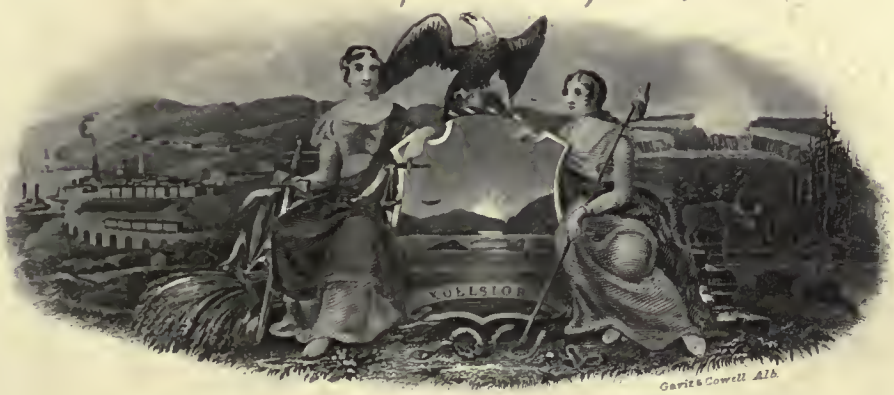
Natural History

OF

NEW YORK.



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Geological Survey of the State of New York.

PALÆONTOLOGY:

VOL. V. PART II.

TEXT.

CONTAINING DESCRIPTIONS OF THE

GASTEROPODA, PTEROPODA AND CEPHALOPODA

OF THE

UPPER HELDERBERG, HAMILTON, PORTAGE AND CHEMUNG GROUPS.

BY JAMES HALL,
STATE GEOLOGIST.

ALBANY, N. Y.:
CHARLES VAN BENTHUYSEN & SONS.
1879.

DEDICATION.

To His Excellency

LUCIUS ROBINSON,

Governor of the State of New York:

SIR—In accordance with the custom which has prevailed from the beginning of the publication of the Natural History of the State, I have the honor to present to your Excellency, Volume V, Part II, of the PALÆONTOLOGY OF THE STATE OF NEW YORK.

Of the mechanical and artistic execution of the work I may speak in general commendation, and of some portions with unqualified praise. In regard to its scientific merit, I can only express the hope that students in natural science, and the enlightened educators of our State and country, may find this volume a contribution worthy of their acceptance, and a source of material for that higher education and intelligence, which the people of New York so earnestly desire, and which was the grand object of the illustrious founders of the GEOLOGICAL SURVEY, and of those friends of science who subsequently authorized and have directed the publication of the NATURAL HISTORY OF THE STATE OF NEW YORK.

Hoping that in this respect the Volume herewith presented may prove acceptable to your Excellency,

I have the honor to be,

With great respect,

Your obedient servant,

JAMES HALL,

State Geologist.

ALBANY, *December* 15, 1879.

LETTER

TO THE

SECRETARY OF STATE AND SECRETARY OF THE BOARD OF REGENTS.

To Hon. ALLEN C. BEACH,
Secretary of State, and

S. B. WOOLWORTH, LL. D.,
Secretary of the Board of Regents:

GENTLEMEN—By a law of the Legislature of the State of New York, all matters relating to the publication of the Natural History of the State are committed to your direction. In accordance with this law, and my own desire, I beg leave to submit to you Volume V, Part II, of the PALÆONTOLOGY OF NEW YORK, which has been done and completed under your direction, and with your approval during its progress.

In submitting this part of the work, it seems proper that I should accompany it with some statement of the present condition of the remaining portions, and an explanation of the causes which have operated to prevent an earlier appearance of the present volume. This explanation is due from myself to you who have so kindly and efficiently sustained the work in its progress through many untoward and discouraging circumstances. It is due to the public of all classes who had a right to expect the publication of a volume long before this time. It is due to myself, because having assumed a position of responsibility, I should either perform the requirements as expected, or offer some reasonable explanation for delay.

It has unfortunately happened that the direction and progress of the work have never been fully within the control of the author, and this has resulted from various causes, as you will see from the following circumstances attending its pursuance:

In 1855, after a virtual suspension of the Palæontology for five years, a contract was made for its continuation, and for its completion in five volumes—two volumes having already been published. Under the conditions of this contract Volumes III and IV were published; and in accordance with the specified conditions of this agreement, the manuscript of the fifth volume was placed in the hands of the Commissioners in charge of the work, in September, 1866. This manuscript contained the descriptions of all the species of Crinoidea, Gasteropoda, Pteropoda, Cephalopoda, and Crustacea, then known to me. This act constituted the fulfillment of the duties imposed upon the author by the original agreement of 1855.

In the final arrangement regarding the completion of this work, made in 1855, the then Secretary of State, Hon. E. W. Leavenworth, had very properly provided that a certain sum of money should be annually expended in making collections of fossils from the rocks of New York, for the more complete illustration of its Natural History in the department of Palæontology—the collections having previously been made at the personal expense of the author. These collections, thus provided for, were continued for eight years, and a large amount of material was brought together for study; but the want of proper working-rooms prevented it from being made immediately available.

Since no suitable rooms for the purpose were then in the control of the Commissioners, or of the Regents of the University, the author erected a large building especially adapted to this object, and finally a second building became necessary; and to-day these are both filled to overflowing with collections of fossils belonging to the State of New York.

From the completion of Volume IV in 1867, the work of printing and lithography remained entirely at a stand-still. The existing contract for the execution of the work having been made many years previously, when prices of labor and material were much lower, it could not be continued without a loss to the contractor. This condition had in fact existed during the preparation

and publication of Volume IV, and had much delayed its progress. It was not until near the close of 1871, that "owing to the enhanced cost of labor and materials," as set forth in the memorandum, a modification of the conditions of the contract was made, which enabled the work to be continued.

In the meantime, in 1866, the writer had been induced to take charge of the State Cabinet of Natural History, in the hope of being able to reorganize the institution and to build up "a Museum of Scientific and Practical Geology and General Natural History," in accordance with the plan recommended and adopted by the Board of Regents, pursuant to a resolution of the Senate and Assembly, passed in April, 1865. It was not, however, until 1870 that an act was passed recognizing "the State Museum of Natural History," and making an annual appropriation for its support, though coming far short of the original plan proposed. During the period from 1866 to 1872, the entire time and energies of the writer had been given to the reorganization, rearrangement and labeling of the collections of the State Museum, and the preparation of its Reports. Large additions were made in nearly every department, and the area of cases and shelf-room occupied by collections was nearly doubled.

During all this time it had been quite impossible to give special and continued attention to the Palæontology; nevertheless, the field collections of former years were prepared and arranged, and further collections made by persons connected with the Museum. A draughtsman had been kept employed in making drawings, and the lithographic work was recommenced under my general direction. Owing to these years of incessant labor and anxiety consequent upon my position in the State Museum, the repeated failures to accomplish the object in view, and the uncertainty of final legislative action, my health had become completely prostrated, and I was compelled to relinquish all labor during the summer and autumn of 1872, while it was only in the following year that I was able to give some attention to the preparation of a volume of the work, and the consideration of a plan for its completion.

In 1874, I presented to the Finance Committee of the Senate a statement of the existing condition of the work, and a plan for its completion, together with a schedule of the material in preparation. The schedule enumerated the

several classes of fossils, the number of drawings already made of each one, and the estimated number to be made, and to be lithographed, with the cost of the whole at the then established prices. This schedule was accepted by the committee and the appropriations were made upon that basis.

It can readily be seen that there was a necessity for a modification of the plan of 1855. The manuscript deposited in the State Library, in 1866, was in accordance with the plan then contemplated. The original proposition for the completion of the work was based upon the collections then known to us. The idea of a special appropriation of money for further collections was of subsequent origin, and had not then been taken into account. I should have been derelict in my duty to the State and to science had I not availed myself of these collections to enhance the value and completeness of the work, and I should have deserved and have received the censure of all enlightened men. As the direct result of this valuable accession of material, Volume V has expanded to two parts, containing altogether 200 plates, with nearly 500 pages of letter-press already printed, as descriptive matter of the second part; requiring 300 pages more for the completion of the first part, without including the Crinoidea and Crustacea of the originally contemplated Volume V. Among an enlightened people this will not be regarded as a fault.

