fauna there is a larger percentage of normal or slightly modified Niagaran forms than is present in the New York Guelph. No crinoids or bryozoans are present in either case.

CONDITIONS OF LIFE AND SEDIMENTATION

DURING THE PREVALENCE OF THE GUELPH FAUNA

In surveying the composition of this fauna one is impressed with the fact that irrespective of class divisions, the species on the whole are either large and heavy shelled or diminutive and thin shelled. We may cite in illustration of this the condition among the brachiopods. The Trimerellidae including the genera Trimerella, Monomerella and Rhinobolus are notable, not alone for their abundance but as well for their great size and weight. Similarly heavy and abundant in Ontario is Pentamerus occidentalis, but for the rest of the brachiopod species all are not merely small and thin shelled but diminutive, specially those which have been continued forward from earlier existence in the Niagaran fauna. Among the lamellibranchs the Canadian fauna contains, as just noted, the heavy Megalomus in surpassing abundance and another thick shelled species, Goniophora crassa, but the other species in Canada and all in New York are small and insignificant. The gastropods are chiefly long, heavy, turreted shells, but a few are of small size. If a diverse habit of growth is indicated by these differences we find that among the cephalopods more uniform effects are expressed as though uniform conditions encompassed and qualified this entire group. The well known habit of life of these creatures would preclude the likelihood of their being subjected to such widely distinct conditions as those which have affected the rest. Of the trilobites all the large species of the Niagaran fauna are absent.

Professor T. C. Chamberlin, in studying the character of the upper Siluric dolomites of Wisconsin, recognized the fact that the lenticular accumulations of the Racine limestone were ancient coral reefs and we shall find on comparison of the phenomena presented by the dolomites in New York with these Racine reefs, with the Jurassic reefs which have been elaborately investigated in France and with conditions of life and sedimentation prevailing on existing reefs, conclusive reasons for construing those dolomites as reef formations.

We may note, first, that the dolomite which carries the chert nodules of the upper horizon (upper Shelby and Rochester) is highly magnesian.[1]

It shows no stratification, is usually dark and so bituminous that it gives off a strong petroleum odor when fresh or struck with the hammer. It is for the most part granular, though compact and contains numerous white silicious concretions in which the fossils are preserved. Outside of these nodules fossils are rarely found except remains of Stromatopora, Halysites and other corals.

It is claimed by Walther and other writers and may be regarded a matter of general acceptance that noncrystalline dolomites carrying so high a percentage of magnesia as these are distinctly coraligenous.[2] Coral rocks of later geologic age may show higher percentages of magnesia than this as the amount apparently increases the longer the process of diagenesis continues; in other calcareous deposits the content of magnesia is always small and this is in correspondence with the fact that shell limestones now forming are low in magnesian content. The skeleton of living corals actually contains but relatively little magnesian salts (Madrepora muricata 2.4% and Isis 6.3%) but it is known that during diagenesis or the sum of the little known processes by which a sediment is changed into rock,[3] the coral

[1] One of the white chert nodules from the Nellis quarry, Rochester gave the following:

SiO_2	74.973%	Mg	4.366%
Ca	5.613%	CO_2 & H_2O	9.112%
Fe & Al	.68%	(Analysis by P. N. Coupland)	

The dark dolomite from the same locality gave: MgO 20.95% or $MgCO_3$ 44±%. The lighter dolomite from the lower Shelby bed at Shelby gave: MgO 16.43% or $MgCO_3$ 36±%. (Analyses by G. I. Finlay)

[2] Walther. Einleitung in die Geologie als historische Wissenschaft. 1894. p. 663 *et seq.*

[3] Doelter and Hoernes have supposed [*Jahrb. k. k. geol.-Reichsanst.* Vienna. 1875. p. 331] that the magnesian salts of the sea water, specially Mg Cl, act on the calcareous secretions of the organisms as soon as formed. Walther [*op. cit.* p. 708] thinks the product due in large measure to bacterial action, just as bacteria have been shown to produce deposits of calcium carbonate by forming ammonium carbonate which in turn acts on the calcium sulfate of the sea water.

rock segregates and concentrates the magnesia of the sea water more than any other sedimentary material. We may note that the admixture of bituminous matter in these Guelph dolomites is further indication of their coral reef origin, or is at least in harmony with recent observations on living coral reefs where petroleum has been found in process of formation as a result of the transformation of the organic matter of the reef. The cavernous character of the dolomites may, according to the views of Walther and others, be regarded not as the result of subsequent corrosion but as the remnants of original cavities in the growing reef which have not been closed up with coral sand.

The chert concretions which are characteristic of the upper Guelph horizon at Rochester and Shelby are doubtless a byproduct of the diagenesis which altered the coral limerock to a dolomite. These nodules contain fossils with their exterior ornament finely retained, that is replaced in amorphous silica, while in the dolomite the shell substance has been removed and never replaced. The source of the silica here, as in the like segregations associated with limestone, is probably to be found in spicules of sponges, organisms which contribute importantly to the comminution of shells and coral skeletons, specially the boring forms like Cliona.[1] It is known that sponges, both silicious and calcareous occur abundantly on the western edge of the Florida bank.[2]

The suggestion, derived from its lithologic characters as to the reef origin of the rocks, is fully borne out by the character of the fauna. The dolomite everywhere contains fragments or traces of corals specially of Stromatopora, Favosites, Syringopores and Cladopora. Here, however, as in other cases of fossil coral reefs, the coral masses have been largely destroyed or altered beyond recognition.

We have noted the existence of extremes of size in the Guelph organisms, the ponderous heavy shelled species, and the diminutive forms. One reading the account given by Klunzinger[3] of the life inhabiting the reefs

---

[1] Hancock. Ann. and Mag. Nat. Hist. ser. 2. 3: 231.

[2] Agassiz, A. Three Cruises of the Blake. 1888. 1: 149.

[3] Bilder aus Oberägypten. 1878. p. 334.

of the Red sea learns that in the numerous cavities and in the small ponds between the masses of seaweed there is displayed an overwhelming variety of small gastropods, echinoderms, lamellibranchs and crustaceans. The gastropods are evidently the prevailing class, the lamellibranchs fewer and the cephalopods almost wholly absent. On the outer edge of the reef where the surf beats with wild force and the corals best flourish there are the thick shelled mollusks which without hiding defy the surf; species of Conus, Ricinula, Fasciolaria, Turbinella and Trochus. The ponderous Monomerellas, Rhinoboli, Trimerellas, Pentamerus, Megalomus, Goniophora crassa and the numerous large gastropods were obviously adapted to similar life conditions on the Guelph reefs, and the contrasting abundant small gastropods, brachiopods and lamellibranchs found congenial conditions in the cavities between the branches of the coral stocks and in the ponds among the alga patches on the reef.

More than one consideration suggests that increasing salinity assisted the development of the thick shelled mollusks. We must look upon the Guelph as a distinct phase in the development of the vast Niagaran coral sea into the desiccating, inclosed sea of the Salina stage, when the salinity of the water finally destroyed all life. The subsequent discussion of the Guelph will show that the Guelph sea was the outcome of a shrinking of the Niagaran sea; it is a derivative of the Niagaran fauna, specially of that element which distinguishes the Racine dolomite of Wisconsin, but it has greatly diminished and its residuum shows a definite adaptation to peculiar conditions. It is therefore legitimate to conclude that the inclosure and desiccation of the continental Niagaran sea had already begun to manifest its influence. Investigations of recent marine faunas sufficiently support this view. Von Baer has shown[1] that in the deep eastern channel of the Caspian sea the magnesian carbonate is much increased and the calcium salts are decreased over their relative proportions elsewhere; under this altered composition of the sea water the shells grow thick and heavier,

[1] Neues Jahrb. für Mineral. 1856. p. 591.

while in the less saline waters of the shallow region they are thin and small.

The dolomite series from the top of the Rochester shale into the Salina bed shows an irregularly increasing magnesian content and increasing salinity. The occurrence of immense banks containing millions of the extraordinarily ponderous Megalomus suggests that increasing salinity may be an essential cause of its great size, for oysters are known to similarly increase in size and thickness of shell in the deeper and more saline parts of the sea. The corals, however, are considerably more sensitive to lack of salt than to increase in salinity. They avoid the neighborhood of river mouths but flourish luxuriantly in the Red sea, which receiving little fresh water drainage, and having but restricted communication with the open sea, is known to possess considerably higher salinity than the ocean without. Altogether the Red sea with its greater salinity, extensive coral reefs and abundant life seems an excellent portrayal of the conditions of the Guelph sea. A complete inclosure of that body of water would repeat the conditions that led to the formation of the Salina beds, with the exception that the Salina sea still at times received much terrigenous detritus.

Various writers have shown that once the optimum of salinity is passed concentration of the brine produces disastrous effects on organisms. Dall has shown that in the salt lagoons or salt pans of the Bahamas[1] the effect of this concentration is shown in the diminished size and thin shells of the mollusks and among the gastropods in a tendency to irregularity of coil and effacement of sculpture. Such extreme conditions may be conceived to have led to the depauperation and actual extinction of the fauna of the Salina stage. In this connection we may note one gastropod of the Guelph, Loxoplocus solutus Whiteaves, which is unique among upper Siluric gastropods in being a completely uncoiled Murchisonia, and which may have received the impulse to its peculiar aberration from the gradually increasing salinity of the water.

[1] Mus. Comp. Zool. Bul. 1894. v. 25, no. 9, p. 113.

We may compare the conditions of the Guelph sea and the character of its fauna with those of fossil coral reefs which have been clearly recognized in the sediments of other formations. Perhaps the best instances are to be found in the Jurassic reefs of France and the Racine reefs of Wisconsin.

In France the investigations of Oppel, Niosch, and more specially of the Abbé Bourgeat,[1] whose results are reproduced in condensed form in Felix Bernard's *Principles of Paleontology*,[2] have shown that reefs were formed at various epochs of the upper Jurassic, and that for every separate coral facies there is always a corresponding muddy or lagoon facies and pelagic facies of the same age, but very different in the character of the fossils. The reef of Valfin is cited in illustration of these conditions. The mass of the reef is described as a limestone of corallic origin; here and there in the irregular mazes is found the special fauna of the reefs which is here very abundant, and particularly rich in forms showing a thick test "which is in accordance with the fact that, the corals growing in regions beaten by waves, the forms, inhabiting them, must necessarily be provided with a strong power of resistance, while small sized species having a thinner covering are only found in well sheltered places." The fauna is described as follows: "There are of the gastropods numerous Nerineas, Cerithiums, Naticas, Turbos, Pleurotomarias; of the Acephala, Diceras (13 species), Lima, Pecten, Trigonia, Corbis; regular Echini of the family of Cidaridae." We note that the Pleurotomarias, which appear in the Guelph reef with 14 species, are still prominent upon the Jurassic reefs, the long, turreted, heavy Paleozoic Murchisonias, Loxonemas, Subulites correspond in their habit to the Nerineas and Cerithiums so prominent upon the Jurassic reefs; and the Poleumitas, so abundant in our Guelph are the Turbos of the later reefs. The Acephala however had not yet attained prominence among the earlier reefs.

On the east side of the Valfin reefs the coraligenous facies changes, passing by intercalation into marls more and more mixed with clay. This

[1] Recherches sur les formations coralligènes du Jura méridional. 1887.

[2] See translation in N. Y. State Geol. 14th An. Rept. 1895. p. 200.

is the lagoon region between the barrier reef and the shore "which was not far to the east." Its fauna is greatly different from that of the reef, the heavy Nerineas and Diceras and the corals having entirely disappeared.

On the other side of the reef the corals disappear suddenly and the pelagic facies extends far toward the north into the open sea. It is characterized by Ammonites, Belemnites, brachiopods and Echini.

The great numeric preponderance of the cephalopods in the lower Shelby dolomite would, by comparison with the equal preponderance of this class in the pelagic facies of the reef, suggest that this may represent the pelagic facies or pelagic side of an early Guelph reef.

An excellent description of the facies of the ancient coraliferous sea of Racine age in Wisconsin has been given by T. C. Chamberlin.[1] We quote part of his interesting summation:

It appears, then, that in the southern counties there are three well marked classes of limestones, with intermediate gradations, one class, consisting of very irregular often brecciated or conglomeritic dolomite, forming masses that usually appear as mounds, or ridges of rock, of obscure stratification, a second class, formed of pure, soft, granular dolomites, a part of them calcareous sandrock, and a third class, consisting of compact, fine grained, regular, even beds. We have demonstrated that the three forms change into each other when traced horizontally. They were therefore formed simultaneously. The view that best explains these facts is, (1) that the mounds and ridges were ancient reefs, and (2) that the granular sand rock was formed from calcareous sands, derived by wave-action from the reef, and (3) that the compact strata originated from the deposit of the finer calcareous mud that settled in deeper and more quiet waters, the whole process being analogous to, if not identical with, the coral formation of the present seas.

But before pursuing this analogy farther, it will be well to consider the evidences of life found in these rocks. While some of the reefs, or at least that portion of them that happens to be exposed to examination, present only a few fragments of fossils, others are prolific in organic remains, and some of them are remarkable for the richness and variety of their fauna. The reef near Wauwatosa (Schoonmaker's quarry), is a striking instance of this. There have been collected from it, chiefly by Dr Day, probably not less than 200 species. Of these there have been identified 28 corals, 8 bryo-

[1] Geol. Wisconsin. 1877. 2:368-71.

zoans, 4 crinoids, 19 brachiopods, 11 gastropods, 9 lamellibranchs, 24 cephalopods, and 16 trilobites. And an exhaustive examination of the collections would doubtless much increase the number.

Of the granular varieties of rock, that which is nearest allied to the reef rock is peculiarly notable for an abundance of crinoids. The locality near Racine is preeminent in this respect. Upwards of 30 species have been identified from this one locality. These are associated, as will be seen by consulting the table, with a large number of corals, brachiopods, gastropods, cephalopods, trilobites and a lesser number of other forms.

The fauna of the compact strata is distinguished for the conspicuous presence of the straight and curved cephalopods with comparatively few associates. The cephalopods are abundant, as already noted, in the reefs and crinoid beds, but are overshadowed by the number and variety of other forms, while in the compact rock they greatly predominate.

It appears then, (1) that upon the reefs there swarmed a vast variety of life; (2) that upon certain banks or shoal areas there was also great abundance and variety, among which the crinoid family attained unusual prominence; (3) that over areas of submarine sand flats there either was little life present, or, from the porous nature of the rock, it has been illy preserved, and (4) that over the deeper areas, that deposited fine calcareous mud, the gigantic cephalopods held sway. The counterpart of all this is to be found among the coral reefs of today.

These conditions in Wisconsin continued from Racine into the Guelph time, as Chamberlin says of the Guelph (p. 377):

In its lithological character, in does not differ essentially from the Racine limestone, being in general a rough, thick bedded, irregular dolomite, usually quite free from impurities, and of buff, gray, or blue color. The distinction between the two subdivisions is a paleontological rather than a physical one. In the latter respect there is less difference between these than either of the other members of the group. There was evidently no marked change in the physical history of the region, but the same conditions continued from the beginning of the deposit of the Racine limestone to the close of the formation of the Guelph beds. In the interval, however, the life underwent a change by the introduction of the species that characterize the Guelph horizon. This introduction was gradual, so that many localities show a mingling of the two faunas.

In New York the Guelph period was still a time of coral reefs, and the distribution of the peculiar fauna, characteristic of this reef in Ontario and Ohio, shows that probably the entire shallow Guelph basin was more or less studded with coral reefs.

DISTRIBUTION OF THE GUELPH

In the identification of the Guelph fauna in North America difficulties arise from two sources, firstly from the evident failure to discern between the Niagara and Guelph rock in some regions, again from the lack of reliable fossil lists of the upper Siluric. On account of the changing correlations of the upper Siluric beds in some of the states with advancing knowledge such an inquiry has to assume the character of a history of investigations upon the Guelph in these states. We, therefore, present here such a history which will furnish the data for a summary statement of the distribution of the Guelph in North America.

After Professor Hall had recorded the existence of "Onondaga salt group" fossils in Wayne county, N. Y. and in Ontario, he discovered during his geologic investigations of Iowa[1] a limestone at the Rapids of Le Claire, Iowa of which he says:

"In descending the Mississippi river the Niagara limestone is succeeded by a gray or whitish gray limestone. The whole mass is semicrystalline, very porous, and vescicular from the solution and removal of fossils." He thought that it might exceed 600 feet in thickness and adds:

So far as we are able to ascertain this important formation has not heretofore been recognized in western geology, or, if recognized, has been confounded with the Niagara limestone. From this, however, it is quite distinct, both in its lithological character and its fossil remains.

The fossils are all in the form of casts, and among them is a small Spirifer, a Spirigera, a Pentamerus undistinguishable from P. occidentalis, several gastropods and some chambered shells. In this reconnaissance no very complete collections were made, but as far as they enable us to form an opinion, the fossils of the limestones of the Le Claire rapids are very similar to those of the limestone of Galt in Upper Canada. The similarity of position is worthy of notice.

Should the identity of the limestone of these two distinct localities be proved, it will afford sufficient ground for separating these beds from the Onondaga salt group, and for establishing a distinct group. It seems quite probable that the limestones of this period have their eastern extremity in central New York, where, from their small development, as well as from

[1] Geol. Sur. Iowa. 1858. 1:73–80.

similarity of lithological character there seemed no sufficient ground for separating them from the nonfossiliferous bed of the Onondaga salt group. Since, however, in Canada these beds attain considerable importance, and (admitting the conclusions above given) acquire a still greater thickness and more distinctive character on the Mississippi river, it seems necessary to elevate these to the same rank as the other groups of the series.

Hall here first clearly recognizes the Galt beds as a separate group and this position was strongly reiterated in *Paleontology of New York*, 1859, 3:30.

This correlation of the Le Claire limestone was soon after attacked by A. H. Worthen[1] who claimed that the limestone was without any true lines of bedding, that Hall greatly overestimated its thickness[2] and that the beds and fossils at Le Claire were to be correlated with those of Bridgeport near Chicago and Port Byron Ill., "all of which are claimed to represent but the Niagara limestone." It would appear, however from Worthen's statements that the fossils upon which he bases his views, specially Pentamerus oblongus, occur only in the lower part of the bed at Bridgeport and Port Byron, while Hall already cited a distinct Guelph form in Pentamerus occidentalis from the Le Claire limestone. Hall and Clarke have cited several species of Trimerella and Monomerella from Port Byron and other localities of this dolomite and there can be no doubt that the Guelph is represented therein.

This rock is described by Worthen[3] as follows:

At Bridgeport, near Chicago, the rock presents the same general characters as at Port Byron and Le Claire, and is extensively used for the manufacture of lime. West and northwest of Chicago and just outside the city limits, it is highly charged with petroleum. . . This bituminous portion of the limestone is from 35 to 40 feet thick, and at the artesian well was found to be underlaid by about 80 feet of regularly bedded limestone, which no doubt includes the Athens marble and the Joliet limestone.

[1] Am. Jour. Science. 1862. 33:46–47; Geol. Sur. Illinois. 1866. 1:30.

[2] The latter point was conceded by Hall in the N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 307.

[3] Geol. Sur. Illinois. 1866. 1:132.

From these statements of Hall and Worthen it would appear that the uppermost 35 to 40 feet of these beds alone may represent the Guelph.

A few years later Hall explored the geology of the central and eastern portions of Wisconsin, and the adjacent parts of Illinois. His results are published in the *Report of the Geological Survey of Wisconsin*, 1862, v. 1. In this important work he separated [p. 67] the Racine limestone from the Niagara limestone proper, as the upper member of the Niagara group. Of the fauna of this limestone is said:

Few of the species are identical with those in the Niagara group farther to the east, or in the State of New York, though the Caryocrinus, in its condition of casts, is not distinguishable from the C. ornatus of New York, Kentucky and Tennessee.

The species already identified with known species of the Niagara group in New York in addition to the Caryocrinus, are Spirifer niagarensis, S. radiatus and Strophomena rugosa, while we have a Spirifer allied to S. sulcatus and an Illaenus closely allied to or identical with L. (Bumastus) barriensis.

In regard to its correlation it is stated: "It may be considered identical with the Le Claire limestone of Iowa, holding precisely the same geological position, and containing some similar if not identical fossils, and both limestones must be regarded as a part of the Niagara group."

From this statement it is clear that, on account of the recognition of New York Niagaran fossils in this Racine bed, Hall considered the Le Claire limestone, which he here correlates with the Racine, neither as belonging to the Onondaga salt group nor to a later stage than Niagaran, but as a member of the Niagaran group.

No mention was made in this report of the finding of Guelph fossils in the Racine bed, but it is stated in the *20th Annual Report of the New York State Cabinet Natural History*, 1867, p. 307:

At the same time, we have recognized from Racine and adjacent localities, including Le Claire in Iowa and a single locality in Illinois, the following species which are identical or very closely allied to those from Galt in Canada West: Pentamerus occidentalis, an Obolus-like fossil, a Favosites and a species of Amplexus which are identical in several localities, Cyclonema sulcata, Murchisonia logani, Murchisonia identical or closely allied to M. mylitta Billings, an undescribed Murchisonia identical with one from Galt, Subulites ventricosa, Pleurotomaria solarioides?, Loxonema longispira, besides other forms which are closely allied to species of the Guelph limestone.

Hall had hence clearly recognized the presence of the Niagaran and of the Guelph fauna also in the Racine beds, a conclusion which has been fully verified.

While Hall worked out the relations of these beds in the west, Billings[1] added to the Guelph fossils described by Hall in v. 2, *Paleontology of New York*, a considerable number of new forms, among them specially the large brachiopods Trimerella and Monomerella cited hitherto as Oboluslike forms, and Logan[2] described the stratigraphic relations of the formation in Canada. As to the relation of the Niagaran and Guelph Sir William remarks in this work:

In Canada, the Niagara rocks are succeeded by a series of strata, which appear to be wanting in the State of New York. . . It has already been stated that the strata seen near the mouth of the Riviere aux Sables, at Chief's Point, probably strike along the coast, by Lyell Island to Cape Hurd; and belong in part to the Niagara formation whose characteristic fossils are met with in several localities along the shore. These strata, however, have for the most part the lithologic characters of the Guelph formation, and some of their undescribed species of Murchisonia have a strong resemblance to others found in this series. The Pleurotomaria huronensis, which belongs to the Guelph rocks, occurs on Lyell island associated with Pentamerus oblongus, and other characteristic Niagara species; so that it is not impossible that some of the strata along this coast may constitute a passage between the Niagara and Guelph formation.

The Guelph formation appears to be absent from the State of New York, and in Canada it probably has the form of a great lenticular mass, the limit of which between Niagara and Guelph is uncertain, though it appears to extend beyond Ancaster. In the other direction it seems to thin out in Lake Huron, before reaching the northern Peninsula of Michigan.

Hall had noted before this[3] that "at some points on the northern shore of Lake Michigan and elsewhere in the lake region, there occurs a light

[1] Paleozoic Fossils. 1861–65. v. 1.

[2] Geol. Canada. 1867. p. 336.

[3] Pal. N. Y. 1859. 3:30.

colored limestone lying above the Niagara strata, containing generally few fossils and among them some forms not unlike those of that in Canada West."

As to the general character of the Guelph Hall concludes:[1]

I am therefore induced to believe that this limestone at Racine, the mass at Le Claire and extending thence into Iowa, as well as the Guelph formation in Canada and the feeble representation of the same in New York, are really lenticular masses of greater or less extent, which have accumulated upon the unequal surface of the ocean bed in a shallow sea during the latter part of the Niagara period. These isolated masses of limestone have close relation with each other while their relation with the Onondaga salt group, though very intimate in the single locality in central New York, becomes less and less conspicuous in a westerly direction.

A considerable number of Galt fossils are described in this 20th Museum report among the fossils from the Racine beds of Wisconsin.

Wisconsin. The relations of the Guelph of Wisconsin have been fully treated by T. C. Chamberlin in *Geology of Wisconsin*, 1877, 2:335 *et seq.* The Niagara group is here divided as follows from top downward:

At the south		At the north	
1	Guelph beds	1	Guelph beds
2	Racine beds	2	Racine beds
3	Waukesha beds	3	Upper Coral beds
		4	Lower Coral beds
		5	Byron beds
4	Mayville beds	6	Mayville beds

In regard to the Guelph and Racine beds it is said:

The term Guelph has been applied to the uppermost beds on account of a similarity of fossils to those of the Guelph limestone of Canada, to which the Wisconsin formation is probably equivalent. The recognition of this equivalence is due to Professor Whitfield.

The Racine beds are the equivalent of what has been known as the Racine limestone, except that the upper portion is now separated as Guelph, and the reefs and associated rocks west of Milwaukee which have been referred to a lower horizon, are included in it.

The suggestion of Hall that a Guelph and a Niagaran horizon are con-

[1] N. Y. State Cab. Nat. Hist. 20th An. Rep't. 1867. p. 307.

tained in the Racine limestone, has here been verified and the separation carried out.

The fauna of the Racine limestone was described and figured by R. P. Whitfield in *Geology of Wisconsin*, 1882, v. 4. A consideration of the fossil lists there given brings out some interesting facts.

In the Lower Coral beds there occur, together with Niagaran corals, Dinobolus conradi (originally described from the Le Claire and Racine limestones), Trimerella grandis, Trochonema (Poleumita?), Murchisonia hercyna (a Canadian Guelph form called billingsana by Miller, as Billings's name is preoccupied). This limestone is 70 feet in greatest thickness.

None of these fossils occur in the Upper Coral beds (90 feet).

The Racine beds (consisting of three facies, viz coral reefs, coral sand and compact strata with cephalopods) contain, together with typical Niagaran brachiopods, the following Guelph forms:

Trimerella grandis, Whitfieldella hyale, Megalomus canadensis, Straparollus solarioides, Bucania angustata (=Trematonotus alpheus), Murchisonia macrospira, M. mylitta, Cyrtoceras brevicorne, C. arcticameratum, Trochoceras desplainense.

The Guelph bed is said not to differ essentially from the Racine, being in general a rough, thick bedded, irregular dolomite, usually quite free from impurities. The distinction between the two subdivisions is paleontologic rather than physical and the introduction of the Guelph fossils was so gradual that many localities show a mingling of the two faunas. The beds are more regular and compact than the subjacent Racine and gastropods predominate among the fossils.

The following Canadian Guelph species appear in the list of fossils:

Monomerella prisca, Whitfieldella hyale, Megalomus canadensis, Holopea guelphensis, H. harmonia, Loxonema boydi, M. hercyna, M. logani, M. longispira, M. macrospira, Cyrtoceras arcticameratum.

These lists bring out the following facts: (1) that a considerable number of characteristic Guelph fossils appear as early as the Racine beds, a few even in the Lower Coral beds, (2) that the large brachiopods (Trimerellids) appear before or with the earliest Guelph gastropods (as at Shelby), (3) that neither the Racine nor the Guelph beds of Wisconsin contain a pure Guelph fauna, but also numerous Niagaran forms.

Hall and Clarke,[1] writing at a later date than the work cited, give the following brachiopods from Wisconsin:

Rhinobolus davidsoni H. & C., Grafton, Monomerella cf. orbicularis Billings, near Grafton, M. egani H. & C., Grafton, M. greeni H. & C., Grafton, Dinobolus conradi Hall, Racine, Grafton. Schuchert cites[2] also Conchidium occidentale Hall, Williamstown, Stricklandinia multilirata Whitfield, Sheboygan.

Iowa. Dr Samuel Calvin in the *Report of the Geological Survey of Iowa*, 1896, 5:50, has divided the Niagaran into four stages from the top down: Bertram, Anamosa, Le Claire, Delaware (Hall's Niagara).

In regard to the Le Claire stage it is stated that its strata are restricted to the southwestern corner of the Niagaran area. It is generally a massive or heavy bedded, highly crystalline dolomite. It contains little chert and in its lower part there are few fossils. There are occasionally specimens of Pentamerus of the P. occidentalis type, and casts of corals. In the upper part small brachiopods abound of the genera Homoeospira, Trematospira, Nucleospira, Rhynchonella, Rhynchotreta, Atrypa, Spirifer and probably others.

The Le Claire limestone is, in some respects, unique among the geologic formations of Iowa. Locally, it varies extremely in thickness, so that its upper surface is very undulating and it is strongly cross bedded. It is suggested by Calvin that the eddies of strong currents piled up the material in lenticular heaps.

Anamosa stage. This is Hall's "Onondaga salt group", an earthy,

[1] Pal. N. Y. 1892. v. 8, pt 1.

[2] Synopsis Am. Paleoz. Brach. 1897. p. 187.

finely and perfectly laminated dolomite, quite free from fossils, but in Cedar county the brachiopod fauna of the upper part of the Le Claire reappears in great force, up near the top of the formation. It was laid down on the uneven floor of the Le Claire formation.

Bertram stage. An irregularly bedded, nonfossiliferous dolomite without fossils.

In volume 11 of the same report, the Anamosa and Le Claire stages are grouped together under the designation *Gower limestone.*[1] The Anamosa "phase" is said to consist of soft granular limestones (dolomites?) with very few fossils, while the Le Claire facies is hard bluish gray limestone (dolomite?) with numerous fossils. "These are often gregarious, and while no complete list of species has been made out, the fauna is known to represent that of the Guelph of Canada. The Le Claire occurs in places in mounds 50 feet high and over, in which little semblance of stratification is to be seen. The rock is brecciated or conglomeritic." [p. 305]

This paper accepts the theory which had already been suggested by Hall that "at the close of the Niagara huge mounds and ridges were built on the bottom of the shallow Silurian sea, in part by the accumulation *in situ* of corals, crinoids and molluscous shells, and in part by the drift of calcareous sediments under strong currents. That these reefs were near the surface is attested by their conglomeritic character."

Illinois. The reports of the Illinois Geological Survey [1–8] give no data in regard to the occurrence of the Guelph in Illinois, as Worthen declined to admit the Guelph nature of the Le Claire limestone [see above].

We have cited above, a number of typical Guelph species from Illinois localities but we learn from Prof. Stuart Weller who has been intimately concerned with the study of the Niagaran fauna that it is not now possible, with existing exposures, to say what part of the species recorded as from the "Niagara" of Illinois have actually been derived from the upper or Guelph horizon.

There are at Grafton 120 feet of a buff colored dolomite in regular

---

[1] Norton, W. H. Geology of Cedar County.

beds and in Cook county the upper beds are described as consisting of a light gray fossiliferous limestone weathering to a yellow or buff color, of a decidedly concretionary structure, and showing stratification very imperfectly. The rock is in many places stained with bitumen, and contains cavities filled with the substance in a semifluid condition. This rock seems to agree lithologically with the Guelph beds of Wisconsin.

Indiana. No indications of the presence of the Guelph beds in this state have been found in the Indiana geological reports. In the 21st report the following series of beds is given by Foerste: (1) Clinton; (2) Basal Niagara limestone; (3) Lower Osgood clay; (4) Osgood limestone; (5) Upper Osgood clay; (6) Laurel limestone; (7) Waldron shale. Above the Waldron shale follows the Louisville limestone, with an average thickness of 40–55 feet. In regard to this it is stated [p. 233] that immediately below the overlying Corniferous limestone there are found in it, in Clark county, Pentamerus mysius var. crassicosta, Strombodes pentagonus, Favosites favosus, Halysites catenulatus. There is herein no Guelph representation in the Louisville limestone. In the 22d annual report, Foerste [p. 214] records that fossils are rare in this limestone, and that most of them have been found just above the Waldron shale; that, further, the lowest fossils which could with certainty be identified with species from Devonic horizons have usually occurred 25 or 30 feet above the Waldron shale. It is added that the opinion, frequently expressed, that all the rocks overlying the Waldron shale are Devonic and that the top of the Waldron shale marks the top of the Siluric, it is believed will not stand investigation. The *Catalogue of the Fossils of Indiana*, furnished by Mr E. M. Kindle, contains no Guelph species.

In the geologic description of northern Indiana by I. A. Price in the 24th annual report, it is also stated that the Waldron shale does not form the top of the upper Siluric. At a number of places some 10 or 12 feet of intervening limestone is to be found between the shale and the base of the Devonic. This is called the Hartsville bed and is considered as corresponding stratigraphically to Foerste's Louisville limestone farther south. It contains no fossils.

We may conclude therefore from the observations here recorded that no strata which either lithologically or faunistically can be considered as representing the Guelph have as yet been found in this state.

Michigan. Hall has distinctly stated[1] that "at some points on the northern shore of Lake Michigan . . . there occurs a light colored limestone lying above the Niagara strata, containing generally few fossils and among them some forms not unlike those of Galt." He also noted this fact in his description of Pentamerus occidentalis.[2] The description of the rocks of the Niagara group of the upper peninsula of Michigan[3] furnishes no additional facts concerning the distribution of these rocks in that still little known region, but from the fact that the Niagara skirts the entire south shore of the Upper Peninsula and that the Salina beds appear along the water edge in some places, as in St Marys Bay, near Mackinac strait, the probable position of the Guelph outcrops may be located. It is, therefore, highly probable that the beds with Pentamerus and corals mentioned by Rominger as occurring at many places on the north shore of Lake Michigan represent actual Guelph beds. The occurrence of large Murchisonias, mentioned by the same author, supports this supposition.

Ohio. Guelph fossils are known to occur in Ohio. Hall and Clarke cite the following brachiopods:[4]

Monomerella prisca Billings, Rising Sun, Wood co.; M. newberryi H. & W., Genoa, M. ortoni H. & C., Rising Sun, Trimerella acuminata Billings, near Hillsboro, T. grandis Billings, near Sinking Spring, T. ohioensis Meek, Rising Sun, Genoa and Ottawa county.

In the second volume of *Paleontology of Ohio* Hall and Whitfield

---

[1] Pal. N. Y. 1859. 3: 30.

[2] Pal. N. Y. 1852. 2: 342.

[3] Rominger, Dr C. Geol. Sur. Michigan. Paleozoic Rocks. 1873. v. 3, pt 2. p. 31.

[4] Pal. N. Y. 1892. v. 8, pt 1.

described and figured the following Guelph forms: Trematonotus alpheus (Genoa and Springfield), Straparollus niagarensis (Cedarville), Trochonema pauper (Greenville), Cyrtoceras herzeri (Cedarville), C. myrice (Yellow Springs), Phragmoceras parvum (Cedarville).

Newberry[1] says:

In the northern part of the state the best exposures of the Niagara are at Geneva, Elmore and Washington. . . In all this region only the upper part of the Niagara is seen, the equivalent of the Guelph limestone of Canada. . . This portion of the formation is a rough, cellular, cream colored magnesian limestone sometimes mistaken for sandstone, yet being nearly a typical dolomite in composition. . . The cells and cavities which are so characteristic of this rock are usually produced through the removal, by solution, of the shells, of which it once contained great numbers; hence all its fossils are represented by casts only.

Among the fossils of the Niagara [Guelph] group which occur most abundantly in northern Ohio, may be mentioned Megalomus canadensis, Tremanotus alpheus, Pleurotomaria solarioides, Murchisonia macrospira, Trimerella ohioensis, Pentamerus occidentalis, Cypricardites? quadrilatera, Favosites niagarensis, Obolus conradi, etc.

In the southwestern portion of the state one of the best sections is found at Hillsboro and was thus determined by Edward Orton.[2]

		FEET
1	Hillsboro sandstone	30
2	Guelph, Cedarville or Pentamerus limestone	20
3	Upper or Springfield cliff	45
4	Lower or West Union cliff	45
5	Niagara shales	60
6	Dayton limestone	5

Newberry says of this: "The upper limestone of the Hillsboro section is evidently the equivalent of that exposed at Geneva, Elmore, etc., and like that, represents the Guelph division of the Niagara. It contains nearly the same fossils at Hillsboro as at Geneva . . . but Pentamerus

[1] Geol. Ohio. 1873. 1:129.

[2] Report of Progress for 1870, p. 301.

oblongus is much more abundant here than at the north." The appended list of fossils includes, besides Niagaran corals and crinoids: Trimerella ohioensis, T. grandis, Obolus conradi, Pentamerus oblongus, Murchisonia macrospira, M. laphami, Platystoma niagarense, Megalomus canadensis, Trochoceras desplainense, Orthoceras abnorme, Calymmene niagarensis.

From Dr Orton's original description of this section[1] we select the following data: The Guelph or Cedarville limestone is a massive magnesian limestone (carbonate of lime 54.25%, carbonate of magnesia 43.23%) varying in thickness from 20 to 90 feet. Even where the whole of the original deposit is present, as in sections where it is found inclosed between higher and lower formations, it has the wide limits already given. It contains bituminous matter distributed through its substance, and it is pointed out that the oil-bearing limestones of Chicago belong to the same horizon. This formation is often destitute of distinct bed lines in its structure. It is acted on quite easily by atmospheric agencies and by its unequal weathering the faces of the cliffs that it forms are rough and irregular.

It will be noticed that this rock shows notable agreement with the Guelph rocks of New York.

Pentamerus oblongus is the most common fossil of the Guelph through this region and further west and it gave the name to the formation. In New York and Canada this shell is a Clinton and Niagaran species but in Ohio it appears in full force only in the upper Niagaran limestone and Guelph. Certain layers are heavily charged with Megalomus while Trimerella is also very abundant. Large gastropods and corals show in many places. The Guelph is overlain by and interstratified with the Hillsboro sandstone and is the only known instance of distinct shore conditions recognizable during the Guelph stage.

Orton also described the section at Yellow Springs, Greene co. where

[1] Rep't of Progress, 1871, p. 278 *et seq.*

the Cedarville dolomite shows an exposure of 23 feet, with a total of 40 feet. In connection with this section it is remarked:[1]

It has received the names of various localities where it is distinctly shown, being styled the Guelph formation in Canada, the Racine beds or Milwaukee beds in Wisconsin and the Bridgeport beds in northern Illinois. In southern Ohio no local name can be selected as appropriate and free from ambiguity as the Cedarville limestone.

Finally in regard to this formation generally within the state of Ohio, Dr Orton wrote in 1893:[2]

The uppermost division of the [Niagaran] formation is the Guelph limestone which differs very noticeably in several points from the Niagara limestone proper. . . It has a maximum thickness in southern Ohio of 200 feet. . . It is either massive or very thin bedded. It is porous to an unusual extent. It is generally very light in color. It is exceedingly rich in fossils containing a large number that is thoroughly characteristic.

Unlike the previously named divisions of the Niagara, the Guelph limestone is as well developed in northern as in southern Ohio in all respects. Not more than 40 feet of it are found in its outcrops there, but the drill has shown several times this amount of Niagara limestone, without giving us, however, the data needed for referring the beds traversed to their proper subdivisions. What facts there are seem to point to the Guelph as the main element in this underground development of this formation in this portion of the state.

From the foregoing we may conclude that the area in which the Guelph fauna manifests itself extends from Wayne county, N. Y. westward to Hamilton Ont., thence northwestward to Cape Hurd and Manitoulin island, and northward almost to James bay. Here it follows the Niagaran on the inner side of the vast arc spanned by that formation over the islands of Georgian bay, the north shore of Lake Huron and north and west shores of Lake Michigan. Still farther to the northwest, evidence of this sediment is afforded by the presence of the coral Pycnostylus guelphensis and the Stromatoporoid Clathrodictyum ostiolatum, on the west shore of Lake Manitoba.[3]

[1] Geol. Ohio. 1874. 2:674.

[2] Geol. Ohio, 7:12.

[3] Reported by Whiteaves. Paleozoic Fossils. 1893. v. 3, pt 2, p. 46.

West of Lake Michigan these deposits spread over southern Wisconsin, northern Illinois and into Iowa, where their extension in this direction is terminated by the barrier of earlier formations. In Ohio it borders the north and east shores of the Cincinnati dome.

Over all this amphitheater, bounded without by the Niagaran, we may conceive of a shallowing sea, dotted with coral banks which must in no small measure have fringed the shore. Indeed contiguity to the shore line of the Cincinnati dome is clearly indicated by the Hillsboro sandstone interbedded with the upper dolomites. It was an almost inclosed sea, its opening being probably through the narrow way toward the north and northwest, a region which still holds the clue to many of our exotic faunas.

In this connection it appears also significant that in the terminal beds of the upper Siluric of Gothland a fauna appears which contains the genera characteristic of the Guelph and often species which are hardly distinguishable. These are specially contained in the beds *f*, *g*, *h*; *f* being characterized[1] as limestone beds composed of crinoids and corals; *g*, large banks of Megalomus and Trimerella, and *h*, Cephalopodan and Stromatopora beds. In looking over these lists one can not fail to conceive the idea that the much richer fauna of these beds contains a vicarious fauna of the American Guelph, for we find there Monomerella, Trimerella (with three species), with the absence of the majority of the Wenlock forms; Megalomus among the lamellibranchs; Trematonotus and a very large number of cephalopods and gastropods, including Pleurotomaria, Murchisonia, Loxonema, Trochus, Pycnomphalus, Horiostoma, etc.; also Stromatoporas.

The appearance of such peculiarly adapted forms as the Trimerellas and Megalomus, at corresponding horizons and in similar associations, is certainly very suggestive not only of the presence of the identical facies, but also of faunistic intercourse between the two seas.

There is a generally recognized distinction between the rich Siluric faunas of northern Europe and those of Bohemia and the Mediterranean

[1] *See* Swedish State Mus. Pal. Dep't. *ed.* List of the Fossil Faunas of Sweden, II, Upper Siluric.

region. Kayser has recently expressed[1] this distinction by terming the former the normal facies or that appertaining to the oceans at large, while the latter is to be regarded as having the value of a local facies. The former it is that is more widespread throughout the world and which we have constantly growing evidence for believing has entered the interior sea of America by way of northern Canada. Its incarceration in the American paleozoic mediterranean has doubtless superinduced a measure of provincial characteristics in some of the minor faunas but the features we find in the Guelph common to those of the Scandinavian faunas appertain to the marine life of the inclosed seas of late Siluric time.

The Coralline or Cobleskill limestone. This study of the Guelph fauna and stratigraphy has thrown important light on the proper construction of the fauna of the Coralline limestone of eastern New York. This formation was first recognized as an element in the succession by John Gebhard, and by Prof. Hall was considered an eastern continuation of the Niagaran limestone. We have elsewhere suggested that the objectionable character of its designation may be remedied by employing for it the term Cobleskill limestone, as along this creek in Schoharie county, N. Y., the section of the formation is typically expressed. We do not here propose entering on an extended discussion of this fauna and its stratigraphic relations. These matters, which we have had under consideration for some years, have recently been made the subject of careful and extended investigation by C. A. Hartnagel, of the staff of this division and we have invited him to insert here the following brief statement of his preliminary conclusions so far as they bear on the relation of this fauna to the Guelph.