The presentation of Volume V, Part II, before the completion of Part I may also require some explanation. I was prepared, in 1875, to commence the printing of the first part of the volume, but the Legislature of that year, on the suggestion of the Comptroller, Hon. Nelson K. Hopkins, passed an appropriation of $1,000 to publish Albertype copies of 100 plates of drawings already prepared for the final work. This plan had two objects in view; one of which was to place before the public, at an earlier period than would otherwise have been possible, some evidence of the work already done; the other object was to test the practicability of illustration by the Albertype process. That volume, as finally published, contained 130 plates, including Gasteropoda, Pteropoda, Cephalopoda, Crustacea, and Corals: the three first-named classes comprising what was then intended to be included in Volume V, Part II. Many of the plates there represented had already been lithographed, the draw-

ings and the arrangement of which had been chiefly done by or under the supervision of an assistant, as stated in the preface to that volume; while owing to the occupation of my time in the State Museum, I had been able to give but a general direction to the Palæontological work. It was only while this volume of plates, with their explanations, was passing through the press that I had an opportunity of critically studying the collections which had been made and arranged for this volume, and I soon discovered that the work in the Cephalopoda was so superficial and incomplete, that a thorough revision would be necessary. The preparation of the material for drawing and lithography was immediately commenced; and this part of the work occupied so much of my time that the completion of the descriptive matter, in the same connection, was the most natural and advantageous course to be pursued.

The printing of the descriptions of the Gasteropoda and a part of the Pteropoda of the present volume was completed in 1877; and since that time, the plates of Gasteropoda from 26 to 30, several plates of the Pteropoda, and numerous additions to others, together with the Cephalopoda from plates 75 to 113 inclusive, making the entire number of 120 plates, have all been drawn and lithographed. I believe that these additions will be welcomed by every student of science, and without them the work would have been unworthy of the liberal patronage of the State. The addition of so many plates has necessitated the binding of the text and plates separately, but this may prove a convenience in the use of the volumes.

Volume V, Part I, Lamellibranchiata, is in a forward state of preparation, eighty plates having been printed some time since. The Corals and Bryozoans, following this, are also well advanced, thirty plates being already lithographed, with a large number of drawings ready for the lithographer. The manuscript of the descriptions of the Corals and Bryozoans of the Lower Helderberg group is already prepared for the printer, and the plates in illustration, twenty-two in number, are completed and printed. The descriptions of the Bryozoa of the Upper Helderberg and Hamilton groups are nearly completed; four plates have already been lithographed, and the drawings for the whole number, of

about twenty-five plates, will be ready for the lithographer within a few months. Of the Crustacea eight plates, and of the Brachiopoda more than thirty plates have been printed. In addition to all this more than 800 drawings of Corals have been made for the final illustration of this class of fossils.

It is scarcely necessary for me to state that, with all this work before me, and the necessity of preparing the material for draughtsmen and lithographers, whose skilled services could only be secured by constant occupation, I was unable to give my undivided attention to the single volume in hand. It is unfortunately true, moreover, that the interruptions from other causes beyond my control, during several successive sessions of the Legislature, have seriously retarded the general progress of the work, and delayed the publication of the present volume by at least one year.

The complaints of the delay in the publication of the Palæontology have been without actual knowledge of the real conditions, or the facts of the case; and it is hoped that the foregoing frank statement of the circumstances may correct these misapprehensions and set at rest the efforts which have, from time to time, been made to suspend and destroy the work. At the same time I must thankfully and with pride avow, that there has never been, within my knowledge, a Legislature of the State of New York in which there were not enough of educated, liberal and enlightened men to appreciate and sustain a work of this character against the opposition of a few who would oppose the creation and dissemination of a higher knowledge among the people of the State. In the Legislature of 1879, the Committee on Public Education, as had, in effect, been done by other committees in previous years, unanimously recommended the continuation and the completion of this part of the Natural History of the State.

Under many obligations for repeated acts of kindness and consideration, and for expressions of confidence and encouragement, I beg leave to subscribe myself,

Very sincerely and respectfully,

Your obedient servant,

JAMES HALL.

December 13, 1879.

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PREFACE.

The present publication constitutes the Second Part of Volume V of the PALÆONTOLOGY OF NEW YORK. The volume contains descriptions and illustrations of the Gasteropoda, Pteropoda, and Cephalopoda of the Upper Helderberg, Hamilton, Portage, and Chemung groups. It was originally intended to include all the Mollusca of the classes Lamellibranchiata, Gasteropoda, Pteropoda and Cephalopoda of the above groups in a single volume; but a yet unfinished study of the first class has required eighty plates for its proper illustration, and for its final revision and completion several more plates will be necessary. The three other classes are here illustrated in one hundred and twenty plates, which still leaves some of the material in our collections unrepresented. Among the Cephalopoda a large proportion of the material is fragmentary and in the condition of casts of the interior, rendering the study more difficult and the illustrations far less satisfactory. Reference to this subject may be found in some remarks preceding the descriptions of the Orthocerata, and the same observations are applicable to all the Cephalopoda of the Schoharie grit. We are compelled to use such material, or to leave the species unillustrated for an indefinite period. The limestones of the Upper Helderberg and the shales of the Hamilton group afford more satisfactory material; but in the Portage and Chemung groups the collections are very fragmentary and unsatisfactory, and the results of the most careful study still leave much to be desired. Under these circumstances an author would prefer to wait for more complete collections; but the public are unwilling to appreciate this sentiment, and the State authorities, who represent the public, demand publication. It therefore only remains for the author to give the best results he has been able to obtain,

leaving for those who may come after him the pleasure and satisfaction of producing a more complete work. Notwithstanding all these difficulties, the author is willing to believe that the students in geology will thank him for presenting to them, in the best dress possible, the imperfect material which would otherwise remain unavailable in their collections, and of no value to science or to scientific museums.

The species described in this volume are illustrated by figures drawn and lithographed from original specimens, which are chiefly in the State Museum collections, derived either from the original Geological Survey or from subsequent acquisitions; together with collections made by myself, or under my direction, and of specimens obtained from other authentic sources.

The order and succession of the species, as presented in the plates of Gasteropoda, may not be strictly that which a systematically arranged conchological collection might require; but it is in accordance with the intention of the author, except in the few supplementary plates, and will be found to present a simple and natural order, so far as external form is concerned.

In the Cephalopoda, the author has preferred to begin with the simple Orthoceratites, and to follow with those which present an external gradation of form, through the genera Gomphoceras, Cyrtoceras, Gyroceras, Trochoceras, Nautilus and Goniatites. Unfortunately, the earlier lithographed plates were arranged with a very incomplete knowledge of the material contained in the State collections, and this has necessitated the introduction of the simpler forms on the plates following the completion of the first arrangement, or from plate 74, ending with the Goniatites. This want of unity could not be avoided, but it affects only the plates—the text presenting the genera and species in consecutive order from page 217 to the end of the volume.

In the preparation and final revision of the descriptions of the species of Cephalopoda I have been very ably assisted by Mr. C. E. Beecher, and in the proof-reading and preparation of the index to the volume I am indebted to Mr. J. A. Lintner.

For the use of specimens in the study and illustration of the work I have been indebted to Prof. S. G. Williams, of Cornell University, from his private

collection ; to Dr. C. Rominger, of Ann Arbor, Michigan ; to Dr. James Powers, of Lexington, and to Dr. Benjamin Rogers, of Pendleton, Indiana ; to Dr. James Knapp, of Louisville, Kentucky, and to other gentlemen. There are other collections within the State of New York which would have helped to elucidate the character and structure of certain forms, and I can only regret that these could not have been placed in my hands for study.

The collections of the late Ledyard Lincklæn, originally deposited in the State Museum, and subsequently presented to the institution by Mrs. Lincklæn, have afforded some interesting specimens from the Goniatite Limestone of the Marcellus Shale and Hamilton Group. The collections purchased by the State from Mr. John Gebhard, have furnished the greater part of all the specimens of species coming from Schoharie, and especially those of the Schoharie grit and the Goniatite limestone of that locality.

December, 1879.

JAMES HALL.

GASTEROPODA, PTEROPODA AND CEPHALOPODA

OF THE

UPPER HELDERBERG, HAMILTON, PORTAGE AND CHEMUNG GROUPS.

GASTEROPODA.

PLATYCERAS, Conrad.

Platyceras (Orthonychia) subrectum.

PLATE I, FIGS. 1, 2.

Orthonychia Hall. Geology of N. Y. Surv. Fourth Geolog. Dist., p. 172, f. 3. 1843.
Platyceras subrectum Hall. Twelfth Rep. N. Y. State Cab. Nat. Hist., p. 18, fig. 1859.
Platyceras (Orthonychia) subrectum Hall. Descriptions of New Species of Fossils, etc., p. 1. 1861.*
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 29. 1862.
" " " " Illustrations of Devonian Fossils: Gasteropoda, pl. 1. 1876.

Shell unguiform, elongate, subspiral, making not more than a quarter of a volution in the length of three-fourths of an inch, below which it is entirely straight. Apex minute, abruptly incurved, solid, nearly cylindrical, for a short distance below the apex, and gradually compressed, becoming a little concave on the posterior side. Aperture somewhat oblique.