The Cobleskill formation in its typical development at Schoharie and Howes Cave, Schoharie co. consists of a massive layer of dark gray, somewhat magnesian limestone averaging 6 feet in thickness. Above this limestone and clearly distinguished from it by a change in lithologic character, lie the Rondout beds, 40 feet thick and marked by basal layer of "cement rock," 6 feet thick. Above this are 45 feet of typical Manlius limestone. Underlying the Cobleskill and resting upon the Lorraine beds are 30 feet

[1] Geologische Formationskunde. ed. 2. 1902. p. 102.

of green argillaceous shales which doubtless pertain to the Salina stage. The Cobleskill or Coralline limestone fauna was early described by Hall who regarded it the eastern representative of the Niagaran group as then known in western New York. He interpreted the underlying shales as of Clinton age. Recent examination however clearly indicates that the Cobleskill limestone as shown in the section described pertains to an age later than Salina, as has been suggested by Schuchert.

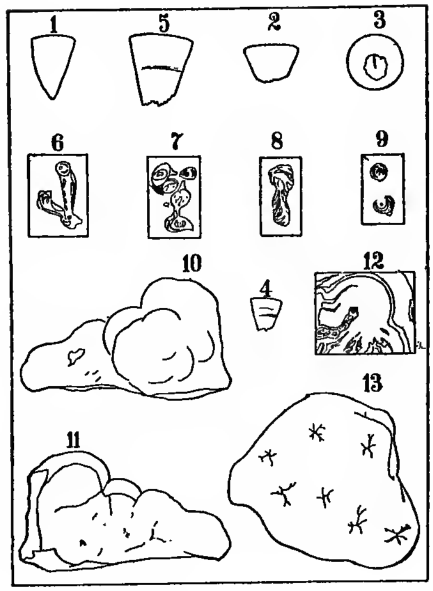
One of the marked differences between the faunas of the Niagaran of New York and the Cobleskill is the presence in the latter of quite an extensive gastropod and cephalopod fauna — one of the features which strongly affiliates it with the Guelph. And, indeed, Hall, in the original descriptions of Pleurotomaria subdepressa and Murchisonia terebralis, notes in each case a similarity to forms described from the Guelph.

An interesting feature of some of the gastropods from the Cobleskill is that in form they are sinistral. Pleurotomaria subdepressa mentioned above belongs to this class. Another species is distinguished from Poleumita crenulata Whiteaves (Guelph), only by its sinistral form. Other specimens of the genus Pleurotomaria have been found which in size and form are similar to the Guelph species, but the delicate surface markings often so well preserved in the Guelph dolomites and upon which specific determinations to a certain degree are dependent, have not yet been ascertained in the Cobleskill limestone specimens and thus specific comparisons become unsatisfactory. Kionoceras darwini Billings occurs at Schoharie, and in the western extension of the Cobleskill fauna on Frontenac island, Cayuga lake, where Orthoceras trusitum Clarke & Ruedemann and Gomphoceras septoris Hall (Guelph) are also found. In Schoharie county mature specimens of Ilionia galtensis Whiteaves occur. Associated with them are forms which in outline and dimensions approach Ilionia canadensis Whiteaves and to that species they are provisionally referred. Spirifers from the Guelph have obsolescent plications and a sinus similar to Spirifer crispus var. corallinensis Grabau.

There are other species common to these faunas but they are mostly forms occurring also in the Niagaran and indicative solely of a late Siluric stage.

EXPLANATION OF PLATES

PLATE 1



Enterolasma cf. **caliculus** Hall (sp.)

Page 24

FIG.

1 The exterior, natural size

Zaphrentis cf. **racinensis** Whitfield

Page 23

2, 3 Lateral and basal view of an internal cast of the calyx. Natural size

Heliophyllum sp. indet.

Page 28

4 Internal cast of a specimen. Natural size

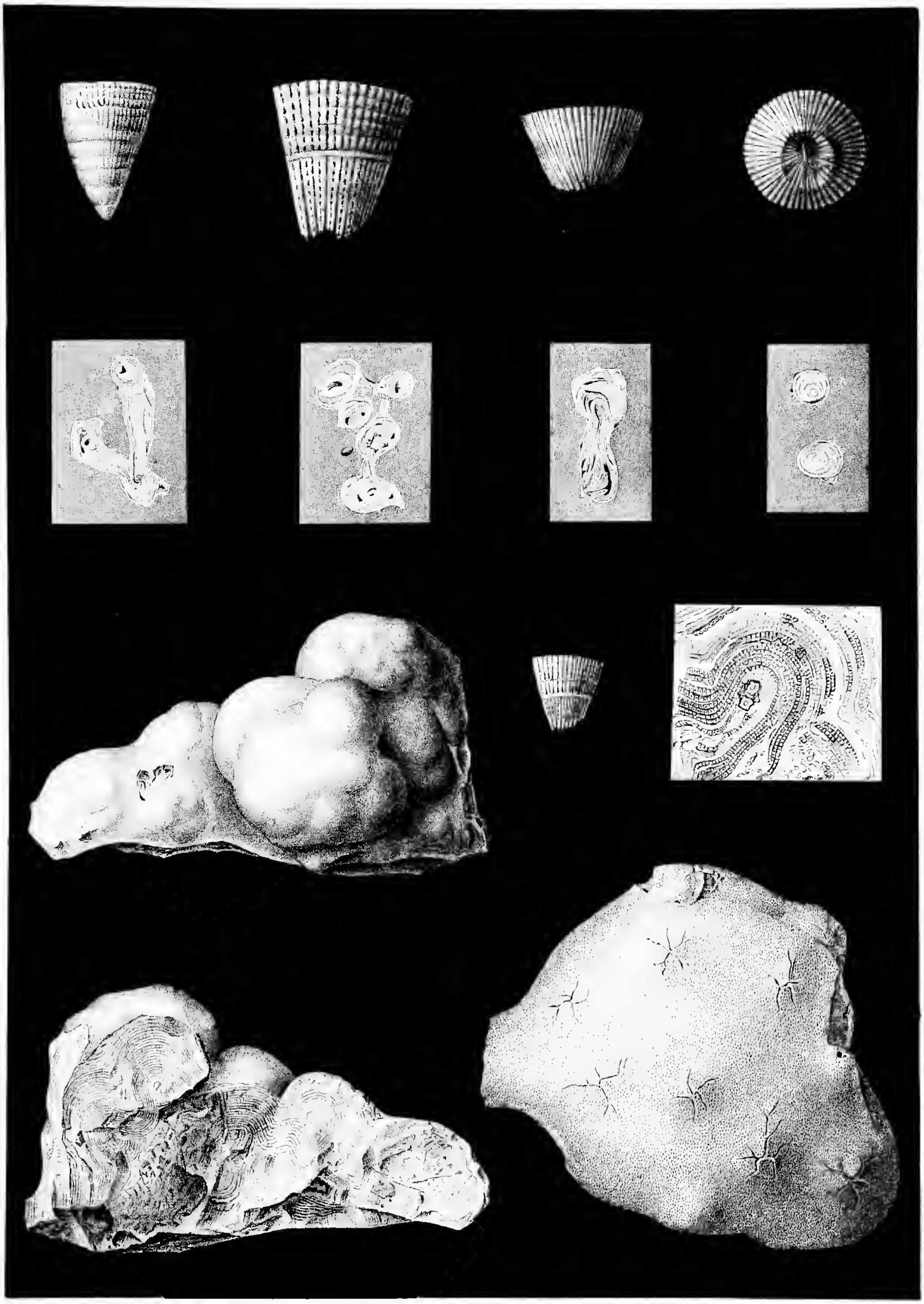
5 Same, x2; to show the impressions of the denticulated carinae on the septa

Syringopora infundibulum Whitfield

Page 35

6–9 Sections obtained on a polished surface, to show the spiniform septa, funnel-shaped tabulae and transverse, hollow connecting processes. x2

GUELPH FAUNA



G S Barkentin del J.B Lyon Co. State Printer Phil. Ast, lith.

Clathrodictyum ostiolatum Nicholson

Page 37

FIG.

10 Surface view of specimen, showing the characteristic botryoidal surface. Natural size

11 Section, shown on broken side of same specimen, and exhibiting the calcareous laminae. Natural size

12 Thin section of a portion, x2, showing the laminae and intermediate vertical dissepiments

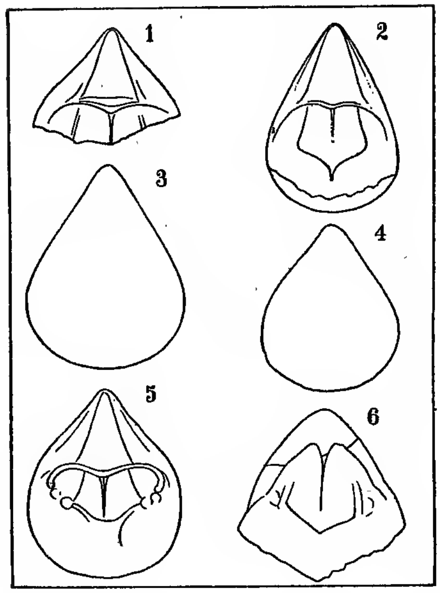
Stromatopora galtensis Dawson (sp.)

Page 36

13 A fragment exhibiting the astrorhizae. x3

The originals of fig. 1–5, 10–13 are from the Guelph bed at Rochester (Arey collection); those of fig. 6–9 from the Upper Shelby bed (N. Y. State Museum).

PLATE 2



Monomerella noveboracum sp. nov.

(*See* plate 3 and plate 4, fig. 38)

Page 39

FIG.

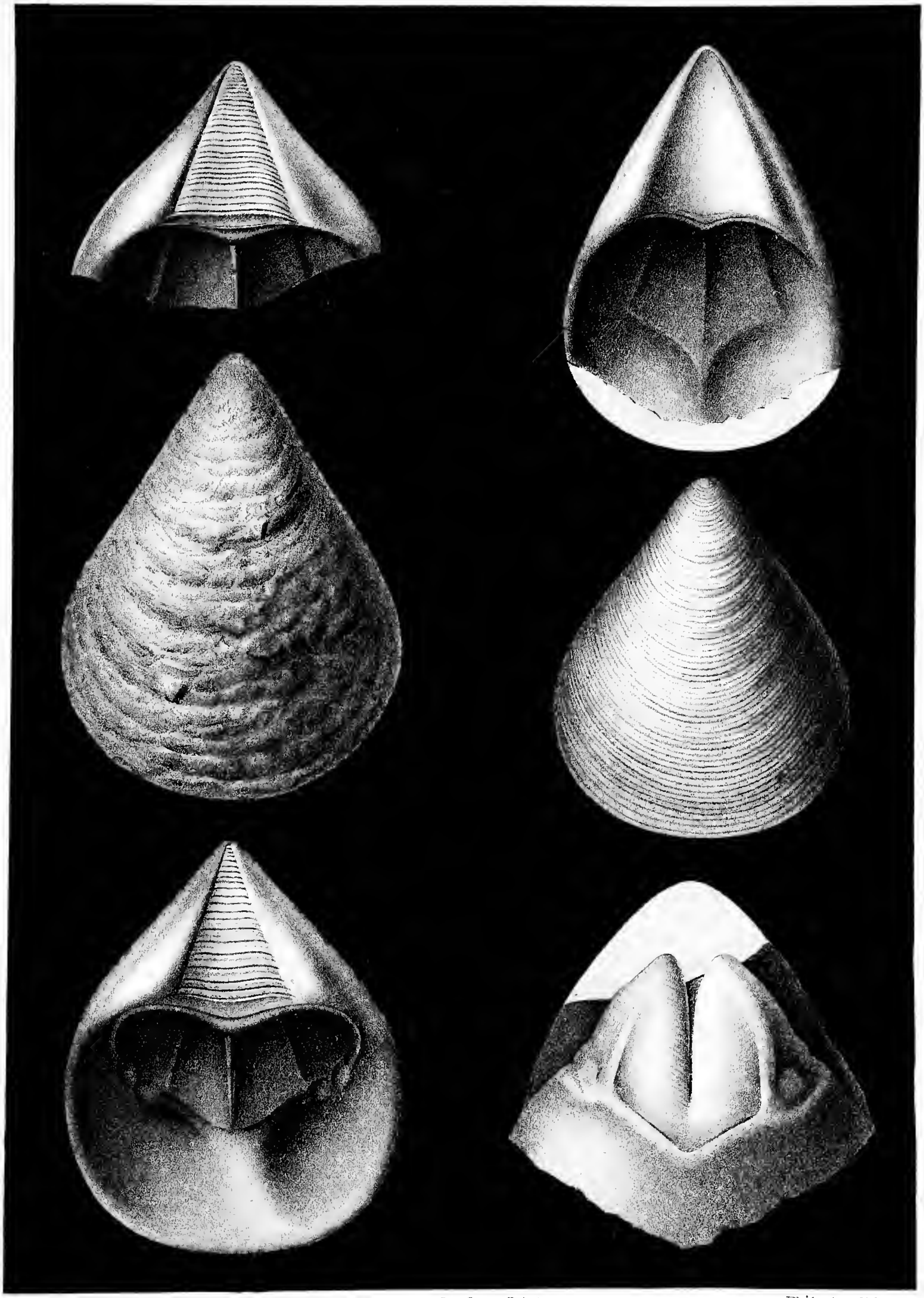
1 Cardinal area of a pedicle valve, showing the coarse striations of the pedicle groove, the lateral slopes, the character of the cardinal slope and cardinal groove, and the narrow but high cardinal buttress

2 A pedicle valve with very high and relatively narrow cardinal region and more depressed median area. From a gutta-percha squeeze of the natural impression

3 The exterior of the pedicle valve of an old individual with very irregular squamous surface. From a gutta-percha squeeze of a natural impression; slightly restored at the anterior and posterior ends

4 The exterior of a younger pedicle valve, showing the growth lines. Also from a gutta-percha impression

GUELPH FAUNA.



G. S. Barkentin. del J. B. Lyon Co. State Printer Phil. Ast, lith.

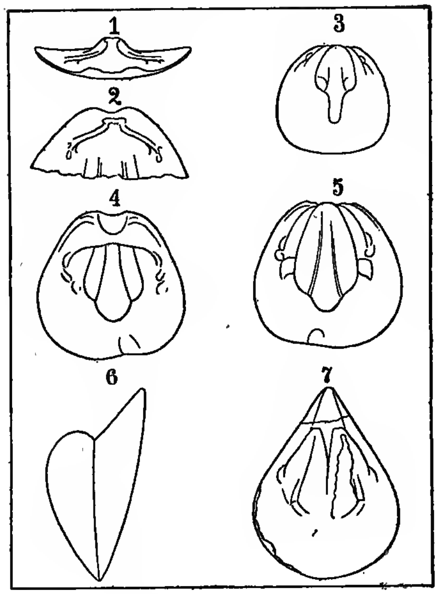
FIG.

5 The interior of a pedicle valve, with the subdivisions of the crescent sharply defined and showing the extent of the cardinal buttress and the low anterior septum. Slightly restored at the umbo. From a gutta-percha impression of the internal cast represented on plate 3, fig. 7

6 Internal cast of part of the pedicle valve of an old individual, showing very strongly marked lateral crescent and platform muscle scars, and short but broad platform vaults

All specimens are drawn in natural size and come from the Lower Shelby bed at Shelby, Orleans co. N. Y. Originals in N. Y. State Museum.

PLATE 3



Monomerella noveboracum sp. nov.

(*See* plate 2 and plate 4, fig. 38)

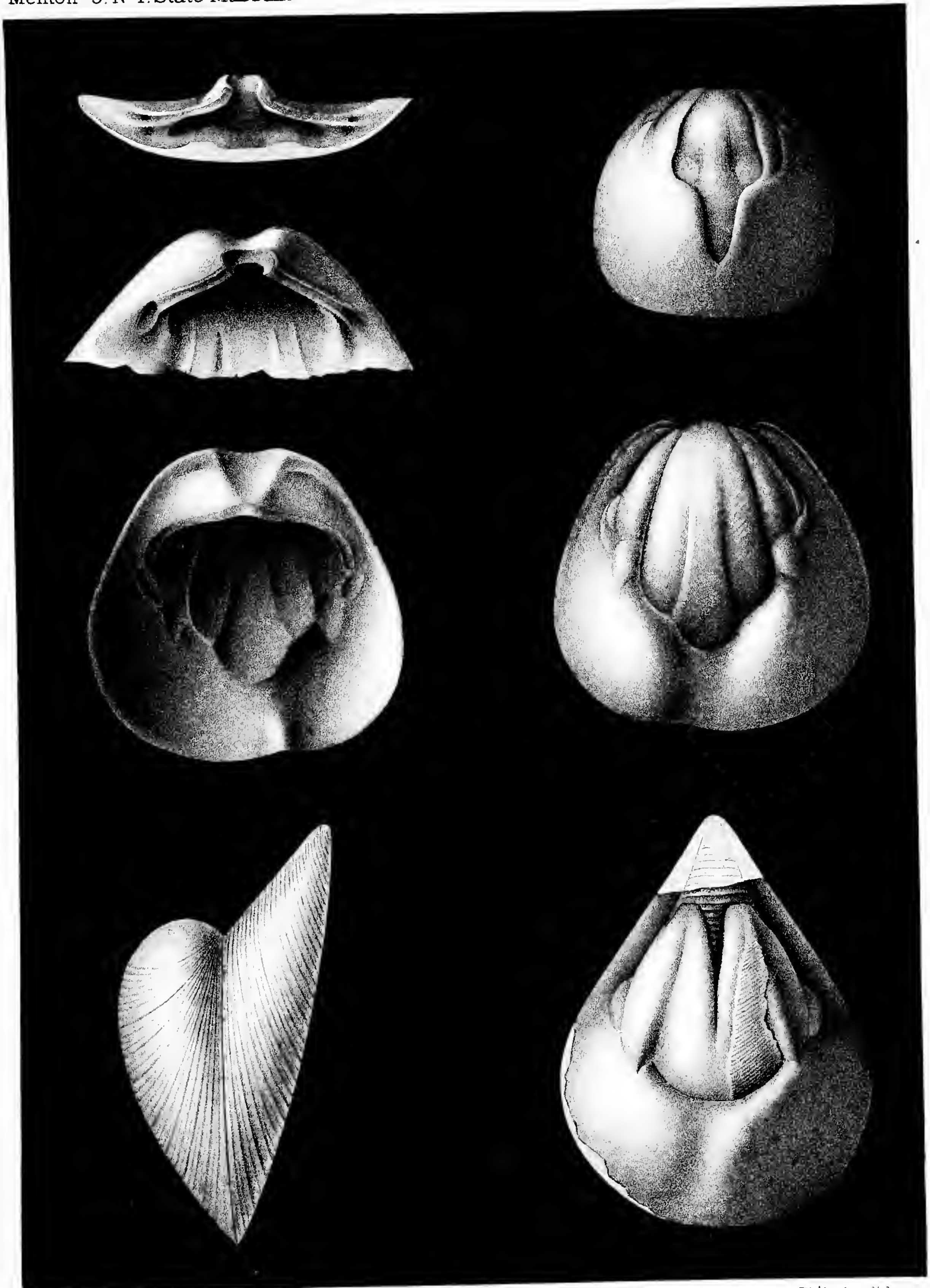
Page 39

FIG.

1, 2 Two views of the cardinal region of the brachial valve, showing the hinge line and the strongly developed crescent. From a gutta-percha squeeze of a natural impression

3 An internal cast of a brachial valve, with the muscular impressions of the platform strongly defined, showing the short platform vaults

4, 5 The interior of a large brachial valve, shown as a natural cast (fig. 5) and as a gutta-percha squeeze taken from this cast (fig. 4). These show well the broad form of the valve, the muscular impressions, the form of the platform and the anterior septum.



G. S. Barkentin. del

J. B. Lyon Co. State Printer

Phil. Ast, lith.

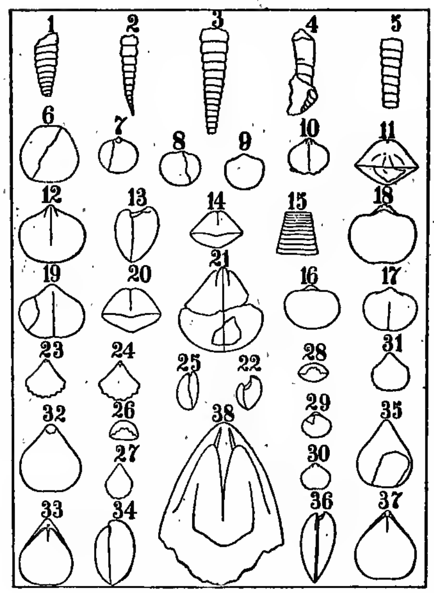
FIG.

6 Lateral view of the two valves in apposition reconstructed from the brachial and pedicle valves figured on this plate, showing the long straight cardinal region, the nearly straight profile of the pedicle valve and the more convex contour of the brachial valve

7 An internal cast of a large pedicle valve, showing the high cardinal area, the very deep platform vaults and the characteristic markings of the platform, as well as the impressions of the sides of the crescent, and the anterior septum

All specimens are drawn natural size, and are from the Lower Shelby bed at Shelby N. Y. Originals in N. Y. State Museum.

PLATE 4



Cornulites arcuatus Conrad

Page 105

FIG.