Surface marked by concentric striæ, which are sometimes crowded together, forming ridges or wrinkles.

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* *Contributions to Palæontology. Continuation of Appendix C* [of the 14th Rep. State Cab. Nat. Hist., published July, 1861]. *Descriptions of New Species of Fossils, from the Upper Helderberg, Hamilton and Chemung Groups*, Albany, 1861. Pages 1–24 of this paper were printed and distributed in August, 1861, and the remaining portion, pp. 25–84, in September, 1861, according to the imprint at the bottom of each page. It is included in the Fifteenth Report on the State Cabinet of Natural History (pp. 26–112) together with illustrations of species therein described (on Plates 4–10) and accompanying explanations of figures.

This species is more robust and rapidly expanding than the *P. dentalium*, and is more enrolled at the apex; but it does not show the longitudinal sulci and ridges which are characteristic of that species.

This is the species figured in the Report of the Fourth Geological District, and the typical form for which the generic name ORTHONYCHIA was proposed. The apex or nucleus of this and of other species is usually solid, and when the shell is removed, the casts show a rounded obtuse apex, which is sometimes scarcely incurved.

Formation and locality. In the limestone of the Upper Helderberg group, near Buffalo and Williamsville, N. Y.

PLATYCERAS (ORTHONYCHIA) DENTALIUM.

PLATE I, FIGS. 3-8.

Platyceras (Orthonychia) dentalium HALL.				Descriptions of New Species of Fossils, etc., p. I. 1861.
"	"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 29. 1862.
"	"	"	"	Illustrations of Devonian Fossils: Gasteropoda, pl. I. 1876.

SHELL slender, elongate, subspiral, making about half of one volution in the length of one inch and a half, somewhat flattened obliquely from the base to near the apex; section subelliptical, with the diameters about as two to three. The middle of the flattened sides is often a little concave, rounded towards the apex, which is minute and abruptly incurved.

SURFACE marked by transverse or concentric striæ of growth, and by longitudinal sulci, which are conspicuous on the lower part of the shell, and give to the transverse striæ a strongly undulated character. Aperture oblique.

In a specimen of one inch and a half in length, the greatest diameter is less than half an inch.

This species is much more slender and less distinctly spiral than the *P. tortuosum* of the Oriskany sandstone, and in the same features differs in a greater degree from any of the species known in the Lower Helderberg group.

Formation and localities. In the limestone of the Upper Helderberg group, near Williamsville and Buffalo, N. Y.

Platyceras (Orthonychia) concavum.

PLATE I, FIGS. 9-12.

Platyceras (Orthonychia) concavum Hall. Descriptions of New Species of Fossils, etc., p. 2. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 30. 1862.
" " " " Illustrations of Devonian Fossils: Gasteropoda. pl. 1. 1876.

Shell robust, subspiral, slender, gradually expanding above and more rapidly dilating towards the aperture, which is subquadrilateral, with the peristome strongly undulated. The specimen is imperfect at the apex, and the lower portion makes less than half a turn from the aperture in the length of about two inches; apex unknown. Anterior side of the body-volution convex and ventricose; posterior side distinctly concave; the right side moderately convex, and the left side rounded.

Surface marked by concentric undulating striæ.

The length of the largest fragment is about two inches; the aperture from the posterior to the anterior side is about seven-eighths of an inch, and the transverse diameter a little more than one inch.

This species resembles the *P. tortuosum* of the Oriskany sandstone, but is more robust and more rapidly expanding towards the aperture, which is much less oblique than in that species, while the concave posterior, and prominent anterior sides are distinguishing features. A comparison with a larger number of specimens of *P. dentalium* suggests that this form, in figs. 9 and 10, may be only a larger variety of that species.

Formation and locality. In the limestone of the Upper Helderberg group, Williamsville, Erie county, N. Y.

Platyceras (Orthonychia) conicum.

PLATE I, FIGS. 13-23.

Platyceras conicum Hall. Descriptions of New Species of Fossils, etc., p. 3. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 31. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, plates 1 and 2. 1876.

Shell erect, conical, the minute apex closely incurved. Body-volution entirely straight, with broad undefined longitudinal ridges and depressions, which become more distinct towards the aperture; height of the shell a little greater than the width of aperture, which is a little longer than wide.

Surface marked by concentric undulating striæ, which become sublamellose towards the aperture, and are sometimes closely crowded and wrinkled with numerous knots or nodes. Peristome deeply sinuous; the width from the anterior to the posterior side a little greater than the transverse diameter. The length of the shell is one inch and a half or more, with the aperture a little less.

This species approaches the *P. pyramidatum* of the Lower Helderberg group, but is less elongate, the peristome is more sinuous, and the indication of longitudinal ridges and depressions is more distinct; the crowded, wrinkled and nodose striæ are likewise a distinctive feature.

Formations and localities. In the Hamilton group, Ontario county; and in the Upper Helderberg limestone, at Darien and Williamsville, N. Y.

Platyceras (Orthonychia) perplexum.

PLATE II, FIGS. 1-3.

Platyceras perplexum Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 2. 1876.

Shell obliquely conical, apex minute, closely incurved, or making a part of one volution. The body-volution slightly curved, expanding gradually from above to the middle of the shell, below which it spreads more rapidly upon one side, becoming strongly plicated; the plications beginning above the middle of the shell, and sometimes at a short distance below the apex, and increasing in number and strength towards the base. Aperture subovate; peristome deeply sinuate.

Surface marked by close concentric striæ of growth which become lamellose, and crowded into undulating bands crossing the radiating ridges.

This is an extremely rare form, and is quite distinct from any of the other species; although presenting in the form of the body-volution an approach to some varieties of *P. Thetis*, it has not the same degree of arcuation, and has never the distinctly convoluted nucleus.

This species bears some resemblance to *P. perplicatum* of the Lower Helderberg group; but a comparison of specimens shows them to be quite distinct.

Formation and locality. In limestone of the Upper Helderberg group, in Onondaga county, N. Y. Communicated by Prof. E. A. Strong.

Platyceras erectum.

PLATE II, FIGS. 4-11.

Acroculia erecta Hall. Geology of N. Y. Surv. Fourth Geolog. Dist., pp. 172, 174, f. 6. 1843.
Platyceras erectum Hall. Descriptions of New Species of Fossils, etc., p. 4. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 32. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 2. 1876.

This species, originally described in the Corniferous limestone, occurs also in the Hamilton group. The spire at the apex is closely enrolled for about one volution and a half, beyond which the body-volution becomes somewhat rapidly expanded, with the aperture often spreading. The specimens are often more arcuate than the figure in the Geological Report, and the aperture oblique, with the peristome sinuate.

The surface is marked by closely arranged revolving lamellose striæ, which, upon the lower half of the body-volution, are abruptly arched along narrow bands, corresponding with former sinuosities of the aperture.

Formations and localities. In the limestone of the Upper Helderberg group, Williamsville, and near Buffalo; and in the Hamilton group at York, Moscow, Darien, and other places.

Platyceras carinatum.

PLATE II, FIGS. 12-20.

Platyceras carinatum Hall. Descriptions of New Species of Fossils, etc., p. 5. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 33. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 2. 1876.

Shell obliquely subconical or subpyramidal; the nucleus or apex minute, and making from one to one and a half volutions which are vertically compressed, and below which the body-volution is abruptly expanded; the dorsum angular, or marked by an angular carina, which often becomes double in old shells, or is rounded on the summit. This angularity or carina indicates, by the direction of the striæ, the existence of a sinus in the peristome from an early period of growth; and sometimes there may have been two such sinuosities close together, giving the double carina. There is usually a depression along one or both sides of the carina, with

longitudinal folds (obscure plications) on one or both sides, which become more strongly developed towards the aperture, and are very conspicuous in old shells; the right side is more expanded than the left, and in some well preserved specimens is nearly twice as wide. Aperture very oblique, rhomboidal or subtriangular, and the peristome sinuous.

Surface marked by fine, closely arranged, undulating striæ of growth, which are not lamellose.

This species is very well marked in its dorsal carina and rapidly expanding body-volution, which spreads always more on the right side. The surface, though distinctly striated, is close, and the shell compact; differing in this respect from some of the other species. Having examined more than a dozen individuals, from the length of less than half an inch to that of an inch and a half, I find that the characters mentioned are preserved in a marked degree in all. In the largest specimens, the aperture is a little more than an inch in its greatest diameter, and nearly equal to the height of the shell.