1 Internal cast of a stout, rapidly tapering specimen. Natural size. Rochester (Arey collection)

2 Internal cast of a slender, slightly arcuate specimen from a gutta-percha squeeze of a natural impression. Natural size. Lower Shelby bed (N. Y. State Museum)

3 A specimen with slightly different character of the annulations. x2. Rochester (Arey collection)

4 A specimen retaining part of the shell and natural surface. Upper Shelby bed (N. Y. State Museum)

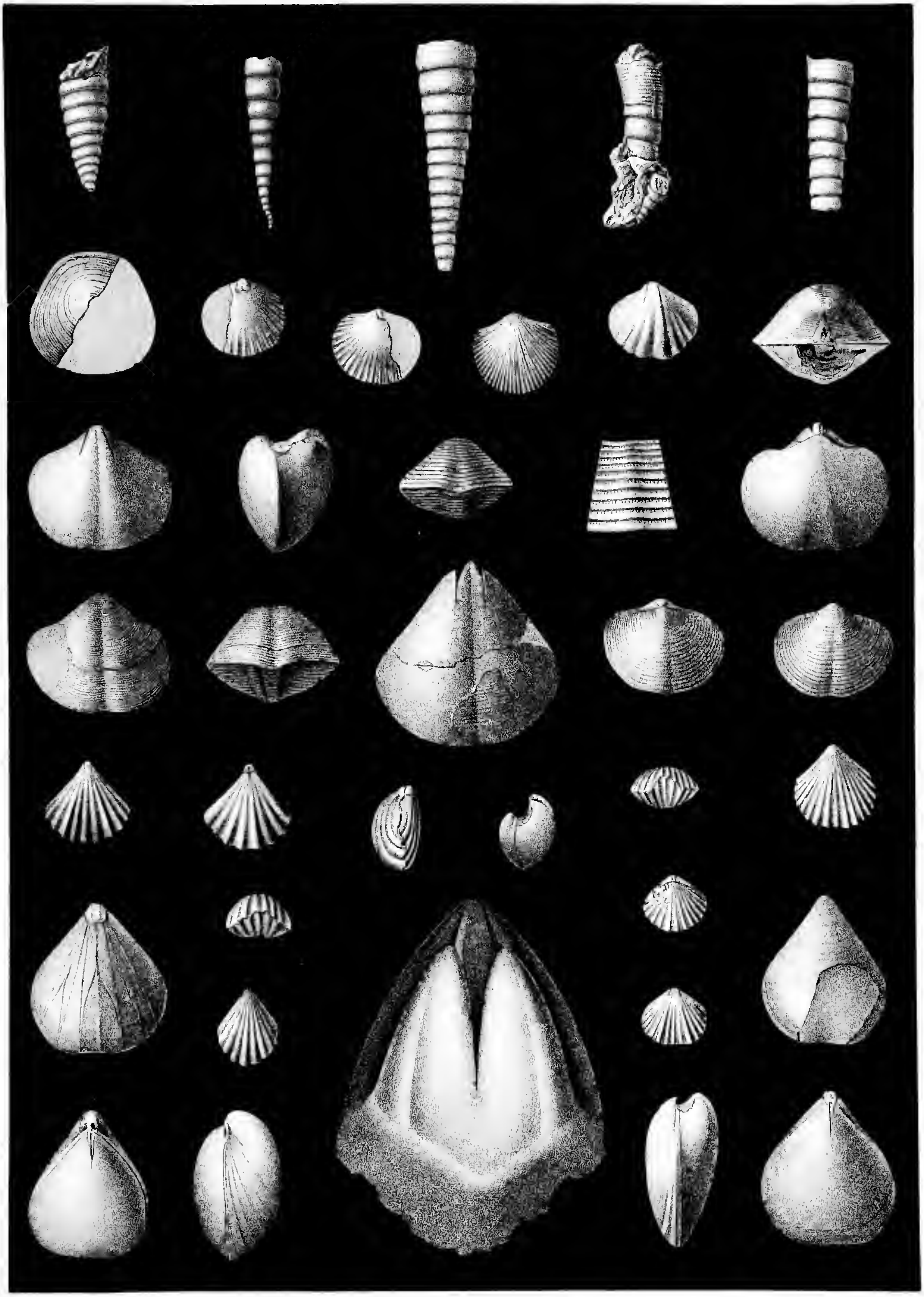
5 An internal cast of a large specimen. Natural size. Rochester

Crania sp.

Page 38

6 Single specimen observed. x2. Rochester (Arey collection)

GUELPH FAUNA



G S Barkentin del. J.B Lyon Co. State Printer Phil. Ast, lith.

Dalmanella cf. **hybrida** Sowerby (sp.)

Page 42

FIG.

7, 8 Two views of a small shell, doubtfully referred to this species. x5. Rochester (Arey collection)

Dalmanella cf. **elegantula** Dalman (sp.)

Page 41

9 Single specimen observed. x3. Rochester (Arey collection)

Spirifer crispus (Hisinger) Hall

Page 42

10 Internal cast of the ventral valve of a specimen with obscure ribs. Natural size. Upper Shelby bed (N. Y. State Museum)

11, 19, 20 Three views of a well preserved example of the prevailing expression of the species, showing the character of the surface. x2. Upper Shelby bed (N. Y. State Museum)

12, 13, 18 Three views of the internal cast of a similar form. x2. Rochester (Arey collection)

14, 16, 17 Three views of a finely preserved specimen from the same locality. x3

15 Enlargement of the surface, to show the characteristic papillose sculpture of the species. x5. Rochester (Arey collection)

Spirifer cf. **bicostatus** (Vanuxem) Hall

Page 44

21 Internal cast of a ventral valve. x2. Rochester (Arey collection)

22 Lateral view of a shell with similar characters. Natural size. Upper Shelby bed (N. Y. State Museum)

Rhynchotreta cuneata americana Hall

Page 46

23–25 Three views of a specimen, natural size. Upper Shelby bed (N. Y. State Museum)

Camarotoechia (?) **indianensis** Hall

Page 46

FIG.

26, 27 Two views of a gutta-percha squeeze from a natural impression. Natural size. Lower Shelby bed (N. Y. State Museum)

Camarotoechia (?) **neglecta** Hall

Page 45

28–30 Three views of a specimen, natural size. Rochester (Arey collection)

31 View of the ventral valve of an excellently preserved typical specimen. x2. Rochester (Arey collection)

Whitfieldella nitida Hall

Page 44

32, 36, 37 Three views of a broad and flat specimen, an internal cast, showing pallial sinuses on pedicle valve. x2

33, 34, 35 Three views of a higher and thicker specimen. x2. Rochester (Arey collection)

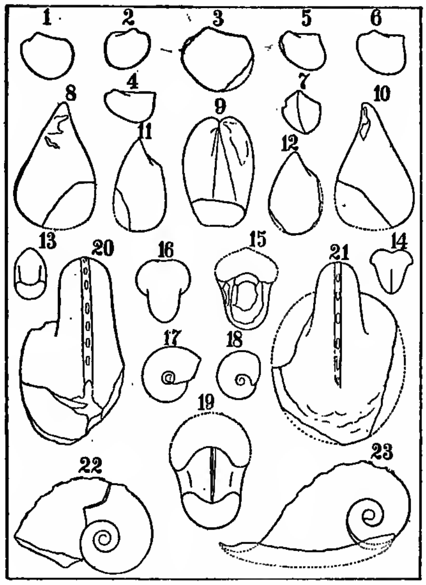
Monomorella noveboracum sp. nov.

(*See* plates 2 and 3)

Page 39

38 Internal cast of a very high pedicle valve with extremely long platform vaults. Natural size. Lower Shelby bed (N. Y. State Museum)

PLATE 5



Modiolopsis sp.

FIG.

1 Internal cast of left valve. x2

2 Same of a right valve, showing posterior cartilage pit. x2

3 Internal cast of a larger individual with suborbicular outline. x2

5 Internal cast of a small, more oblique specimen with long posterior wing. x2

All are from the Guelph at Rochester (Arey collection)

Pterinea subplana Hall (sp.)

Page 49

4 Internal cast of a left valve, natural size. Upper Shelby bed (N. Y. State Museum)

Pterinea undata Hall (sp.)

Page 50

6 Internal cast of a left valve. x2. Upper Shelby bed (N. Y. State Museum)

Conocardium sp.

Page 50

FIG.

7 View of a left valve. x3. Rochester (Arey collection)

Mytilarca eduliformis sp. nov.

Page 47

8–10 Three views of the type specimen. x2. Lower Shelby bed (N. Y. State Museum)

Mytilarca acutirostrum Hall (sp.)

Page 48

11 Internal cast of a high left valve. Natural size

12 Another more gibbous specimen, showing the posterior lateral teeth. Natural size

Both specimens are from the Lower Shelby bed (N. Y. State Museum).

Bellerophon shelbiensis sp. nov.

Page 51

13 Ventral view of a specimen, apertural part broken away. Natural size

14 Dorsal view of an internal cast, showing aperture and apertural emargination. Natural size

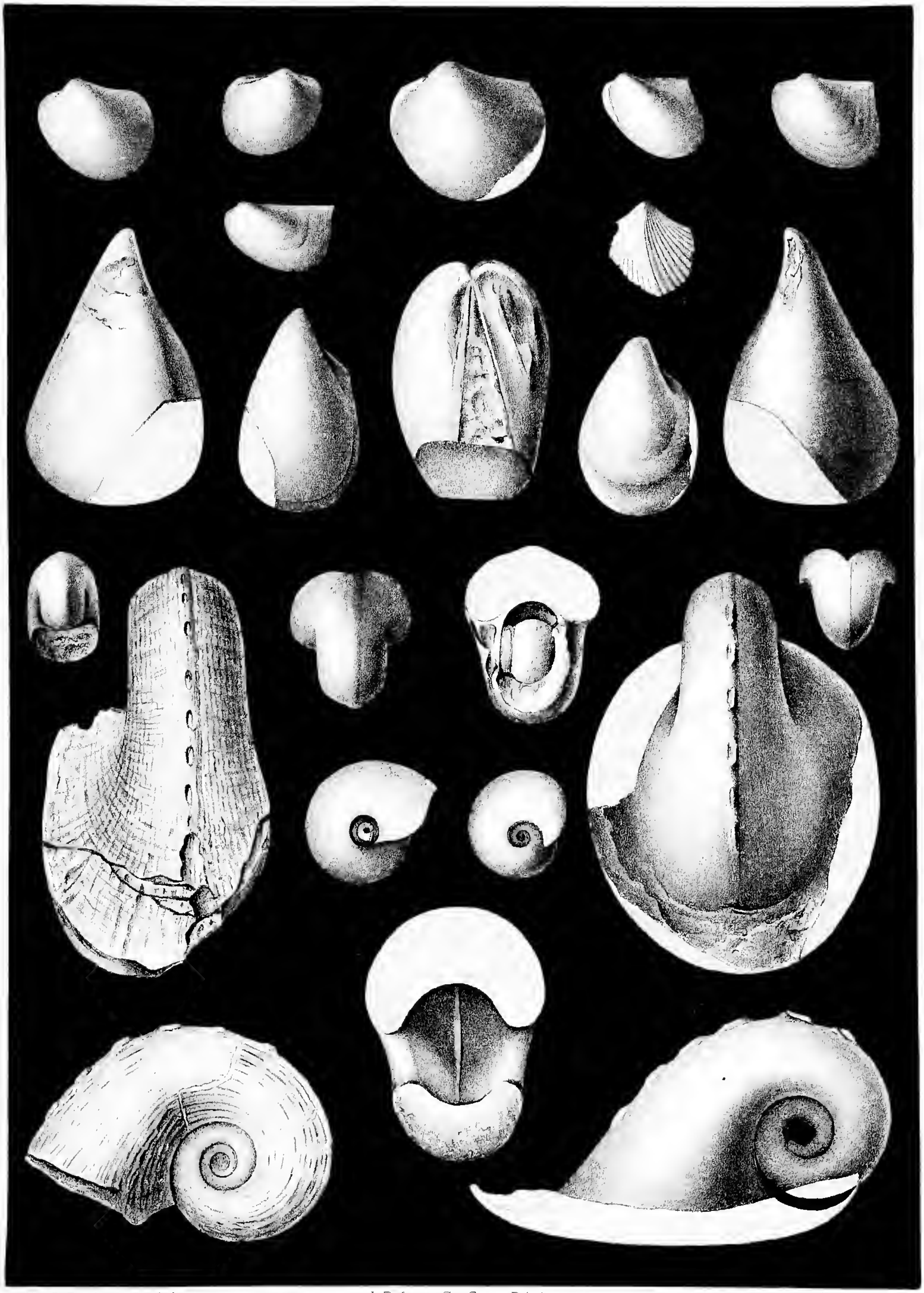
18 Lateral view of same specimen, showing cast of umbilicus. Natural size

15 Broken specimen, showing inner volution and umbilical wall. x2

16, 17 Two views of a large specimen, showing aperture and dorsal keel. Natural size

19 View of inner side of volution, showing slit band of preceding volution. Natural size

All specimens are from the Lower Shelby bed (N. Y. State Museum).



W. S. Barkentin del. J. B. Lyon Co. State Printer Phil. Ast, lith.

Trematonotus alpheus Hall

(*See* plate 6, fig. 1–9)

Page 54

FIG.

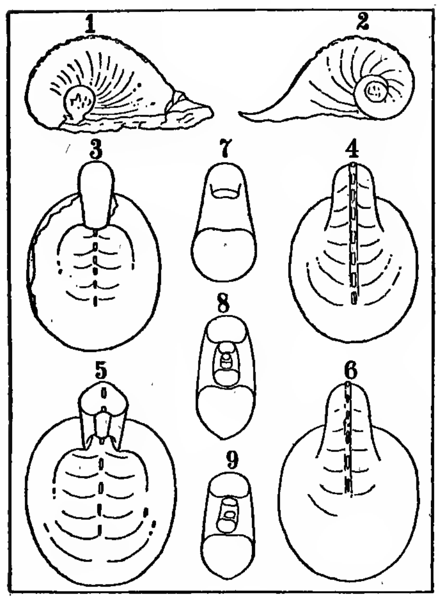
20 Dorsal view of sculpture cast, showing peristome. Natural size. Rochester (Arey collection. Same specimen as plate 6, fig. 1)

21 Dorsal view of internal cast, showing dorsal perforations and smooth internal surface. Natural size

23 Lateral view of same cast, showing umbilicus and inner volutions. Natural size. Lower Shelby bed (N. Y. State Museum)

22 Fragment of a specimen with very strongly developed revolving ridges and wide umbilicus. Natural size. Rochester (Arey collection)

PLATE 6



Trematonotus alpheus Hall

(*See* plate 5, fig. 20–23)

Page 54

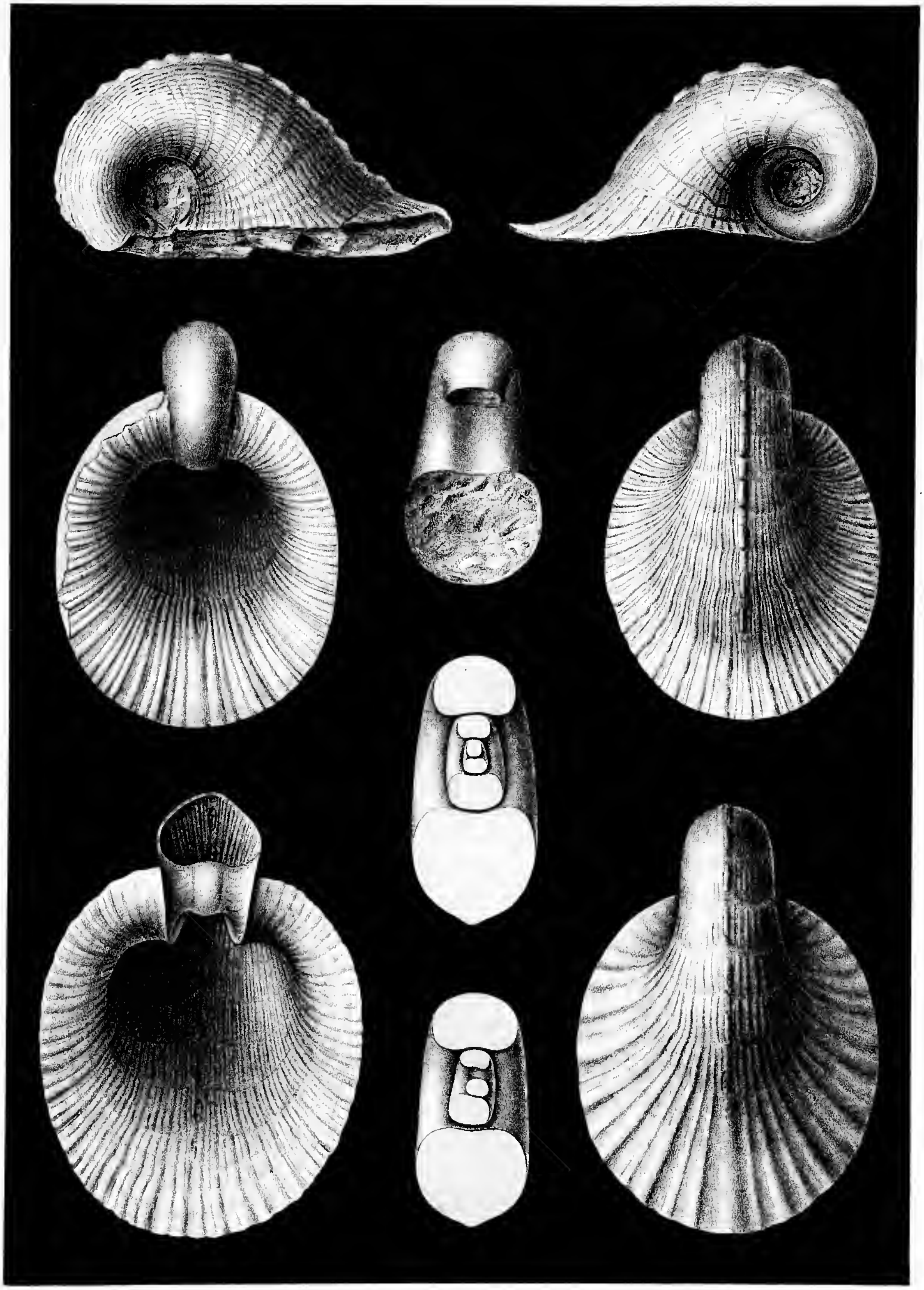
FIG.

1 Lateral view of a specimen, showing the revolving ribs and the broad transverse folds

2 Lateral view of a specimen, showing distinctly the dorsal keel interrupted by the perforations, the alternation of the revolving ribs and the wide and deep umbilicus. From a gutta-percha impression of a natural mold

3 A natural cast of the exterior of the apertural part of the last volution and of the interior of the penultimate volution, showing the dorsal perforations of the last volution and the smooth internal surface of the earlier volutions

4 An exterior dorsal view of a shell, showing distinctly the interruptions of the revolving ribs by concentric growth and the widening of the ribs upon the lip. From a gutta-percha squeeze of a natural impression



G S Barkentin del J. B. Lyon Co. State Printer Phil. Ast, lith.

FIG.

5 A natural cast of the exterior of an older individual, showing a more nodose character of the revolving ribs upon the outer lip and the cast of one of the innermost volutions

6 The exterior of the last volution of a gerontic specimen, showing a partial suppression on the outer lip of the smaller ribs which are made much too strong in the drawing. From a gutta-percha impression of a natural mold

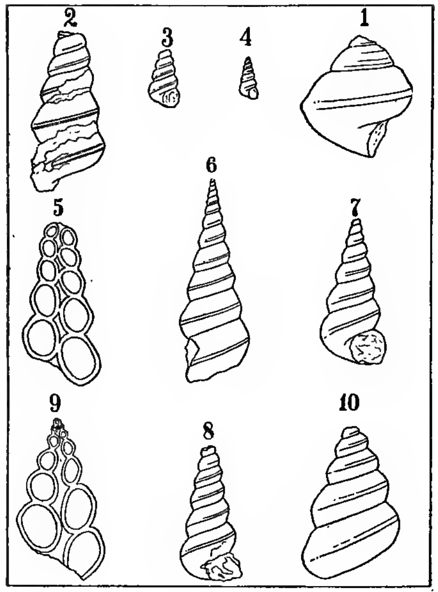
7 Ventral view of the internal cast of the last volution, showing the ventral depressed zone

8 Section of an internal cast, showing the relative width and hight of the volutions

9 Another section of an internal cast, exhibiting a somewhat asymmetric arrangement of the inner volutions

All specimens drawn natural size. With the exception of the original of fig. 1 which is from the Guelph at Rochester (Arey collection), all are from the Lower Shelby bed (N. Y. State Museum).

PLATE 7



Eotomaria kayseri sp. nov.

(*See* plate 8, fig. 1)

Page 70

FIG.

1 Lateral view of the internal cast

Coelidium macrospira Hall (sp.)