Formations and localities. In limestones of the Upper Helderberg group, Helderberg mountains; Williamsville, N. Y., and at Sandusky, Ohio; in the Hamilton group, at Eighteen-mile creek, Darien, Pavilion, Canandaigua and Seneca lakes.

Platyceras (Orthonychia) attenuatum.

PLATE III, FIGS. 1-6.

Platyceras attenuatum Hall. Descriptions of New Species of Fossils, etc., p. 2. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 30. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 3. 1876.
Not *Platyceras attenuatum*, Meek: Proceedings Phila. Acad. Nat. Sci., p. 75. 1871.
Not *P. dumosum* v. *attenuatum*, Meek: Geol. Rep. Ohio: Palæontology, I. Expl. of plate 20, fig. 1.

Shell elongate-ovate or conically subovate with a slender apex, the nucleus making about one volution or one and a half, below which the body-whorl becomes rather abruptly inflated, and thence gradually expands to the aperture, which is very oblique—the anterior side of the peristome being much more extended.

SURFACE marked by crowded, undulating, concentric striæ and longitudinal, irregular and undefined folds, which vary greatly in different specimens: the latter becoming more distinctly marked as plications near the aperture. Peristome sinuous, with numerous indentations corresponding to the folds upon the surface.

In many specimens the surface is marked by abrupt undulations without distinct folds or with the folds obscurely developed. Length of shell about one inch, with the greatest diameter a little less than half an inch.

This species is distinguished by the abrupt contraction of the upper part of the shell at the beginning of the body-whorl or just below the curvature: while the apex, consisting of scarcely more than a single minute volution, is abruptly contracted, and proportionally more slender than in most other species. It somewhat resembles the *P. clavatum* of the Lower Helderberg group.

Formation and localities. In the shales of the Hamilton group on the shores of Seneca and Cayuga lakes, Geneseo, Moscow, and other places in Western New York.

PLATYCERAS AURICULATUM.

PLATE III, FIGS. 8-10.

Platyceras auriculatum HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 3, figs. 8-10. 1876.

SHELL subovoid, extremely arcuate, the nucleus making little more than one volution, beyond which the shell at first gradually expands, and finally becomes ventricose below, being much more expanded on the right side. The back of the shell, to the end of about the second volution, shows the existence of a deep dorsal sinus, which at this point becomes filled, and the margin of the shell projects, while the peristome has become indented by numerous shallow sinuosities, appearing on the surface of the body-volution as sharp carinæ or subdued plications; each one of which indicates the degree of sinuosity in the margin of the shell. The expansion on the right side, beginning as described, is marked by three prominent carinæ, while the remaining portion of the surface is traversed by smaller and less distinct elevations, of which five occupy the dorsum towards the aperture.

Surface marked by fine closely arranged concentric striæ, which are crowded in fascicles from irregular growth, and are distinctly undulated in crossing the folds of the shell. In parts of the surface, where well preserved, fine revolving striæ are seen. The aperture is subrhomboidal, and the peristome sinuous.

This form possesses many characters in common with *P. carinatum*, but there is no development of a carina upon the dorsum, though we may consider that this feature is represented in the several low folds which are all in the line of the deep sinus which existed in the early growth of the shell, and that the single carina is represented by the four or five smaller folds. The posterior margin of the peristome is likewise in close proximity to the spire, as in *P. carinatum*. In other respects, it presents some characters in common with *P. symmetricum*.

Formation and locality. In a calcareous band in the shales of the Hamilton group at Darien, N. Y.

Platyceras Thetis.

PLATE III, FIGS. 11-16.

Platyceras Thetis Hall.			Descriptions of New Species of Fossils, etc., p. 4. 1861.
"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 32. 1862.
"	"	"	Illustrations of Devonian Fossils: Gasteropoda, pl. 3. 1876.

Shell obliquely arcuate from the base, with the apex incurved, the nucleus making barely more than a single minute volution; gradually expanding from the apex to near the aperture, which is sometimes more abruptly spreading. The back of the body-whorl is prominent, and a little flattened on the left side; while the right side, from one-third to one-half the length, is sometimes marked by two or three longitudinal folds, and often by more numerous, finer plications. Aperture a little oblique, nearly round or subquadrangular, with the peristome sinuous.

Surface marked by fine, closely arranged lamellose striæ, which are abruptly undulated on all parts of the body of the shell.

In many, and perhaps nearly all specimens, the body of the shell, along a line a little to the left of the dorsum, is marked by an abrupt curvature of the

striæ, indicating a notch in the margin of the peristome. This line is sometimes marked by a narrow prominent band, not unlike that of PLEUROTOMARIA.

This species differ from *P. attenuatum*, in being arcuate from the base, in the gradual attenuation towards the apex, and the more closely incurved nucleus and less abrupt expansion.

An unusual form (fig. 30, pl. 3) has been referred with doubt to this species. It has the general form and expression of *P. Thetis*, but is much larger than the prevailing forms, and preserves several protuberances on the surface which have the appearance of spine-bases. The surface preserves the fine revolving striæ crossing the concentric ones.

Formations and localities. In shales of the Hamilton group, at Moscow, York, and Ontario county; also in limestone of the Upper Helderberg group, Albany county, N. Y.

PLATYCERAS SYMMETRICUM.

PLATE III, FIGS. 17-25.

Platyceras symmetricum, HALL.	Descriptions of New Species of Fossils, etc., p. 6.	1861.
" " "	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 34.	1862.
" " "	Illustrations of Devonian Fossils: Gasteropoda, pl. 3.	1876.

SHELL elongate, subovoid, arcuate, incurved nearly in the same plane; nucleus minute, the spire making about one volution or one and a half, when the body-whorl becomes free and rapidly, or somewhat abruptly, expanded; spreading about equally on the two sides of the dorsum, which is more prominent and sometimes marked by a ridge. Aperture oblique, subquadrate or rhomboidal; margin of the peristome sinuate, and on the posterior side distant from the spire.

SURFACE marked by concentric undulating striæ, and longitudinally by obscure interrupted ridges, which, on some parts of the older shells, become regular and uniform, with a narrow groove between.

This species is well marked by the equilateral expansion on each side of the dorsum, and by the volution of the apex being nearly in the same plane. The

posterior margin of the aperture is widely separated from the preceding volution. The longitudinal ridges are more strongly marked, and of a different character from those of characteristic specimens of *P. bucculentum;* it is not, however, improbable that we may find intermediate forms uniting the two species. It is also possible that a comparison of a larger number of specimens may prove that the forms included under *P. Thetis*, *P. symmetricum* and *P. bucculentum* are varieties of one species.

Formations and localities. In the Upper Helderberg limestone at Darien, and in the Hamilton group at Darien, York, and Canandaigua lake, N. Y.

Platyceras bucculentum.

PLATE III, FIGS. 7, 26-29.

Platyceras bucculentum, Hall.		Descriptions of New Species of Fossils, etc., p. 5. 1861.
"	"	" Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 33. 1862.
"	"	" Illustrations of Devonian Fossils: Gasteropoda, pl. 3. 1876.

Shell ventricose, obliquely subovoid. Apex extremely attenuate, the spire making one or two closely enrolled volutions, with a gently enlarging diameter, and below this abruptly expanding and becoming very ventricose in the middle and lower part; spreading more upon the right side than upon the left; the shell near the posterior side swells out into a distinct pouch-like projection, with two or three rounded folds or semiplications, which give a deeply sinuous outline to the margin. Aperture subovate, and sinuate on the right posterior side. Peristome sinuous, and on the posterior side spreading partially over the preceding volution.

Surface marked by fine closely arranged concentric striæ, which are undulated towards the margin of the aperture, and sometimes over the greater part of the surface, the irregularity having commenced during the earlier stages of growth. In well-preserved specimens there are revolving striæ or fascicles, rising in little bands of obsolescent striæ, giving a waved aspect to the surface.

This species is more ventricose than any of the preceding forms. The character of apex, and the widely expanded body-volution resemble in some degree

the *P. ventricosum* of the Lower Helderberg group; but the first volution is more slender, and the spire less closely enrolled, while the lateral pouch-like expansion and the revolving bands are distinctive features. This shell is also much smaller, being rarely more than an inch and a quarter high, with the greatest diameter of the aperture about equal to the height. The length from the apex to the anterior margin of the aperture is about one inch and a quarter in large individuals. The small specimen (fig. 7) is a very symmetrical form of a young individual of the species which preserves the peristome in contact with the preceding volution. The figure scarcely represents the true character of the specimen.

Formation and localities. In shales of the Hamilton group, at York and Moscow, in Livingston county, N. Y.

PLATYCERAS FORNICATUM.

PLATE IV, FIGS. 1-5, 7, 8, 18, 19, 20, AND PLATE V, FIGS. 8, 9 [?].

Platyceras fornicatum, HALL. Descriptions of New Species of Fossils, etc., p. 7. 1861.
" " " Fifteenth Rep. State Cab. Nat. Hist., p. 35. 1862.
" " " Illustrations of Devonian Fossils, pl. 4. 1876.
(?) " " v. *contractum*, HALL. Id., pl. 5, figs. 8, 9. 1876.
" *rictum* (part), HALL. Id., pl. 4, figs. 18, 19, 20. 1876.

SHELL obliquely subhemispherical, or very depressed, obliquely subconical. Apex minute, distinct, spirally enrolled for about one turn and a half, below which it expands, so that in the extent of an inch and a half along the dorsum to the front, it has acquired an aperture of about an inch and a half in diameter in both directions. The upper side of the spire for the first volution and the following half is flattened; the angle continuing into the broad expansion of the body-whorl, and dying out before reaching the margin, as shown in figs. 1–5. Aperture nearly round or round-ovate; peristome scarcely sinuous, except at the postero-lateral margin.

SURFACE marked by fine concentric striæ, with a few strong spines upon the body-volution.

This species is conspicuously different from the *P. dumosum* in the shorter and comparatively equilateral and more expanded form; while the few scattered tubular spines appear to be disposed without order on the surface. A variety (figs. 8 and 9 of pl. 5), which may belong to this species, has a less expansion of aperture, an obliquely ovoid form, less attenuate apex, and greater proportionate height.

Formation and localities. In limestone of the Upper Helderberg group, at Williamsville, and near Carlisle, N. Y. The varieties are from Darien, N. Y.

PLATYCERAS CYMBIUM.

PLATE IV, FIGS. 9-11.

Platyceras cymbium, HALL.			Descriptions of New Species of Fossils, etc., p. 7. 1861.
"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 35. 1862.
"	"	"	Illustrations of Devonian Fossils: Gasteropoda, pl. 4. 1876.

SHELL subangularly ovoid. Apex minute, making one or more turns, below which the shell is abruptly expanded; the back flattened or but moderately convex, while the right side is distinctly flattened, making an obtuse angular ridge between the side and back of the shell: sloping more gently on the left side and becoming regularly convex. Aperture widely expanded.

SURFACE marked by transverse striæ, which are undulated on the dorso-lateral angle. Shell lamellose striate.

This species is characterised by the broad expansion of the aperture, the usually flattened dorsum, and the abrupt right or upper side, giving an obtuse dorso-lateral angle.

A careful examination of specimens renders it quite doubtful whether any of those with scattered spines really belong to this species.

Formation and locality. In Upper Helderberg limestone, at Clarence Hollow, N. Y.

PLATYCERAS RICTUM.

PLATE IV, FIGS. 6, 12-17.

Platyceras rictum, HALL. Descriptions of New Species of Fossils, etc., page 7. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 35. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 4. 1876.

SHELL very depressed, arcuate, or sometimes obliquely subconical, the width equalling and often exceeding the height. Nucleus minute, the spire enrolled to about one turn and a half, when it abruptly expands, spreading more upon the right posterior side and becoming greatly extended and expanded in front. The dorsal line of the first volution is continued in an oblique angular ridge extending on the left side, and often reaching to the front of the shell giving a peculiar obliquity to the form. Aperture expanded, obliquely ovate; peristome entire, or with a slight sinuosity on the left posterior side, and sometimes showing the effect of the undefined folds of the posterior margin usually contiguous to the preceding volution.

SURFACE marked by undulating concentric striæ, and a few broad undulations longitudinally; width of aperture from one inch to one and three-fourths, and a little greater from the anterior to the posterior margin; height about one inch and varying from three-fourths of an inch to an inch and a quarter.

Formations and localities. In the Upper Helderberg limestone of Onondaga county, and in the shales of the Hamilton group in Ontario county, N. Y.

PLATYCERAS ECHINATUM.

PLATE V, FIGS. 1-4.

Platyceras echinatum, HALL. Descriptions of New Species of Fossils, etc., p. 10. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 38. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 5. 1876.

SHELL small, obliquely subovoid. Apex closely incurved for about one volution or one and a half; the body-whorl, from one-half to one volution,

is ventricose, rapidly expanding from the first, giving an obliquely conical form. Aperture nearly circular or broad oval; peristome sinuate, the lines of growth and fine striæ conforming in direction to the outline of the margin. Remains of revolving striæ are sometimes traceable, when the shell is not exfoliated. Besides the concentric and less conspicuous revolving striæ, the surface is studded with numerous nodes or small spines—the latter preserved only when the shell has been imbedded in soft shale, and quite separable from the rock; when imbedded in limestone, the spines and exterior shell are removed with the matrix.

In this species the shell varies from half an inch to an inch and a quarter in length, and in a large specimen, the greatest diameter of aperture is one inch.

In this form we have a miniature representation of the *P. dumosum*, and it might perhaps be considered as the young of that species if occurring in the same formation. Since, however, it is known only in a higher geological horizon, it must be regarded as a distinct species or a degenerate condition of *P. dumosum*.

Formation and localities. In shales of the Hamilton group; Moscow and Ludlowville; and in Tully limestone, at Ovid, N. Y.

PLATYCERAS DUMOSUM.

PLATE V, FIGS. 11-16, AND PLATE VI, FIG. 1.

Platyceras dumosum, CONRAD. Third Ann. Rep. Pal. Dept. [N. Y.] Surv., p. 205. 1840.
" " (CONR.) HALL. Twelfth Rep. N. Y. State Cab. Nat. Hist., p. 19. 1859.
" " " Descriptions of New Species of Fossils, etc., p. 9. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 37. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, plates 5 and 6. 1876.
Compare *Platyceras multispinosum*, MEEK. Proc. Acad. Nat. Sci., Philadelphia, p. 17. 1871.
" " " " Geolog. Surv. Ohio: Pal., vol. 1, p. 210, pl 20, f. 7. 1873.

SHELL subovoid, arcuate, extremely ventricose when full-grown; the length from the apex to the anterior margin of the aperture greater than the height. Apex minute, closely enrolled for a single volution or more, when the body-volution becomes free and rapidly expanded, spreading

more upon the right side, which is sometimes depressed-convex, while the left side is more abruptly rounded. The aperture is subrhomboid-ovate, with the peristome making a sinus on the left side, the posterior margin widely separated from the preceding volution.

SURFACE marked by strong concentric striæ, which are interrupted and irregular from the numerous nodes projecting from the shell, and extended into long tubular spines.

Formation and localities. From the Upper Helderberg group, Helderberg mountains, in Albany and Schoharie counties, N. Y.; Columbus, Ohio, and Falls of the Ohio river.

This shell, in its full size, attains a length of two and a half inches, with the entire surface covered with strong spines which are sometimes two inches in length. In well-marked specimens, these spines are arranged in diagonal rows across the body of the shell in a nearly regular quincunx order. One specimen shows the bases of ninety of these spines, and, from the extent of the shell, the whole number must have been more than one hundred.

Mr. CONRAD'S description is as follows: "Shell covered with thick tubular spines, arranged in longitudinal rows; margin of aperture waved; volutions free." He remarks that, "in some varieties the spines are comparatively few."

In some specimens of about one-half the full size, there are not more than fifteen or twenty spines; and in all those with few spines, the expansion of the body-whorl is much less abrupt, and they rarely attain more than half the size of the large typical forms of the species. The number of volutions in the smaller forms is fully equal to the larger ones, being two or more, with the last one quite free.

Since this form is so distinct and constant, I propose to designate it as variety *rarispinum*.

The *Platyceras multispinosum* of Meek, figured in the Geological Report of Ohio, presents the form and proportions of well preserved specimens of *P. dumosum* as they occur in the limestone of New York, but is somewhat larger than any specimens we have seen. It is described as "much

larger" and "more rapidly expanding," and "having much more numerous spines." For the purpose of comparison with the New York forms, I have introduced on plate 6, two figures of a very fine specimen of this species from the Upper Helderberg group, near Columbus, Ohio, kindly loaned to me by Dr. J. S. NEWBERRY for this purpose.

PLATYCERAS DUMOSUM var. RARISPINUM.

PLATE V, FIGS. 5-7, 10.

Platyceras dumosum var. *rarispinum*, HALL.				Descriptions of New Species of Fossils, etc., p. 10. 1861.
"	"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 38. 1862.
"	"	"	"	Illustrations of Devonian Fossils: Gasteropoda, pl. 5. 1876.