(*See* plate 10, fig. 13)

Page 65

2 Lateral view of a specimen with angular volutions, showing distinctly the surface characters

3 Young, somewhat rapidly widening specimen with rounded volutions (M. logani)

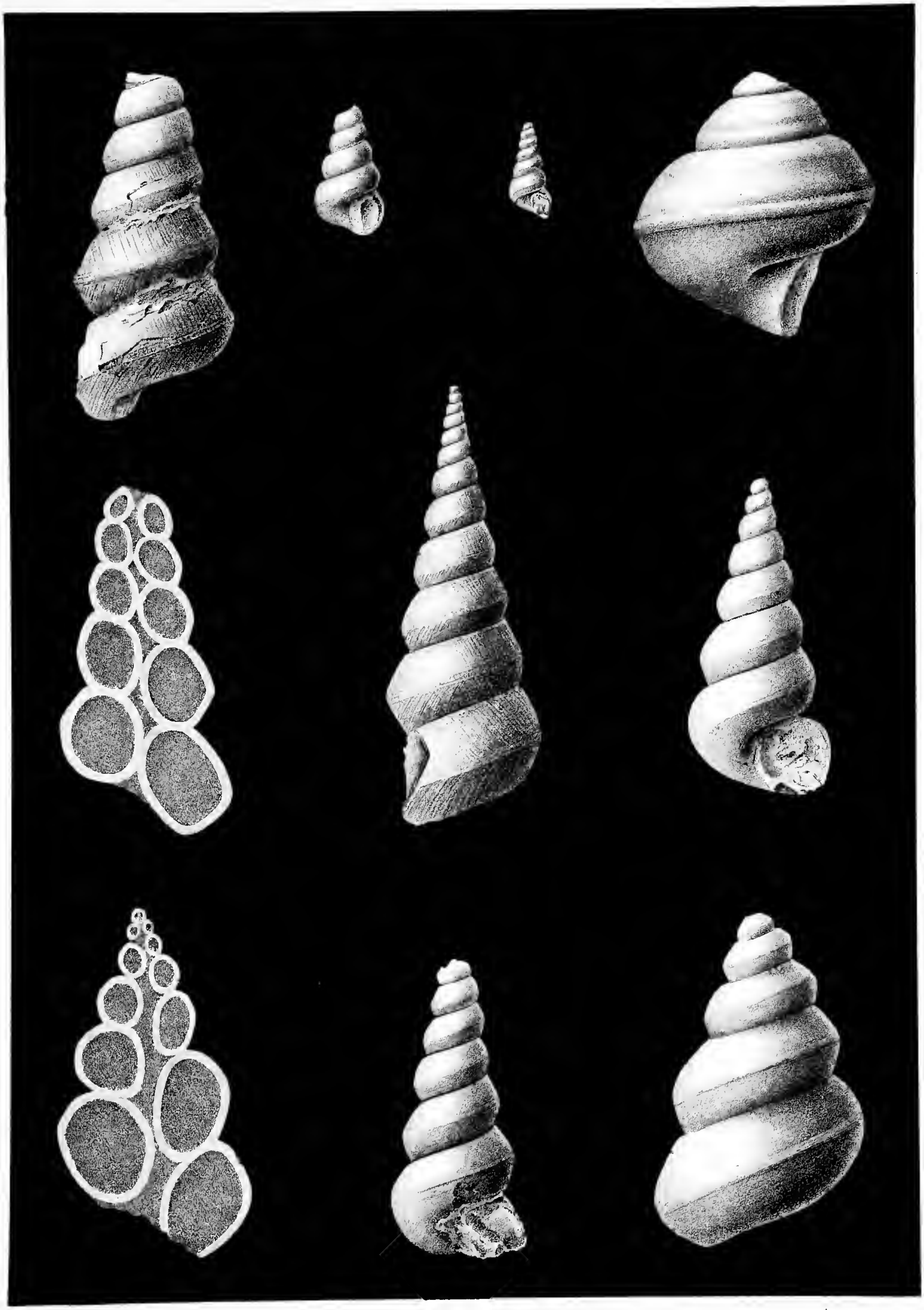
4 A still younger specimen, showing the same characters

5 A section of the specimen figure 2, showing the perforate axis of the shell

6 A nearly complete example, showing a gradual change from the round to more angulated volutions. From a gutta-percha squeeze of a natural impression

Memoir 5. N.Y. State Museum

Plate 7



W S Barkentin.del

J.B Lyon Co. State Printer

Phil. Ast, lith.

FIG.

7 An internal cast of the shell, showing the rounded character of the volutions (M. logani)

8 Another internal cast of a shell, showing the rounded volutions, which are all represented as too angular

Coelidium cf. **vitellia** Billings (sp.)

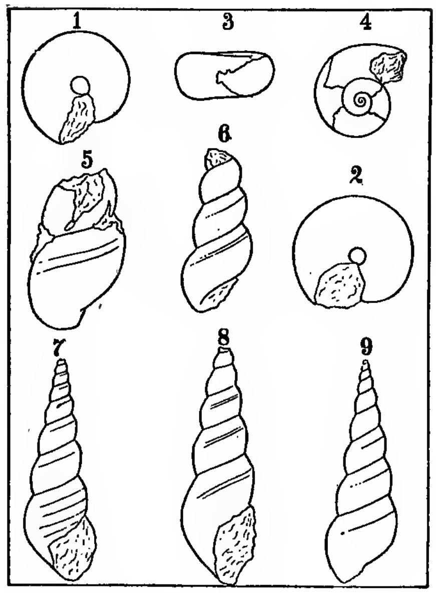
Page 67

9 Section of the shell, showing the wide perforation of the axis; rather badly restored at the apex

10 Exterior view of the same specimen

All specimens are drawn natural size and are from the Guelph beds at Rochester (Arey collection).

PLATE 8



Eotomaria kayseri sp. nov.

(*See* plate 7, fig. 1)

Page 70

FIG.

1 Basal view of the specimen represented on plate 7, showing the narrow umbilicus

Eotomaria areyi sp. nov.

(*See* figures, p. 69)

Page 68

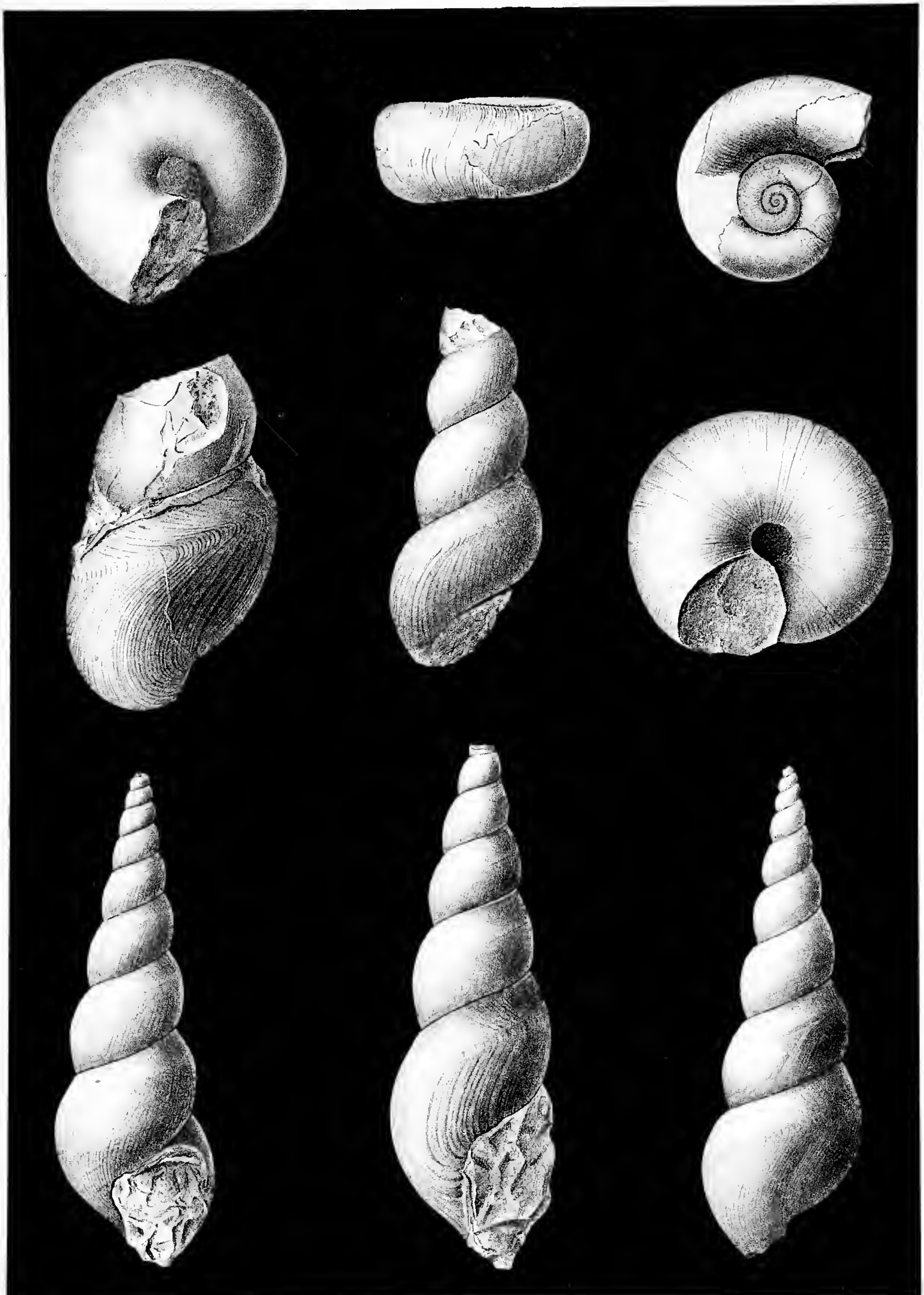
2 Basal view of the type specimen represented on p. 69, exhibiting the narrow umbilicus and the growth lines

Euomphalus fairchildi sp. nov.

Page 75

3 Lateral view of the type specimen of the species, showing the forward curvature of the growth lines

4 Upper side of the same specimen



G. S. Barkentin, del. J. B. Lyon Co. State Printer Phil. Ast, lith.

Hormotoma whiteavesi sp. nov.

Page 72

FIG.

5 Last volutions of a very large individual with strongly marked sculpture of the surface and slit band

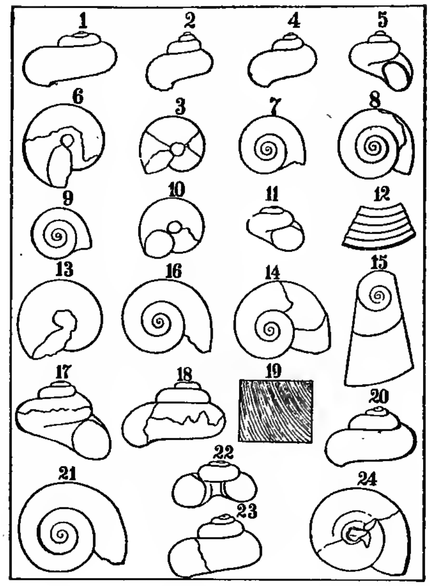
6 A younger, very slender specimen, showing the strongly recurving growth lines

7, 9 Two views of a nearly complete specimen in solid chert with very faint indications of the growth lines and slit band

8 View of a very large example, showing the long, narrow, prolonged aperture

All specimens are drawn natural size, and are from the Guelph beds at Rochester (Arey collection).

PLATE 9



Poleumita scamnata sp. nov.

Page 60

FIG.

1 Lateral view of a specimen with depressed spire

2, 3, 5 Three views of an individual with high spire

4, 7 Two views of an average specimen

6 Umbilical view, showing the size of umbilicus

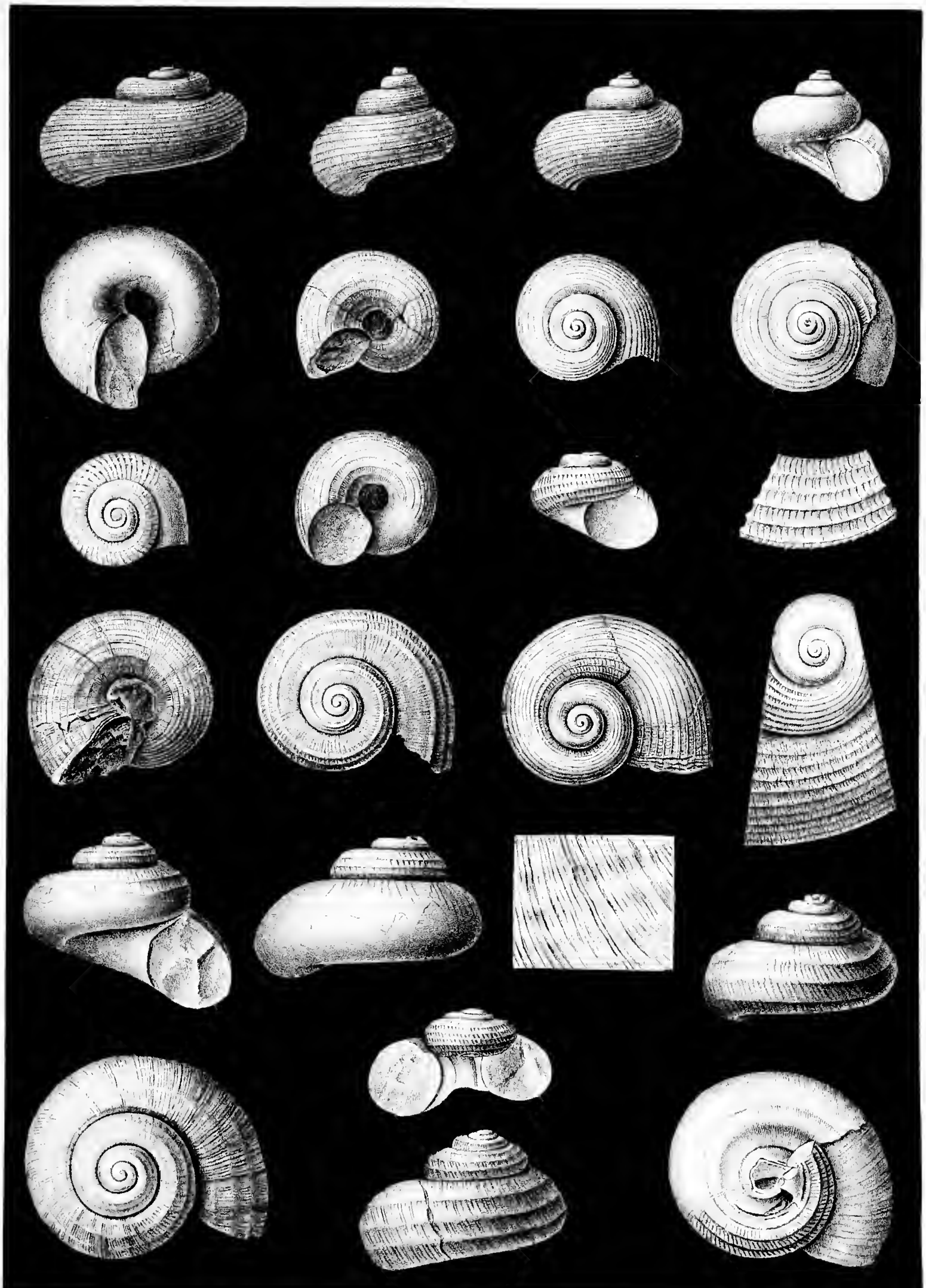
8 Apical view of a young specimen, showing distinctly the surface sculpture of the early volutions. x2

10 Umbilical view of a specimen with very distinct sculpture of the basal region

12 Enlargement of the surface. x3

13 Umbilical view of an older individual, showing the wider interval between the revolving lines near the umbilicus.

14 Apical view of an individual with very sharp revolving and indistinct transverse lines. From a gutta-percha squeeze of a natural impression (*see* fig. 12)



G. S. Barkentin del. J. B. Lyon Co. State Printer Phil. Ast, lith.

FIG.

15 Enlargement of part of a specimen with extremely coarse revolving and irregular transverse lamellose growth lines on the last volution

Poleumita crenulata Whiteaves (sp.)

Page 64

9, 11 Two views of a young specimen, exhibiting very sharp sculpture lines

16 Apical view of a typical individual. From a gutta-percha squeeze of a natural cast. Lower Shelby bed (N. Y. State Museum)

17, 18 Two views of a specimen with very sharp, distant, transverse lines, showing also the gradual suppression of the revolving ridges upon mature volutions

19 Enlargement of the sculpture on the basal side of a large individual, showing the coarse growth lines and the faint revolving ridges. x3

20 Individual retaining the revolving ridges upon the last volution

21 A very large individual, showing distinct gerontic characters upon the last volution. From a gutta-percha squeeze of a natural impression. Lower Shelby bed (N. Y. State Museum)

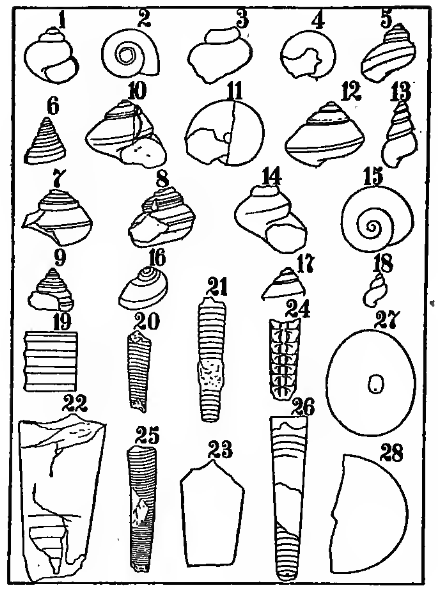
22 Natural section of the volutions

23 Lateral view of an individual with depressed spire

24 Apical view of a specimen, showing strong contrast between the ornament of the last and early volutions

All figures are natural size and all originals are from the Guelph at Rochester, where not otherwise stated.

PLATE 10



Poleumita (?) **sulcata** Hall (sp.)

Page 62

FIG.

1, 2 Two views of a typical specimen. Natural size

3, 4 Profile and umbilical views of another specimen. Natural size. Rochester (Arey collection)

Trochonema cf. **fatuum** Hall

Page 75

5 Lateral view of the only specimen observed. Natural size. Upper Shelby bed (N. Y. State Museum)

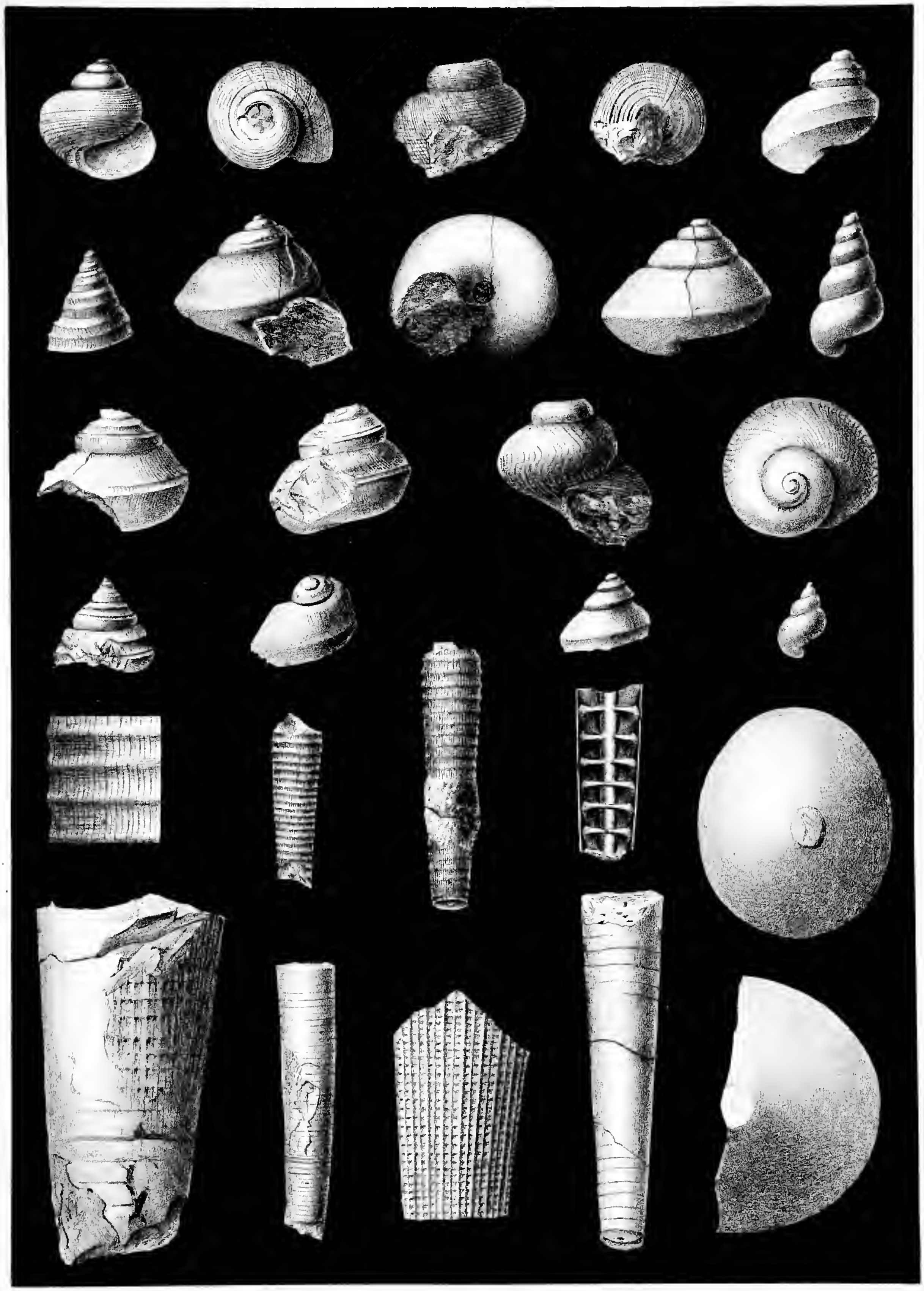
Lophospira bispiralis Hall (sp.)

Page 71

6 Apical part of a specimen, showing distinctly the carinae. From a gutta-percha impression of a natural mold. x2. Lower Shelby bed (N. Y. State Museum)

7, 8 Two older individuals which show the structure of the slit band and the gradual obsolescence of the carina on the upper side of the volution. Natural size. Rochester

GUELPH FAUNA



G S. Barkentin. del J.B Lyon Co. State Printer W S Barkentin lith.

FIG.

9 Young individual with very strongly marked carinae and slit band. Natural size. Rochester

Eotomaria galtensis Billings (sp.)

Page 70

10–12 Three views of an internal cast with parts of the shell preserved. Natural size. Upper Shelby bed (N. Y. State Museum)

Coelidium macrospira Hall (sp.)

(*See* plate 7, fig. 2–8)

Page 65

13 Gutta-percha impression of an internal cast of a young individual. Lower Shelby bed (N. Y. State Museum)

Diaphorostoma niagarense Hall (sp.)