SHELL consisting of about two or more volutions. Apex closely enrolled for more than one volution, and sometimes the volutions are contiguous nearly to the aperture; for one volution and a half the apex is slender and gently enlarging; the body-volution expanding more rapidly below, and becoming moderately ventricose, depressed on the dorsum, and the left side sometimes marked by a strong fold, indicating a sinus in the margin of the peristome, commencing at an early stage of growth. Aperture somewhat round, oval or slightly transverse.

SURFACE marked by wrinkled concentric striæ, which are strongly undulated at the base of the spines, and often abruptly bent backward at other places. Spines scattered; comparatively strong, from five to fifteen or seventeen on shells from the medium to the largest size.

The larger shells have a length of less then two inches, with a height of one inch and a quarter; the greatest diameter is one inch and a quarter.

This shell is never so ventricose as the *P. dumosum* proper, and the dorsum is often flattened while in that it is always convex. The *P. dumosum* is a comparatively rare shell, while the var. *rarispinum* is not uncommon, and I have not seen any of the latter which have attained the size of the full-grown individuals of the former.

The *P. dumosum* cited by Mr. CONRAD as occurring in the Hamilton group is

a small variety of more ventricose form than the one here described, and has but few spines.

Formation and localities. In limestone of the Upper Helderberg group, Helderberg mountains, and in Oneida, Onondaga and Erie counties, N. Y.; Ontario, Ohio, and at the Falls of the Ohio river.

A specimen from the Corniferous limestone of Columbus, Ohio, which I have illustrated on plate 5, fig. 13 of this volume, I have considered to be the young of *P. dumosum*, since it shows no characters by which it may be separated from specimens of the same size in the limestone of New York. The specimen on the same plate, fig. 11, might perhaps be referred to the variety *attenuatum* of Meek. But it seems scarcely possible to make reliable specific distinctions upon the greater or less number of spines or even upon the form of the shell in a genus subject to such extreme variations.

PLATYCERAS NODOSUM.

PLATE VII, FIGS. 4, 5.

Platyceras nodosus, CONRAD. Fifth Ann. Rep. Pal. State of N. Y., p. 56. 1841.
" *nodosum* (CONR.), HALL. Geolog. Surv. N. Y.—Pal., vol. 3, p. 473, plates 115 and 116. 1859.
Platyceras dumosum and *P. dumosum* var. *rarispinum*, HALL. Illustrations of Devonian Fossils: Gasteropoda, plates 5 and 7. 1876.

This form has occurred in two specimens only among all the collections made in the progress of the work.

They are casts of the interior, preserving a stronger and more angular character than the ordinary forms of *P. rarispinum*, and are in all respects similar to the *P. nodosum* of the Oriskany sandstone, to which they are referred.

Formation and localities. In the limestone of the Upper Helderberg group at Schoharie and the Helderberg mountains, N. Y.

PLATYCERAS UNDATUM.

PLATE VII, FIGS. 1, 2.

Platyceras undatum, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 7. 1876.
Compare *Platyceras sulnodosum*, HALL. Geolog. Surv. N. Y.—Pal., vol. 3, p. 474, pl. 115. 1859

SHELL elongated, arcuate. Apex incurved, nucleus unknown, the succeeding

volution gradually expanding above and more rapidly towards the aperture, where it has a longitudinal diameter of nearly two and a half inches, the greatest transverse diameter being two inches. The length on the outer curvature is fully four inches; the posterior or concave side is flattened, a rounded ridge being gradually developed and extending to the peristome which is marked by a sinus. A broad obtusely angular ridge extends along the upper side to the base at the right posterior angle.

A transverse section in the middle of the shell is somewhat pentagonal, and the form of the aperture varies from this in having the angles more rounded.

SURFACE strongly undulated by series of interrupted concentric ridges, which doubtless were more fully developed on the surface of the external shell.

The specimen is essentially a cast, preserving some portions of shell, but not of the external surface.

The species is sufficiently distinct from any other known in this formation, resembling in some degree the *P. subnodosum* of the Oriskany sandstone.

Formation and locality. In limestone of the Upper Helderberg group at Schoharie, N. Y.

PLATYCERAS CRASSUM.

PLATE VII, FIGS. 6–10.

Platyceras crassum, HALL.	Descriptions of New Species of Fossils, etc., p. 8. 1861.
" " "	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 36. 1862.
" " "	Illustrations of Devonian Fossils: Gasteropoda, pl. 7. 1876.

SHELL large, irregular, obliquely subovate, arcuate, somewhat broadly flattened on the back, with several more or less strongly defined longitudinal folds, strongly incurved at the summit, the apex making one or two volutions; the body-whorl expanding more on the right side, while the left posterior side is often flattened or depressed, with a greater expansion or sinuosity immediately behind. Aperture very oblique, subquadrangular or irregularly rounded, with a deep sinus on the right anterior margin; the peristome sinuous.

SURFACE marked by concentric undulating lamellose striæ; shell very thick.

The length of large specimens is two and a half inches, and height a little less than two inches. The transverse diameter of the aperture is from one and a half to two inches, and the longitudinal diameter a little less.

This shell is remarkable for its great strength and thickness; it is more oblique than the *P. rarispinum* and expands less rapidly, and the fold or carina near the summit is on the left side.

Formation and localities. In the Upper Helderberg limestone, Helderberg mountains in Albany and Schoharie counties, N. Y.

PLATYCERAS ARGO.

PLATE VIII, FIGS. 1-6.

Platyceras Argo, HALL. Descriptions of New Species of Fossils, etc., p. 11. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 39. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 8. 1876.

SHELL varying from subdiscoid to obliquely subovoid, with body-whorl extremely ventricose. Nucleus minute, with the apex closely enrolled for about two volutions, beyond which it expands more or less abruptly; the last volution nearly or quite in contact with the preceding one. The body of the shell is rounded above, and often obtusely subtrilobate below the middle, becoming rounded towards the aperture. Aperture round or round-ovate, sometimes approaching to quadrangular, broadly sinuate on the right side, and deeply sinuate on the left side, where the peristome is sometimes strongly reflexed, forming an apparent columellar lip. The shell is thick, and its structure is lamellose, as in the Cephalopoda, with a nacreous lustre.

SURFACE marked by fine revolving striæ, with distant stronger ones, and cancellated by scarcely coarser concentric undulating striæ, which are bent backwards upon the somewhat regular ridges, presenting several bands similar to the single one in PLEUROTOMARIA.

This species is remarkable for the peculiar lamellose structure throughout,

presenting on fracture or exfoliation the character of the shell of a NAUTILUS or BACULITES of the Secondary rocks. When the apex remains covered, it might be mistaken for a reversed shell; the depression on the upper side of the spire being sometimes deeper and more abrupt than on the lower side, as the plane of the first volution is below the centre of the shell, and the spire is shown only in the first, or first and second volutions.

The specimens figured are essentially casts, preserving the surface only in a partial degree. The thickness and peculiar texture of the shell are unlike any of the other Gasteropoda in the same formation.

This and the following species are placed at the end of the series of PLATYCERAS, as indicating their doubtful relationship to that group of shells.

Formation and locality. In the Upper Helderberg limestone, at Williamsville, Erie county, N. Y.

PLATYCERAS AMMON.

PLATE VIII, FIGS. 7-10.

Platyceras Ammon, HALL. Descriptions of New Species of Fossils, etc., p. 9. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 37. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 8. 1876.

SHELL depressed, suborbicular, making about two or three volutions, with the summit of the spire on the same plane or a little below the plane of the outer volution. Spire small; volutions contiguous throughout their whole extent, very gradually expanding above; the last half of the body-whorl ventricose. Aperture large, subovate, deeply sinuate on the left anterior margin.

SURFACE marked by fine concentric undulating striæ, which are deeply arcuate on the back of the last volution, corresponding to the sinuosity of the aperture; the striæ are aggregated in lamellose folds or ridges, giving an irregular or undulating surface to the shell.

This species has the form of PLATYOSTOMA; but the peristome shows no columella, and presents a wide umbilicus. The length of the largest specimen,

from the outer margin of the aperture to the opposite side of the volution, is more than three inches; the longitudinal diameter of the aperture is nearly two inches; the width a little less.

Formation and localities. In the Upper Helderberg limestone, at Darien, N. Y. I have also seen the same from Port Colborne, Canada West.

PLATYOSTOMA Conrad.

Platyostoma lineata.

PLATE X, FIGS. 1-21.

Platyostoma lineata, Conrad. Jour. Acad. Nat. Sci. Phil., vol. 8, p. 276, pl. 17, f. 7. 1842.
" " " Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 9. 1876.

Shell subovate, approaching to subglobose. Spire elevated above the body-whorl, though varying in degree; in some extreme varieties, on the same plane or below the outer volutions. The shell with four or five volutions when entire, but seldom preserving more than three,—the apex being usually imperfect. The outer volution usually very ventricose and regularly convex, a little depressed below the suture-line (but not canaliculate). Aperture suborbicular in perfect specimens, sometimes subrhomboidal; outer lip thin, with a sharp entire margin; columellar lip thickened, folded, and reflexed over the umbilicus, which in adult specimens, is entirely closed.

Surface marked by fine, nearly equidistant, thread-like revolving striæ, which are cancellated by fine concentric striæ of about the same strength, but unequally distant; the latter sometimes bent abruptly backwards upon the back of the shell, indicating a sinus in the lip at some period of growth, and are frequently crowded in fascicles giving a rugose character to the surface.

In well-preserved specimens, the surface is beautifully cancellated; and in

worn and partially exfoliated specimens, some remains of these surface markings are usually visible, the revolving striæ being first obliterated. This species approaches in surface characters the *P. turbinata* of the Schoharie grit and Helderberg limestone; but the volutions are never so depressed on the upper side, and the aperture never so straight above, nor so extended on the lower side. It has usually a length of from one to two inches; young individuals of half an inch in length are not uncommon. A well formed individual measures one inch and a half long, with a vertical height of about one inch; another specimen, preserving its proportions free from compression, has a length of two inches, with a vertical height from base of aperture to apex of less than one inch and a half. A single extravagant specimen has a length of three inches, with a width of aperture of nearly two inches; the body-volution, for a distance of two inches from the aperture, is more than usually straight, and marked by crowded and unequal concentric striæ, without revolving striæ, while the latter are preserved on the upper part of the shell. A cast of a specimen in the Corniferous limestone of Western New York, bearing no evidence of compression, has a length of more than three inches, while the vertical diameter of the aperture does not exceed one inch and a half. The specimens which I have seen from Ohio and the West, are casts in limestone, which, not preserving their striæ, are identified only by their form and proportions.

The original description of *Platyostoma lineata* is as follows:

"Transversely subovate, with wrinkled reticulated striæ; aperture orbicular; spire depressed, or slightly elevated above the top of the body-whorl."

Although no geological position is assigned to the species by Mr. Conrad, and the figure given by him does not correspond with the prevailing form of the specimens examined, I am still inclined to regard it as the common form of the Hamilton group, of which I have seen several hundred individuals.

Formations and localities. In the Upper Helderberg limestone throughout the limestone range from east to west in New York, and in the Hamilton group in the western part of the State.

PLATYOSTOMA LINEATA var. CALLOSA.

PLATE X, FIGS. 22, 23.

Platyostoma lineata var. *callosa*, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 9. 1876.

This variety has the general form of specimens of *P. lineata*, except that the spire is extremely depressed, being almost flat upon the top. The mouth is suborbicular, with the peristome slightly sinuate on the upper side near its junction with the preceding volution. The inner lip is marked by a thickened callus, not observed in any other specimens, the callosity extending into the lip below (as shown in fig. 22), which thence assumes the ordinary features of the species.

This variety is from the Hamilton group, near Geneseo, N. Y.

PLATYOSTOMA LINEATA var. AMPLA.

PLATE X, FIGS. 25, 26.

Platyostoma lineata var. *ampla*, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 9. 1876.

The specimen has had about four and a half volutions, the last one enlarging very rapidly, and terminating in a broadly expanded aperture, as shown in fig. 26. The margin of the peristome is slightly sinuate on the upper side, and the columellar lip slightly grooved. The surface is marked as in other forms of this species.

This form corresponds very nearly with the outline figure of the species *P. lineata*, given by Mr. CONRAD, loc. cit. It is of rare occurrence, so far as my own observations have gone, there being not more than five or six specimens among a collection of several hundred of the ordinary forms from different localities. There are, however, so many intermediate phases as to leave no doubt of the relations of the most extreme varieties represented in this and the preceding as well as the following form, which, if separated from their associates, might be considered distinct species. Those indicated as *P. defigurata* and *P. euomphaloides* may, perhaps, prove to be only varieties of the same species when a larger collection of specimens shall be examined—those at hand, at the present time, not furnishing the requisite data for uniting them with *P. lineata*.

The specimen figured was found in the Hamilton shales, at Bellona, N. Y.

PLATYOSTOMA LINEATA var. SINUOSA.

PLATE XI, FIGS. 4-8.

Platyostoma lineata v. *sinuosa*, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 11. 1876.

Several specimens of this species have been observed where the peristome at the base of the pillar lip is deeply indented by a sinus, as shown in the figures. One of the specimens figured has the spire slightly concave, the outer volution flattened upon the upper side, and symmetrically rounded below. The other specimen has more nearly the prevailing form, with moderately elevated spire, the volutions rounded above an orbicular aperture with deep sinus.

This species, in its prevailing form, is very widely distributed within the limits of the State. Occurring in moderate numbers in the Upper Helderberg limestone from the Helderberg mountains, to Black Rock, it becomes abundant in the Hamilton group throughout the central and western part of the State. In the arenaceous shales of this group in Eastern New York, it is not a common form, but with the accession of calcareous matter in the deposit, it increases in numbers, and is one of the most common forms in localities along Seneca, Cayuga and Canandaigua lakes; at West Bloomfield in Ontario county, at Geneseo, Moscow and York in Livingston county, at Darien in Genesee county, and at Hamburgh on the shore of Lake Erie.

PLATYOSTOMA DEFIGURATA.

PLATE X, FIG. 24.

Platyostoma defigurata, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 9. 1876.

The shell preserves five volutions which are rounded, gradually enlarging from the apex; the suture close. The surface is marked by fine concentric striæ, which become crowded and fasciculate on the outer volution—the revolving striæ being very subordinate.

This shell differs from characteristic examples of *P. lineata* only in the more elevated spire, and in preserving one more volution than in ordinary forms of that species. It occurs in the Hamilton group, at Canandaigua lake, N. Y.

Platyostoma euomphaloides.

PLATE X, FIGS. 27-29.

Platyostoma euomphaloides, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 9. 1876.

Shell depressed subhemispheric; spire moderately elevated; volutions three or four, gradually enlarging from the apex,—the last one expanded, not ventricose, with its exterior or periphery flat or slightly convex, and flattened or gently concave in the middle above; suture-line close. Aperture expanded, broadly subovoid; the inner lip has a thickened callus, which projects in a prominent rim along the posterior border of the aperture.

Surface marked by fine concentric striæ, which are crowded in fascicles.

At present, we know only a single specimen having the character described. The flattened upper side of the volutions and the flattened periphery are very unlike any form of Platyostoma described, but at the same time it is not difficult to see how a still farther degree of variation in *P. lineata* var. *callosa* may result in such a form as this. In that variety, the summit is depressed, but the volutions are rotund and rapidly expanding, with an aperture suborbicular. Unlike the prevailing or characteristic forms of *P. lineata*, that one has a thickened callosity on the inner lip, but less defined and developed than in the specimen described as *P. euompholoides*.

Platyostoma Strophius.

Platyostoma Strophius, Hall. Descriptions of New Species of Fossils, etc., p. 13. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 41. 1862.

Shell obliquely ovoid. Apex minute; spire ascending, composed of about three or four volutions, very gradually expanding above; the body-whorl ventricose, somewhat depressed-convex on the side, and sloping downward rather than swelling out in a rotund form; the upper volutions standing out prominently above the last one. Suture-line narrow, even,

and sometimes appearing as very narrowly and deeply canaliculate. Aperture ovate, and, in one specimen, with a sinus near the base.

Surface marked by fine concentric striæ, which are sometimes crowded into wave-like fascicles or undulating folds, and sometimes abruptly bent forward near the base. Occasionally these striæ are very regular and even, as in Strophostylus.

This species is less ventricose than the *P. lineata*, and the spire much more elevated, while no revolving lines have been observed. In many respects it resembles Strophostylus; but the aperture has not been entirely determined.

Formation. In the Corniferous limestone.

Platyostoma aplata.

PLATE XI, FIG. 9.

Platyostoma aplata, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 11. 1876.

The specimen is a part of a large individual, retaining between three and four volutions, which are flattened upon the upper side,—the flattening partly due to pressure. The form of aperture is unknown, and no definite surface markings are preserved.

Formation and locality. In the Schoharie grit, Schoharie, N. Y.

Platyostoma unisulcata.

PLATE IX, FIGS. 25, 26.

Pleurotomaria unisulcata [?] Conrad. Jour. Acad. Nat. Sci. Phil., vol. 8, pt. 2, p. 271, pl. 17, fig. 9. 1842.
Platyostoma unisulcata (Conr.) Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 10. 1876.