Page 59

14, 15 Two views of a very small specimen. x3. Fig. 15 is slightly restored at the apex. Rochester (Arey collection)

16 An individual from the Upper Shelby bed. From a gutta-percha impression. x2. (N. Y. State Museum)

Eotomaria durhamensis Whiteaves (sp.)

Page 68

17 Apical part of an individual. Natural size. Rochester (Arey collection)

Macrochilina sp. indet.

Page 74

18 Single individual observed. x5. Rochester (Arey collection)

Dawsonoceras annulatum americanum Foord

(*See* plate 11, fig. 1)

Page 81

19 Enlargement of surface of original of fig. 20. x5

20 A young individual, with extremely close arrangement of the annulations. Natural size. Rochester (Arey collection)

FIG.

21 Young individual, showing the longitudinal lines with marked distinctness. Natural size. Rochester (Arey collection)

Kionoceras darwini Billings (sp.)

(*See* plate 11, fig. 6; plate 12, fig. 1–8)

Page 84

22 Fragment of shell, showing both the longitudinal ribs and transverse lines. Rochester (Arey collection)

Kionoceras medullare Hall (sp.)

Page 86

23 Fragment of shell, showing the ornament; from a gutta-percha impression of a natural mold. Natural size. Lower Shelby bed (N. Y. State Museum)

Orthoceras trusitum sp. nov.

(*See* plate 13, fig. 1–10)

Page 77

25 Internal cast of a slightly curved individual with very closely arranged septa. Natural size

26 Young individual, showing the smooth surface and the depth of the camerae. Natural size. Rochester (Arey collection)

Orthoceras crebescens Hall

(*See* plate 11, fig. 2–5)

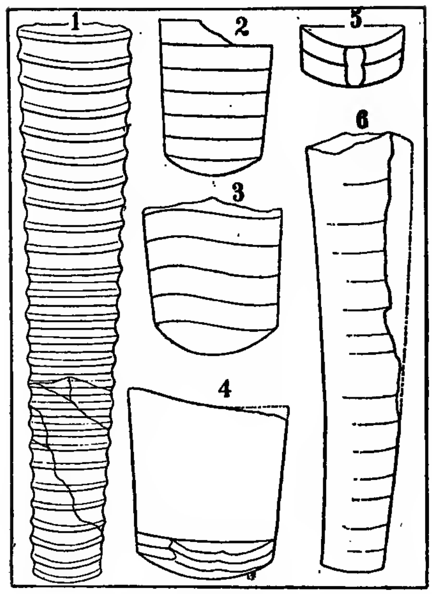
Page 80

24 Internal cast of camerae and siphuncle of young specimen, referred with some doubt to this species. Natural size

27 Septal view of specimen figured on plate 11, fig. 2, showing the section of conch, position and size of siphuncle. Natural size

28 Septal view of specimen figured on plate 11, fig. 3. Lower Shelby bed (N. Y. State Museum)

PLATE 11



Dawsonoceras annulatum americanum Foord

(*See* plate 10, fig. 19–21)

Page 80

FIG.

1 A large individual from the Lower Shelby bed.

Orthoceras crebescens Hall

(*See* plate 10, fig. 24, 27, 28)

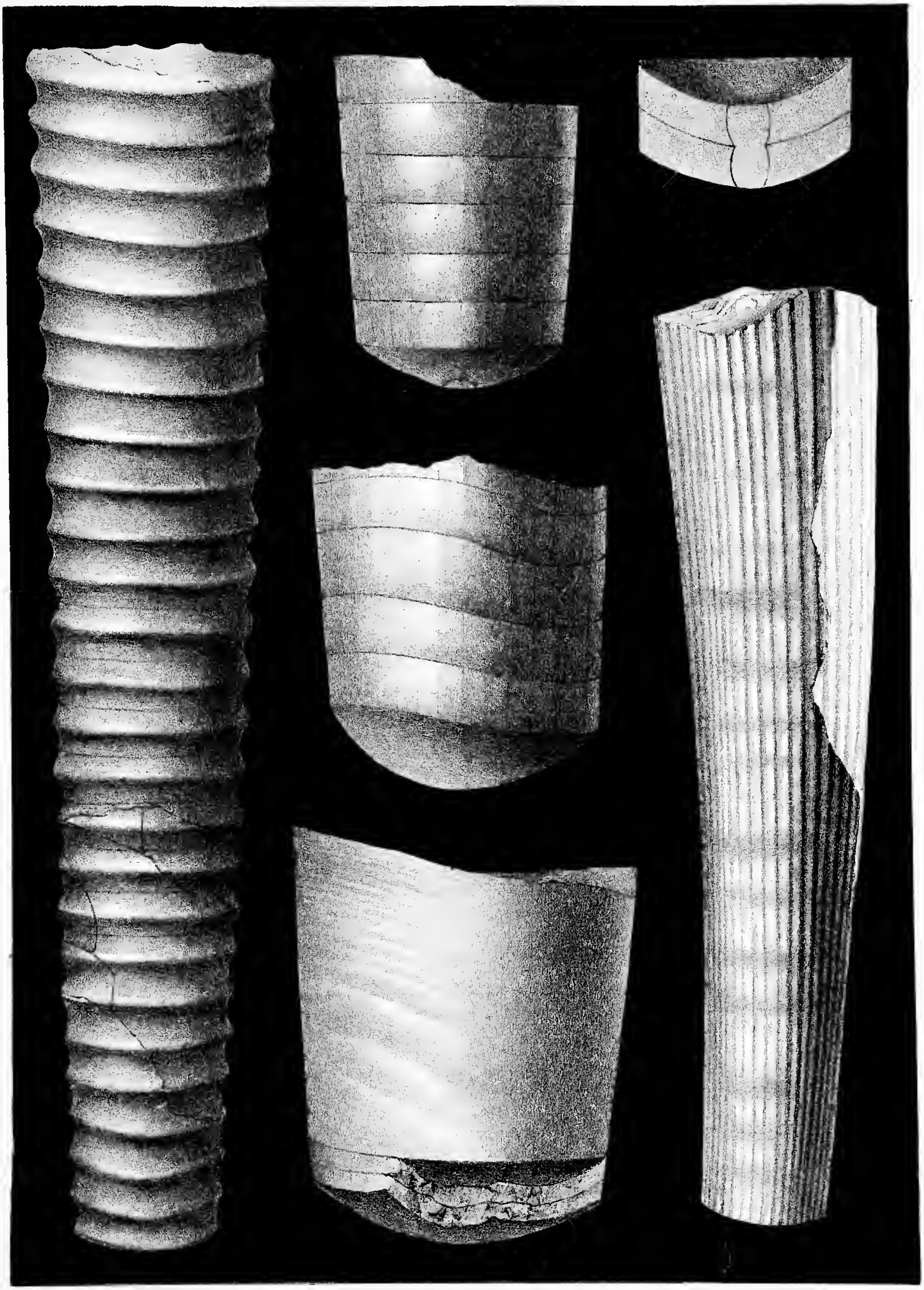
Page 80

2 Fragment of internal cast, showing septal sutures and obscure longitudinal ridges

3 Internal cast of a fragment of an old individual, showing curved septal sutures, relatively deep camerae and septa and low longitudinal ribs.

4 An internal cast of the living chamber and camerae of an old individual, showing the sinuate growth lines on living chamber and shallow gerontic chambers

GUELPH FAUNA



G. S. Barkentin. del. J. B. Lyon Co. State Printer W. S. Barkentin. lith.

FIG.

5 Section through lower part of individual represented in fig. 2, showing the curvature and depth of camerae and slightly expanded siphuncle.

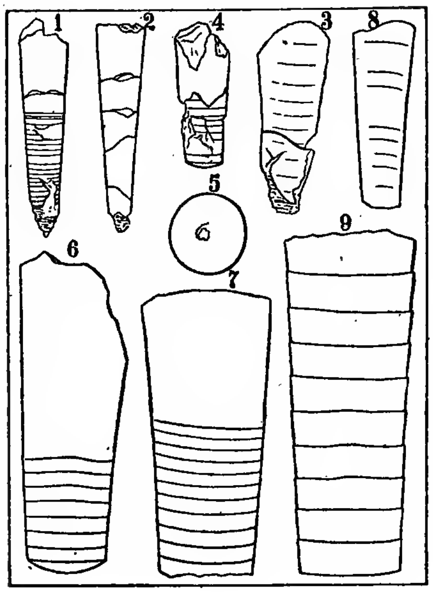
Kionoceras darwini Billings (sp.)

(*See* plate 10, fig. 22; plate 12, fig. 1–8)
Page 84

6 A very large individual, retaining the longitudinal ribs to mature age. From a gutta-percha squeeze of a natural impression

All figures are natural size. All originals are from the Lower Shelby bed (N. Y. State Museum).

PLATE 12



Kionoceras darwini Billings (sp.)

(*See* plate 10, fig. 22; plate 11, fig. 6)

Page 84

FIG.

1, 2 Two views of a young specimen with excellently preserved surface sculpture

3 Fragment showing obscure transverse undulations and alternating ribs

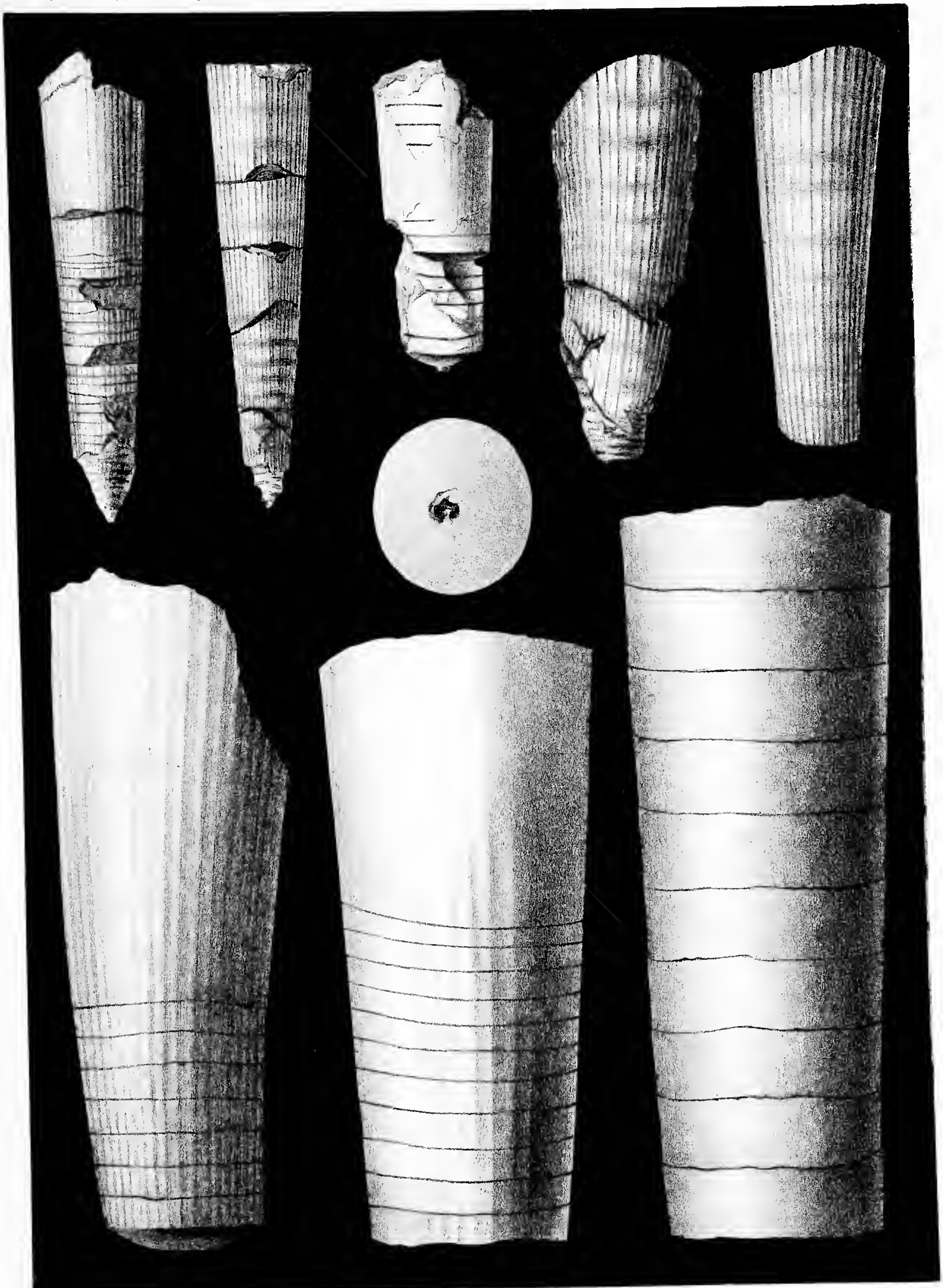
4 Specimen showing the depth of the camerae and septa

Originals of fig. 1–4 from Rochester (Arey collection).

5 Septal view of individual represented in fig. 6

6 Internal cast of older specimen, showing part of the living chamber and the increase in the depth of the chambers

7 Internal cast of specimen with gerontic approach of the septa and somewhat oblique septal sutures



G S. Barkentin del.

J. B. Lyon Co. State Printer

W S Barkentin lith.

FIG.

8 An individual with strong subequal longitudinal ribs. From a gutta-percha impression

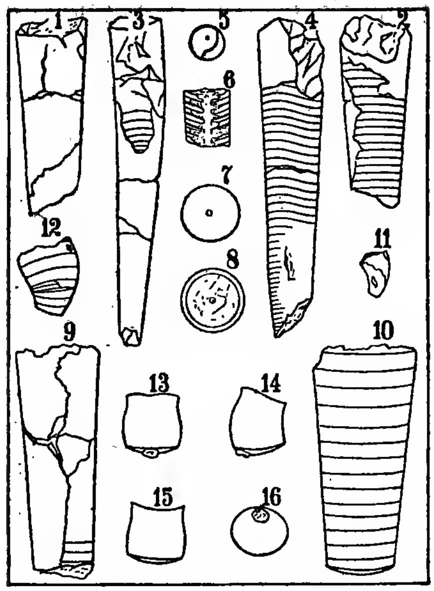
Originals of fig. 5–8 are from the Lower Shelby bed (N. Y. State Museum).

Orthoceras rectum Worthen

Page 78

9 Internal cast of a large specimen, showing the great depth of the camerae. Lower Shelby bed (N. Y. State Museum)

PLATE 13



Orthoceras trusitum sp. nov.

(*See* plate 10, fig. 25, 26)

Page 77

FIG.

1 Fragment preserving the longitudinally lineated surface

2 Internal casts, showing the numerous, shallow camerae and straight transverse suture lines

3 Young individual, showing the slenderness of conch

4 Internal cast, showing undulating septal sutures

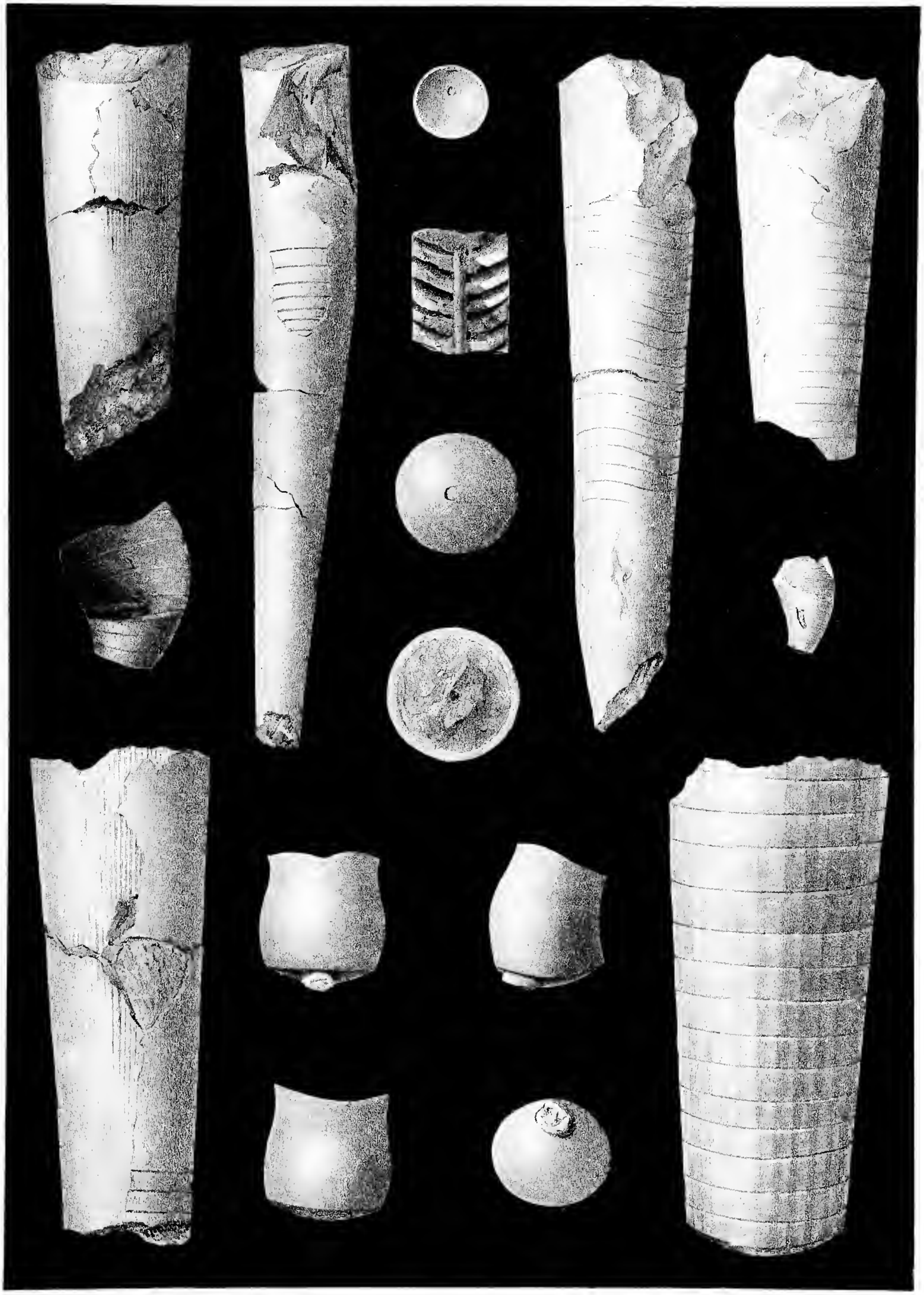
5 Septum with excentric siphuncle

6 Broken internal cast, showing the depth of camerae and the tubular siphuncle

7 Septum, showing the circular section of conch and subcentral location and relative size of siphuncle

8 Section of specimen represented in fig. 1, showing the relatively great thickness of conch

9 Part of living chamber, showing longitudinal lineation



G S Barkentin.del. J.B. Lyon Co. State Printer W.S. Barkentin. lith

FIG.

10 Internal cast of an older individual with deeper chambers and obscure longitudinal ribs

All figures are natural size. The originals of fig. 1–5, 7–9 are from Rochester (Arey collection); those of fig. 6 and 10 from the Lower Shelby bed (N. Y. State Museum).

Cyrtoceras cf. **brevicorne** Hall

Page 89

11 Fragment showing the living chamber and sinuous growth lines. Natural size. Rochester (Arey collection)

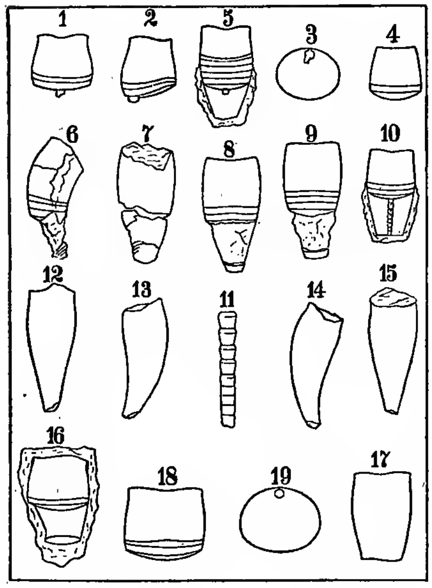
12 Mold and internal cast of a fragmentary specimen, showing the amount of curvature and the unequal depth of the camerae. Lower Shelby bed (N. Y. State Museum)

Poterioceras sp.

Page 97

13–16 Four views of the internal cast of the living chamber of the only specimen observed, showing the contraction of the chamber and the submarginal position of the nummuloidal siphuncle. Lower Shelby bed (N. Y. State Museum)

PLATE 14



Poterioceras sauridens sp. nov.

Page 93

FIG.

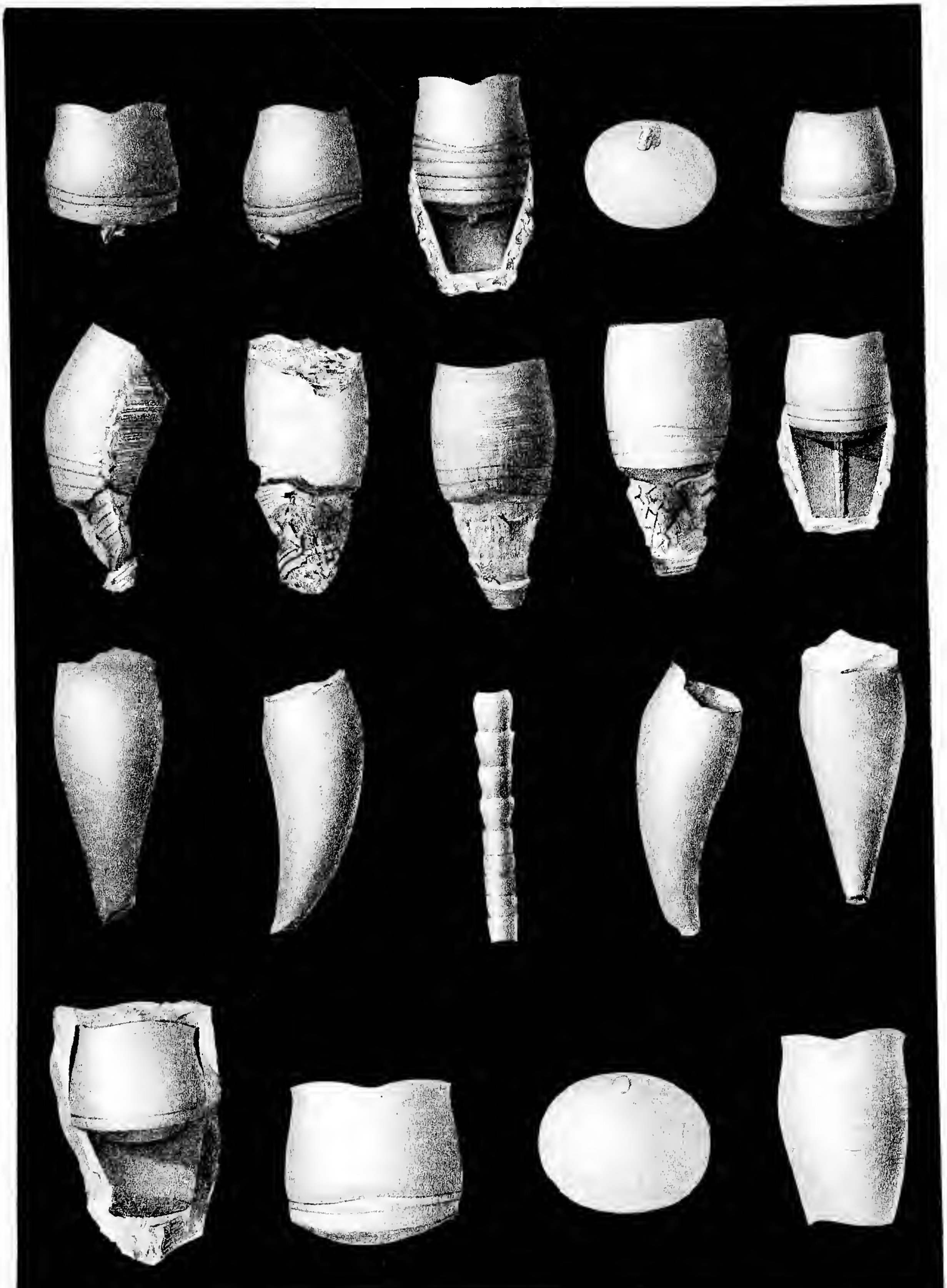
1-3 Three views of an internal cast of the living chamber and the two latest camerae, showing the aperture, contraction of living chamber, transversely oval section and position of siphuncle

4 Ventral view of another internal cast, showing the depth of the septum

5 Internal cast and mold of a nearly complete individual, showing hyponomic indenture of aperture, a greater number of camerae and form of conch

Originals of fig. 1-5 are from the Lower Shelby bed (N. Y. State Museum).

GUELPH FAUNA



W S Barkentin del. et. lith.

J B Lyon Co. State Printer

FIG.

6–9 Four views of a partially crushed specimen which shows the surface characters of the species and the form of the living chamber. Fig. 9 is from a gutta-percha squeeze of the mold and shows the hyponomic curve of the growth lines on the ventral side. Rochester (Arey collection)

10 Interior cast and mold of a specimen, retaining the siphuncle in position

11 The siphuncle of the same specimen. x3.

12–15 Four views of the most complete specimen observed. From a sulfur cast of a natural mold in the rock

16 Mold and cast, showing the thickening of the conch near the aperture

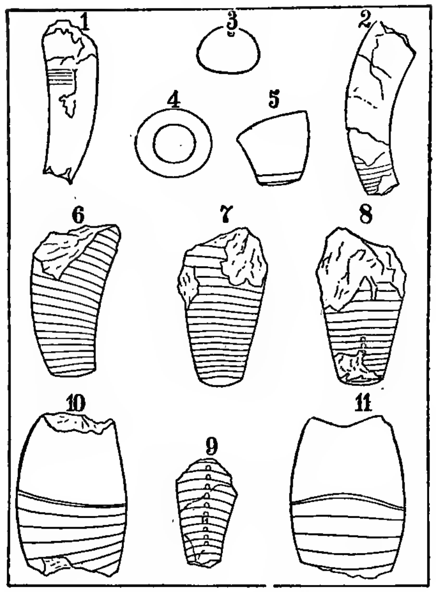
17 Specimen which shows the hyponomic sinus of the growth lines on the ventral side and the contraction of the shell near the aperture. From a gutta-percha impression of a natural mold

18 Internal cast of a large specimen, showing a broad and low living chamber and shallow septum

19 Septal view of same

All figures except 11 are natural size. Originals of fig. 10–19 are from the Lower Shelby bed (N. Y. State Museum).

PLATE 15



Cyrtoceras arcticameratum Hall

(*See* plate 16, fig. 1–7)

Page 87

FIG.

1 A specimen retaining the shell and exhibiting the character of the surface

2 A specimen with closely arranged septa

Cyrtoceras orodes Billings

Page 88

3 Septal view of a specimen, showing the marginal position of the siphuncle and the difference in curvature between the inner and outer sides

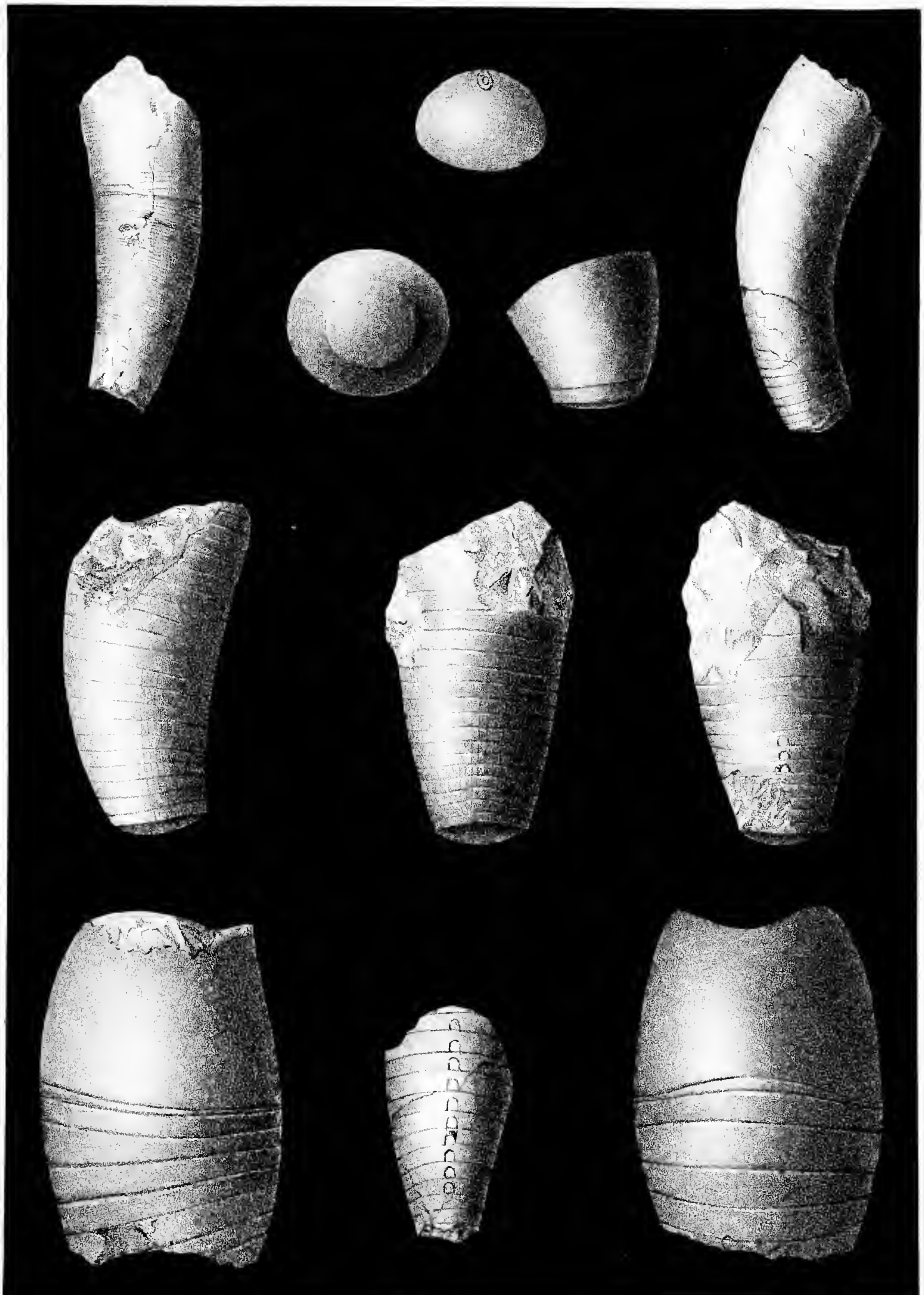
4, 5 Two views of an internal cast, referred with some doubt to this species, showing a rapidly expanding living chamber and subcircular section

6–8 Three views of an internal cast, showing the depth of the camerae and direction of the sutures

9 A specimen exhibiting the siphuncle

Memoir 5. N.Y. State Museum

Plate 15



W. S. Barkentin del. et lith.

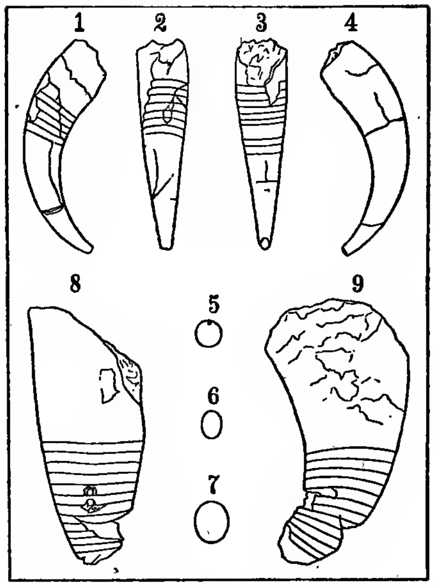
J. B. Lyon Co. State Printer

FIG.

10, 11 Internal cast of a large specimen, referred with doubt to this species, possessing a strongly contracted living chamber

All figures are natural size. The originals of fig. 1–3, 6–9 are from Rochester (Arey collection); those of fig. 4–5, 10, 11 are from the Lower Shelby bed (N. Y. State Museum).

PLATE 16



Cyrtoceras arcticameratum Hall

(*See* plate 15, fig. 1, 2)

Page 87

FIG.

1–4 Four views of the most complete specimen observed; showing the degree of curvature and rate of expansion of the conch

5 Septum of a specimen, showing the marginal position of the siphuncle and a subcircular section

6, 7 Two sections of another specimen with longer dorsoventral axis

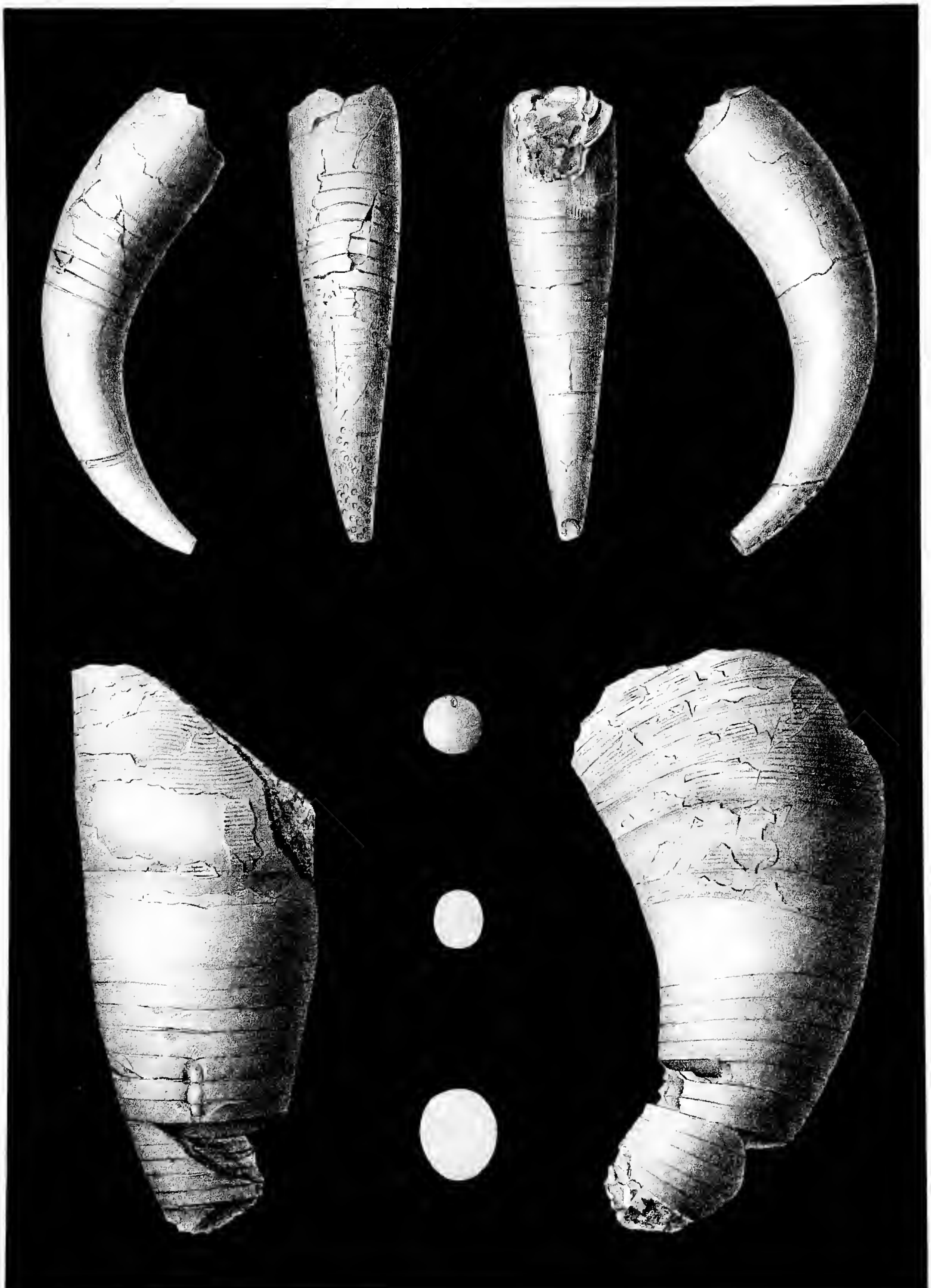
Cyrtoceras bovinum sp. nov.

(*See* plate 18, fig. 5, 6)

Page 90

8, 9 Two views of a specimen, showing the rapid expansion of the shell, depth of camerae and surface characters

All figures are drawn natural size, and are from Rochester (Arey collection).

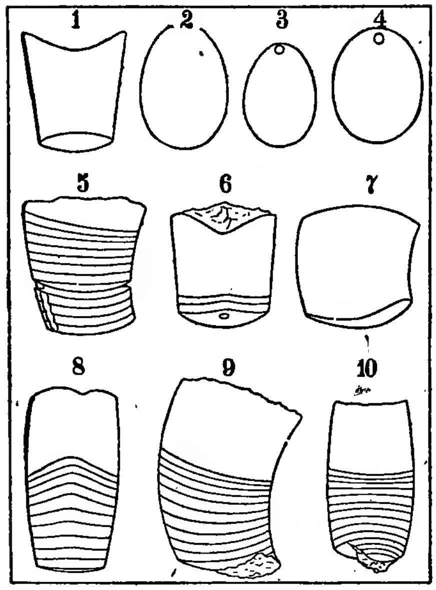


W S Barkentin del

J.B Lyon Co. State Printer.

Phil. Ast, lith.

PLATE 17



Cyrtorhizoceras curvicameratum sp. nov.

Page 90

FIG.

1 Dorsal view of internal cast of living chamber (*see* fig. 7)

2 Section of aperture of same, showing the lateral compression of the living chamber

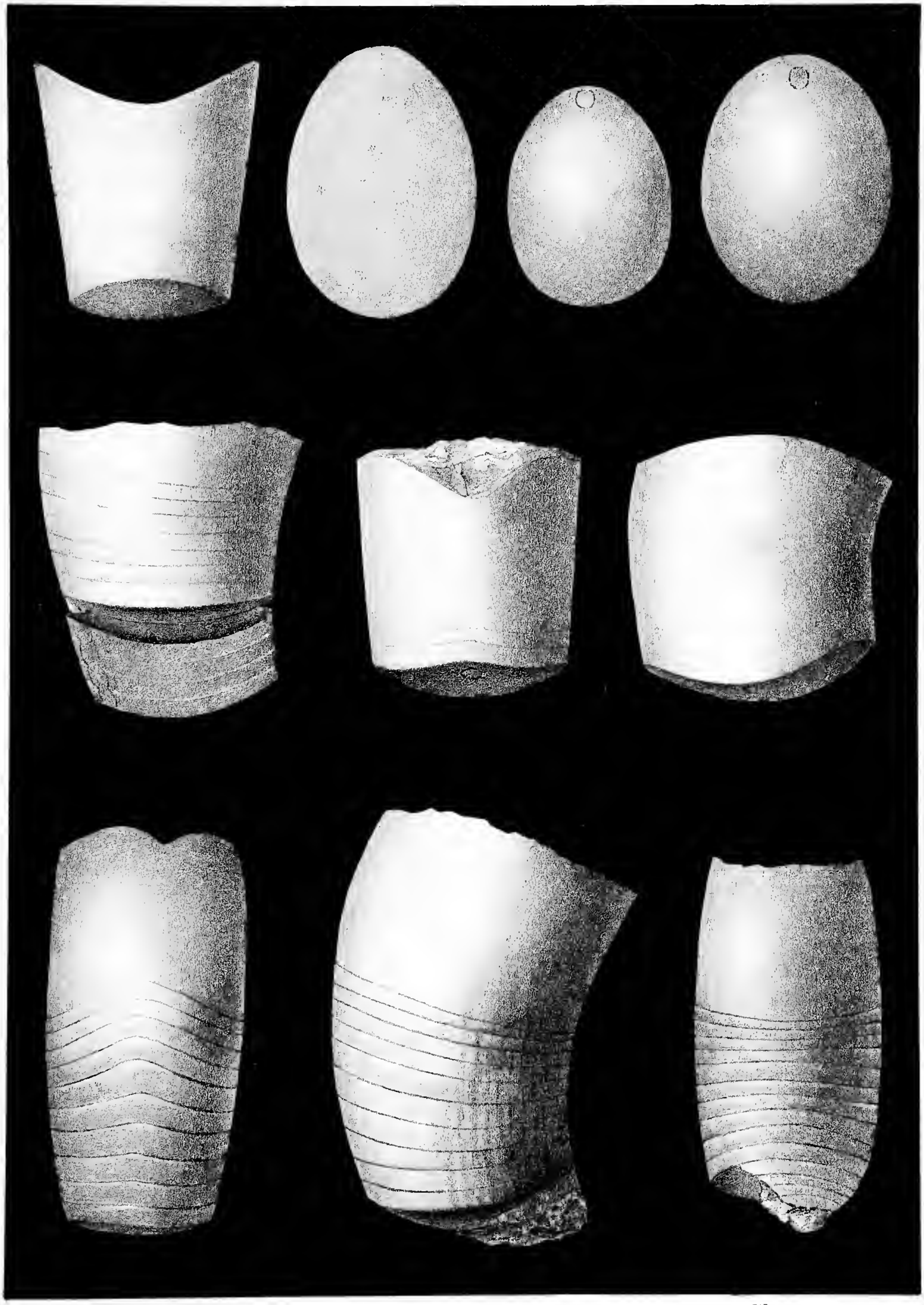
3 Septal view of same, showing marginal position of siphuncle

4 Septal view of another, somewhat rounded form (*see* fig. 6)

5 Specimen which shows the direction of septal sutures, depth of camerae, position of, and slightly expanded siphuncle

6 Internal cast, showing the living chamber and the ventral lobe of the sutures

7 Internal cast of living chamber of large individual, showing the aperture, the strong curvature of the last septum and the curvature of the chamber



G S Barkentin del

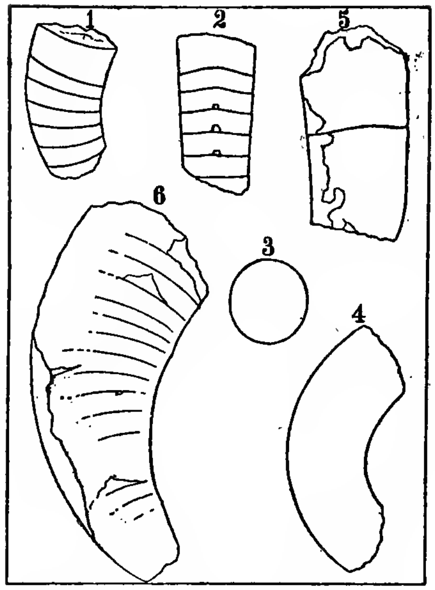
J.B Lyon Co. State Printer

W S Barkentin lith

FIG.
8–10 Three views of the most complete specimen observed; showing the depth of the camerae, the ventral lobes of the sutures and the low longitudinal surface ribs

The originals of all drawings are from the Lower Shelby bed (N. Y. State Museum).

PLATE 18



Gyroceras farcimen sp. nov.

Page 92

FIG.

1–3 Three views of an internal cast, showing the sutures, depth of camerae, position of siphuncle and circular section of conch

4 Fragment, showing the curvature of the conch and the smooth surface. From a gutta-percha impression of a natural mold

Cyrtoceras bovinum sp. nov.

(*See* plate 16, fig. 8, 9)

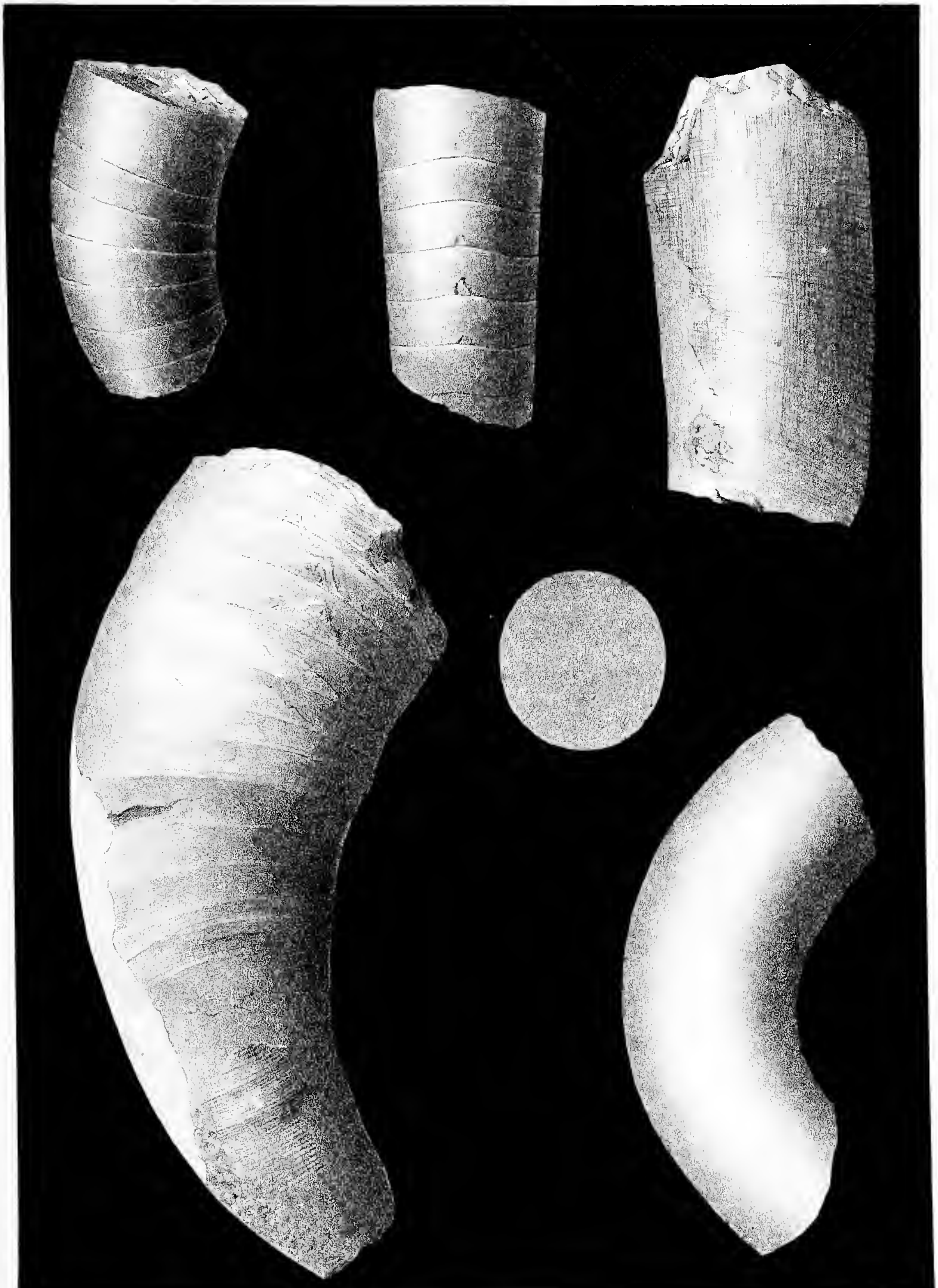
Page 90

5 Specimen retaining the surface sculpture

6 A large individual, showing the curvature and expansion of the conch, direction of sutures and depth of camerae

All figures are natural size. The originals of fig. 1–4 are from the Lower Shelby bed (N. Y. State Museum); those of fig. 5, 6 from Rochester (Arey collection).

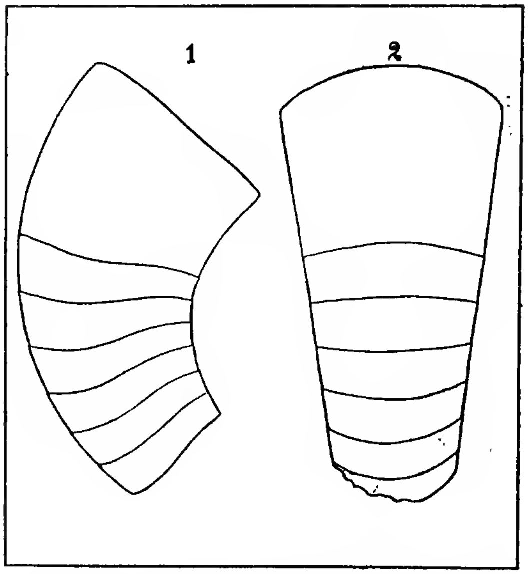
GUELPH FAUNA



W S Barkentin del et lith.

J. B. Lyon Co. State Printer

PLATE 19

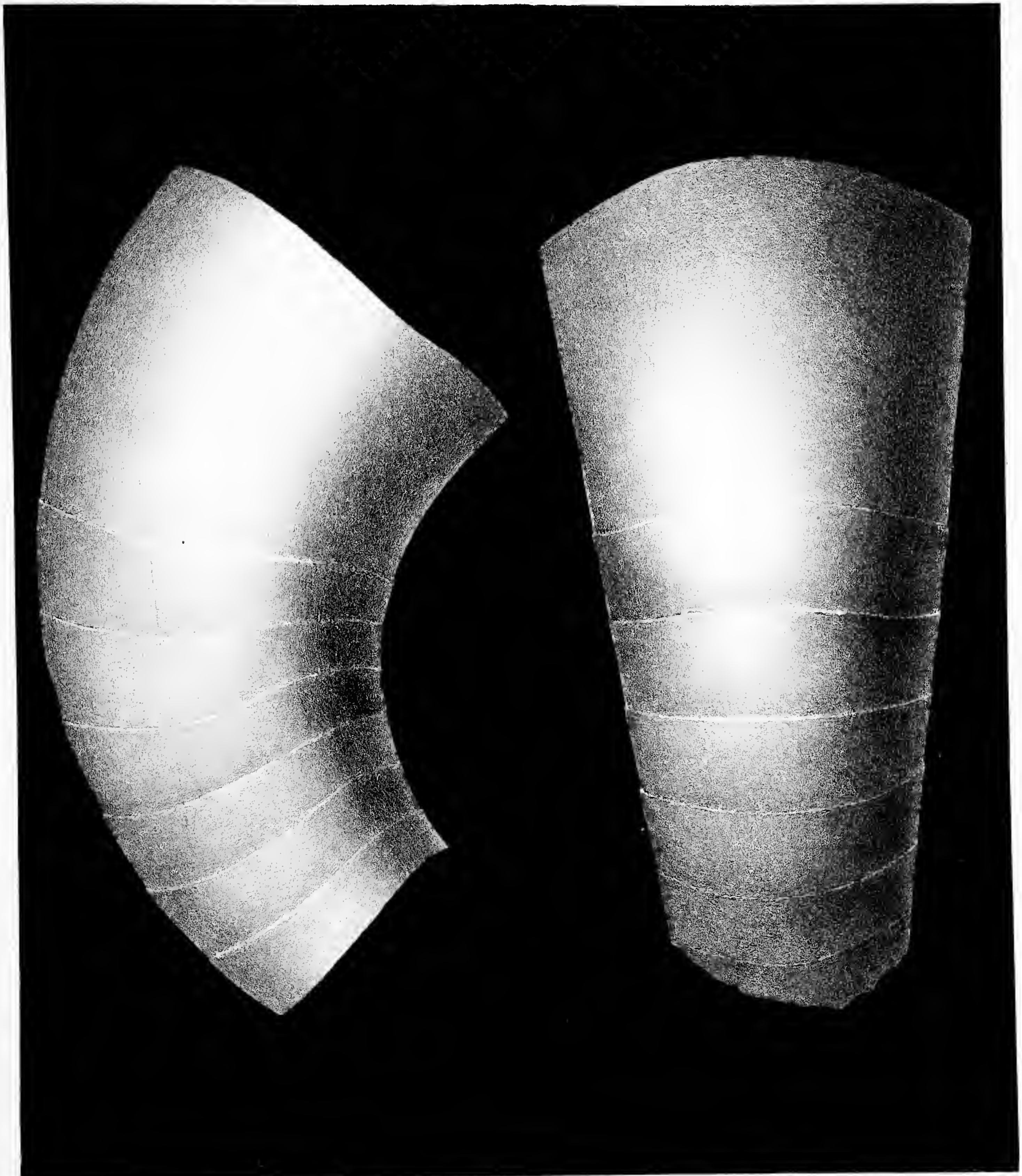


Protophragmoceras patronus sp. nov.

Page 97

FIG.

1, 2 Two views of the only specimen observed. Natural size. Lower Shelby bed (N. Y. State Museum)

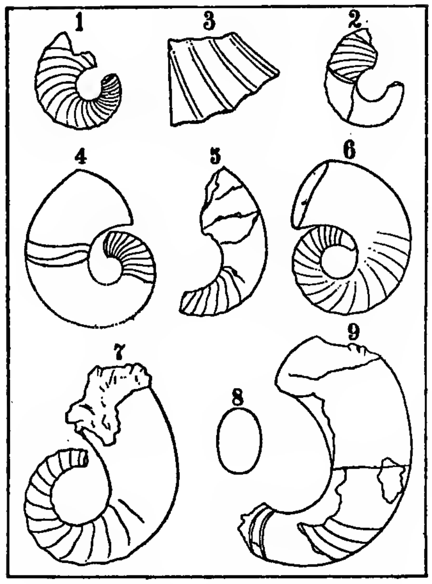


G. S. Barkentin. del.

J. B. Lyon Co. State Printer

W. S. Barkentin. lith.

PLATE 20



Trochoceras costatum Hall

Page 103

FIG.

1 Specimen showing the rate of expansion, curvature of conch and the character of the costae. From a gutta-percha impression of a natural mold

2 An individual which shows the living chamber and the curvature and depth of the last septum. The costae on the living chamber are drawn somewhat too strong.

Trochoceras desplainense McChesney

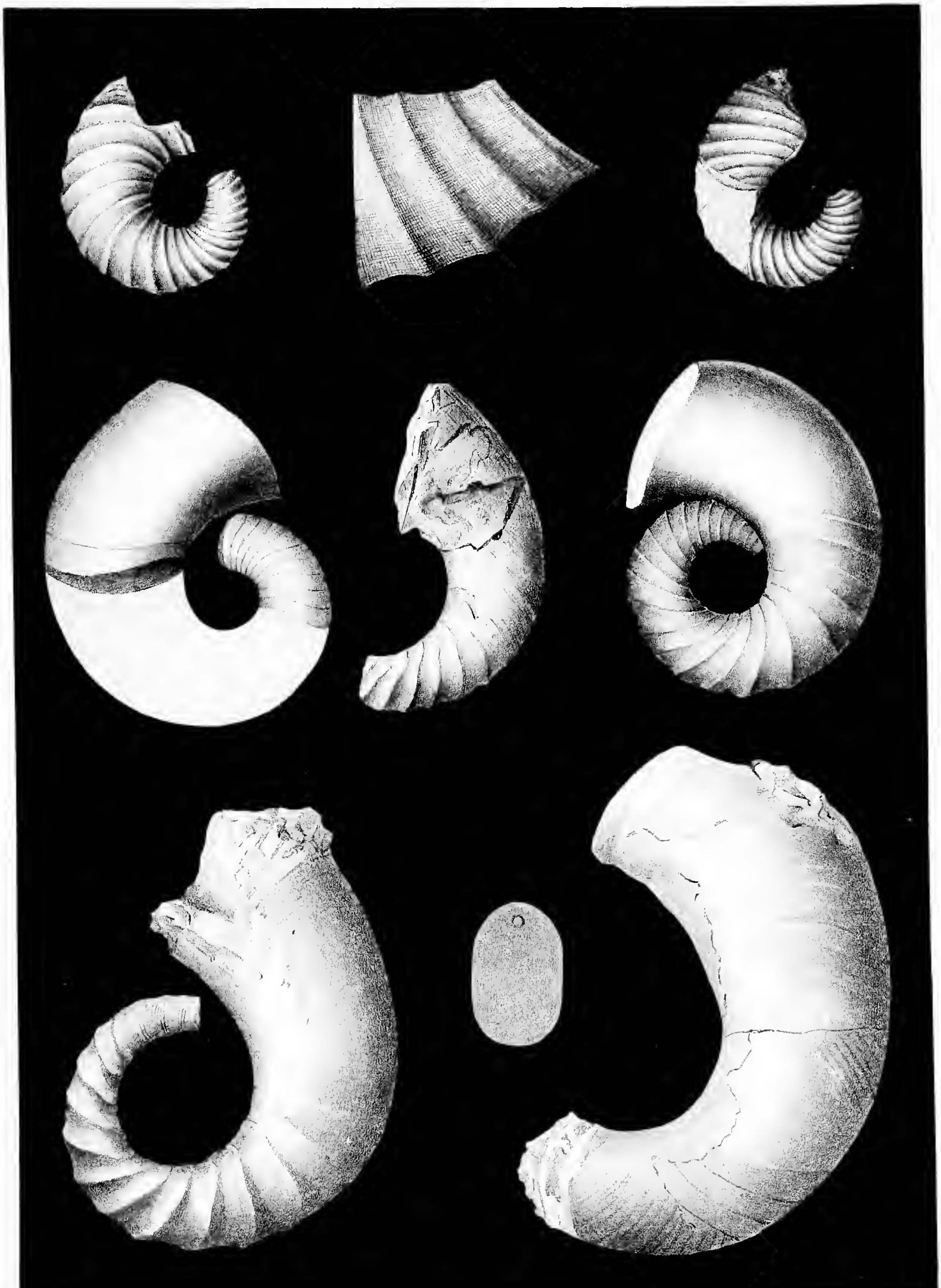
Page 100

3 Enlargement of surface (x3) to show the fine transverse and longitudinal lineation. From a gutta-percha impression of a natural mold

4 Internal cast of specimen, showing the aperture, living chamber and septal sutures of an early whorl

5 Specimen with strongly developed costae and growth lines

GUELPH FAUNA



G. S. Barkentin, del. J. B. Lyon Co. State Printer Phil. Ast, et W. S. Barkentin lith.

FIG.

6 A nearly complete individual, showing the gradual obsolescence of the costae on the living chamber. From a gutta-percha impression of a natural mold

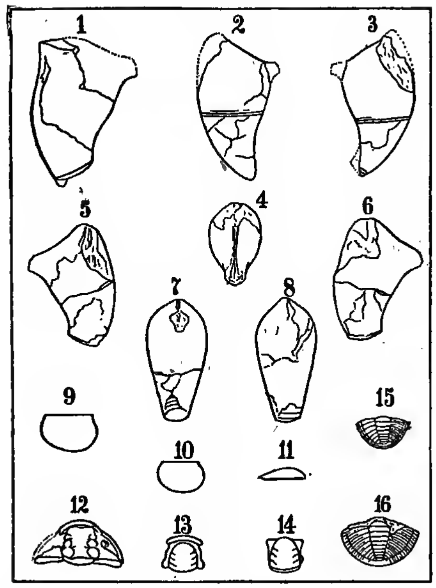
7 An older, nearly complete individual, showing the tangential direction of the gerontic portion of the conch

8 Section showing the lateral compression of the conch and the position of the siphuncle

9 Part of a mature individual, showing the size and expansion of the living chamber, and the surface sculpture on the mature shell

All figures except 3 are natural size. The originals of fig. 1, 2, 4, 6 and 8 are from the Lower Shelby bed (N. Y. State Museum); those of fig. 3, 5, 7 and 9 from Rochester (Arey collection).

PLATE 21



Phragmoceras parvum Hall & Whitfield

Page 99

FIG.

1 Lateral view of a relatively large specimen with well preserved surface sculpture

2, 3 Two views of a specimen, showing the curvature of the apical part, the last camerae, the living chamber and the different direction of the septal sutures and surface lines

4–8 Five views of a specimen, showing the long and narrow hyponomic area of the contracted aperture and the hyponomic curve of the growth lines upon the ventral side (fig. 7)

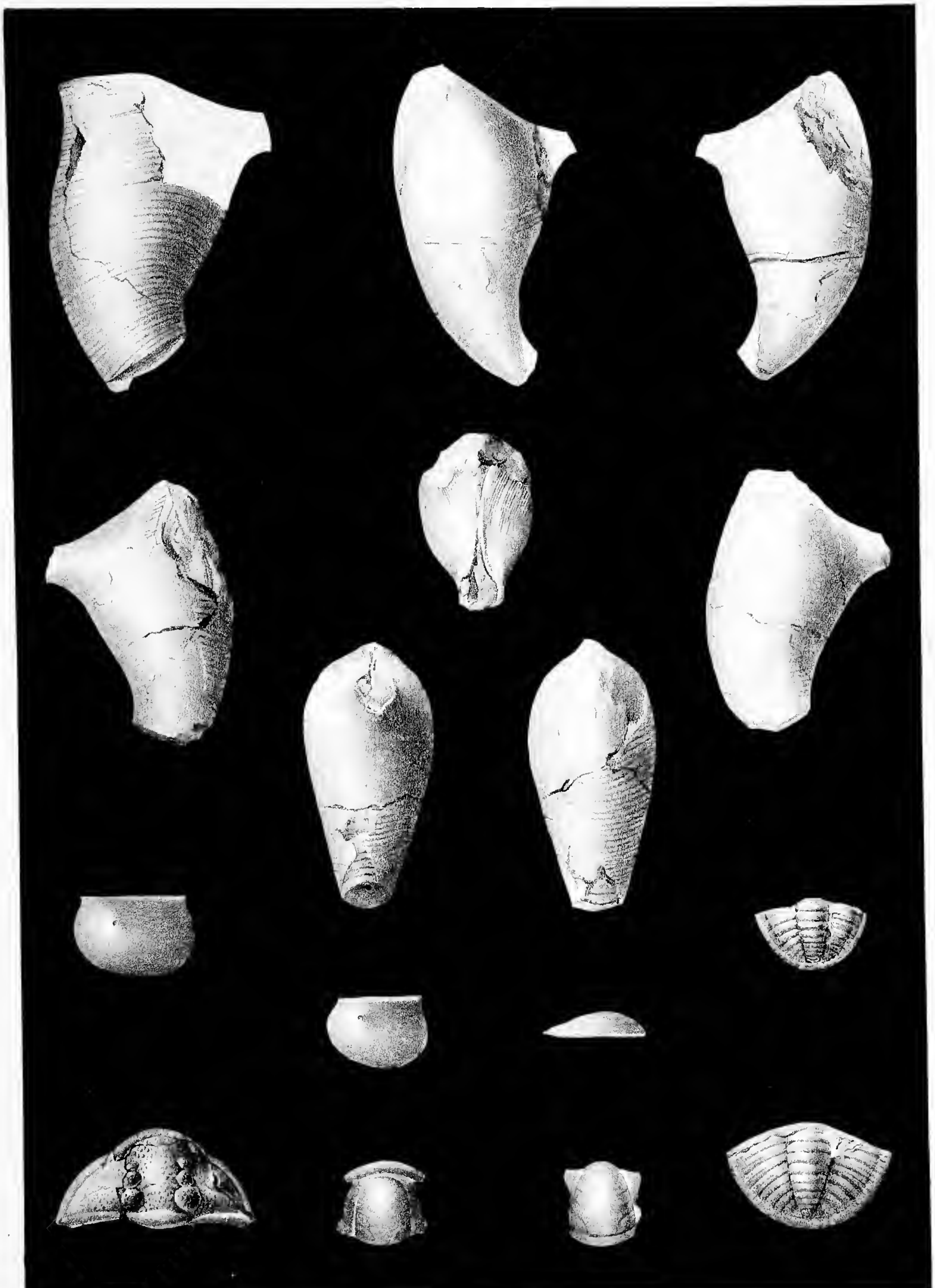
All figures are natural size. The originals are from Rochester (Arey collection).

Leperditia balthica Hisinger, var. **guelphica** Jones

Page 106

9 The largest valve observed. x2

10, 11 Two views of a valve, showing the eye tubercle distinctly. x2. Both from the Guelph at Rochester



W. S. Barkentin del. et lith. J. B. Lyon Co. State Printer

Calymmene niagarensis Hall

Page 107

FIG.
12 Cephalon from the Guelph at Rochester. x2

Proetus sp.

Page 108

13 Cranidium, from a gutta-percha squeeze of a natural impression. x2. Rochester

14 Another, smaller cranium. x3

15 Small pygidium, retaining partially the test. x2

16 Largest pygidium observed. x2

Originals of fig. 14–16 are from the Upper Shelby bed (N. Y. State Museum).

INDEX

Page numbers referring to descriptions of fossils are printed in black face type.