The description given by Mr. Conrad is as follows:

"Short-fusiform; spire conical-depressed; upper surface of the large volution slightly concave from the outer margin to a carinated line which borders a transversely rugose sulcus; another, but more obtuse line, margins the suture; penultimate whorl rounded, obtusely carinated at the suture; base nearly rectilinear towards the labrum, slightly convex above the aperture."

"*Locality.* Near Schoharie, in Onondaga limestone."

A specimen, which has been supposed to represent the original of Mr. CONRAD, is illustrated in figs. 25 and 26, plate 9. The apparent band bordering the suture is caused by a narrow depression of the surface, parallel with the suture, from which the striæ rise abruptly and bend forward, leaving a narrow depressed line or canaliculation along the suture. It has not the defined band of PLEUROTOMARIA, and the recurving of the striæ is less distinct and abrupt than in some other specimens of PLATYOSTOMA.

Formation and locality. In limestone of the Upper Helderberg group, Schoharie, N. Y.

PLATYOSTOMA UNISULCATA var.

PLATE XI, FIGS. 1-3.

Platyostoma unisulcata var., HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 11. 1876.

This form, from the Hamilton group at West Bloomfield, N. Y., has so much the form and aspect of Mr. CONRAD's original figure ut cit., except in the lesser elevation of the spire above the last volution, and the absence of a sutural band, that I have placed it under the above designation.

PLATYOSTOMA TURBINATA.

PLATE IX, FIGS. 12-24.

Platyostoma turbinata, HALL. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 106. 1861.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 10. 1876.

SHELL subturbinate, sometimes approaching a subglobose form. Spire depressed, or more or less elevated above the outer volution, sometimes nearly on the same plane; volutions three or four, rapidly expanding, the last extremely ventricose, with the lower part projected in the direction of the columella, which is much extended. Aperture subovate, broader above, narrowing and often extended below.

Surface marked by fine subequal concentric striæ, crossed by finer revolving striæ; the former variously undulated upon the surface, indicating sinuosities in the aperture at different stages of growth. In older shells the striæ become lamellose and often crowded in fascicles.

In well-marked specimens of the species, as originally described, the spire rises little above the general plane of the volutions, as shown in figs. 12, 14, 15, 16 and 19. Figs. 20 and 24 show a more elevated spire. Figs. 23 and 24 represent an extremely old shell, much thickened, and showing very irregular growth; the striæ are crowded in strong fascicles, and curved backward on the summit of the last volution, upon the periphery, and again below the periphery.

Formation and localities. In shaly limestone of the Upper Helderberg group, in the town of Onondaga, Onondaga county, and more rarely in the Helderberg mountains, Albany and Schoharie counties. Some varieties of the species also occur in the Hamilton group, at York and at West Bloomfield, N. Y.

Platyostoma turbinata var. cochleata.

PLATE IX, FIGS. 1-11.

Platyostoma turbinata var. *cochleata*, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 10. 1876.

Shell turbinate. Spire elevated, conical; volutions about four or five; periphery of the last volution obtusely rounded or distinctly subangular, with a sinus in the margin of the aperture; the last volution sometimes becoming free near the aperture, as shown in figs. 5, 6 and 7. Aperture obliquely subovate or ovate; peristome sinuous, often with a deep notch in the upper margin, and sometimes continued in a columellar extension below.

The specimens referred to this variety all agree in having an elevated spire, with rounded volutions above the last one, which is almost invariably subangular. Specimens represented in figs. 8, 10 and 11 are symmetrical, and

have distinctly marked characters; but it is not possible to restrict the variety to such forms, unless by indicating as distinct varieties several of the other forms illustrated.

Formation and locality. In limestone of the Upper Helderberg group, in Onondaga, Onondaga county.

Until the discovery of this locality by Prof. E. A. STRONG, few individuals of the type of *P. turbinata* were known, and these were very constant in their characters. All the varieties of form represented in the illustration of this species have been derived from that locality, which has afforded probably twenty times as many specimens of the species as all other localities in the State. *Strophostylus varians* is not known to me from any other locality; and *Platyostoma lineata*, and several species of *Platyceras*, are also common in the same place.

It would appear that the physical conditions favoring the abundant production of individuals has, at the same time, favored a degree of variation unknown under conditions existing elsewhere.

PLATYOSTOMA TURBINATA var.

PLATE IX, FIGS. 27-30.

Platyostoma turbinata var., HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 10. 1876.

I have indicated in the *Illustrations of Devonian Fossils*, pl. 10, the forms above cited as a variety of *P. turbinata*, the principal features of which are the low turbinate form, depressed spire, aperture narrow and extended vertically, with a distinct sinus in the upper margin of the peristome.

In this variety the spire is more elevated than in typical forms of *P. turbinata*, but does not rise so high as in *V. cochleata*. Compared with the latter, the volutions are less rotund, obscurely angulated at the periphery, with a very similar form of aperture. The specimen (figs. 28–30) is from the Hamilton group in the neighborhood of Moscow, N. Y. Its surface, as shown in fig. 28, is incrusted by a Bryozoan.

Platyostoma pleurotoma.

PLATE IX, FIGS. 31-35.

Platyostoma pleurotoma, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 10. 1876.

Shell rotund, subturbinate. Spire depressed; volutions rounded, gradually enlarging, and the last one much expanded. Aperture broadly oval, and extended below; peristome more or less sinuous, and, on the columellar side, extended below in a thickened and slightly contorted callosity.

Surface finely striated with concentric and revolving striæ, the latter, conspicuous, and the former scarcely perceptible. In one specimen, a distinct narrow band marks the suture-line; and in another, a narrow carina marks the periphery, giving the aspect of Pleurotomaria.

Formation and locality. In limestone of the Upper Helderberg group, Onondaga, N. Y.

Strophostylus unicus.

PLATE XI, FIGS. 14, 15.

Strophostylus unica, Hall. Descriptions of New Species of Fossils, etc., p. 13. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 41. 1862.
" *unicus* " Illustrations of Devonian Fossils: Gasteropoda, pl. 11. 1876.

Shell suborbicular; height and length about as three to four. Spire consisting of three or four volutions; the apex moderately elevated above the outer volution; suture close, and the volutions evenly convex upon the upper side; body-whorl ventricose, evenly and equally rounded upon the back. Aperture subovate, a little extended at the lower side, and slightly straightened on the posterior side; outer lip regularly curved; columellar lip thickened and slightly twisted, the fold being near the upper part of the lip.

Surface marked by fine, crowded, concentric striæ, which are broadly curved backward on the dorsum; shell very thick. At one point, where the shell is broken away, the surface within the cavity is marked by revolving striæ.

The slight thickening and fold in the columellar lip distinguish this as a STROPHOSTYLUS, while there is no indication of an umbilicus. The form of this shell differs little from *Platyostoma lineata;* but the even convexity of the spire, and the absence usually of revolving striæ, are distinguishing external features.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

STROPHOSTYLUS VARIANS.

PLATE XI, FIGS. 16-31.

Strophostylus varians, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 11. 1876.

SHELL obliquely subconical, or depressed subglobose. Spire moderately elevated; volutions about three or four, symmetrically rounded above, and somewhat gradually enlarging to the last one, which is very ventricose, extending downward and forward. Aperture ovate or suborbicular; peristome entire; the columellar lip usually expanded and spreading over the umbilicus, sometimes free, and leaving the umbilicus exposed.

SURFACE finely striate, with the peculiar thread-like striæ visible on well-preserved surfaces, while, on the weathered portions, they become lamellose; and on some specimens the surface is marked by peculiar waved and interrupted striæ (shown in fig. 18).

This species, in some respects, makes a wider departure from the typical forms of STROPHOSTYLUS than any other of the genus known to me. The peculiar and characteristic form is preserved; the symmetrical rounding of the volutions above, and the delicately formed spire, as well as the form of aperture in some specimens, are all characteristic of the genus. The striæ, however, have a tendency to become lamellose, or interruptedly undulating; and there are evidences of irregularity of growth and indentations in the margin of the peristome (indicated in figs. 24 and 25), both above and below the periphery. The form of the aperture is extremely variable, from narrow elliptical to broadly expanded. There is (rarely shown) a tendency in the last volution to become free (fig. 23), and the characteristic plication of the columellar lip is

not often well preserved. In some of its variations it simulates PLATYOSTOMA; but in all phases it differs from that genus in the characteristic expression of the spire. Although a considerable number of individuals have been examined, it does not appear to be an abundant form, nor to have any wide distribution.

Formation and locality. In limestone of the Upper Helderberg group, in Onondaga county, N. Y. The specimens have all been communicated by Prof. E. A. STRONG.

MACROCHEILUS, PHILLIPS.

MACROCHEILUS HEBE.

PLATE XII, FIGS. 4-7.

Macrocheilus Hebe, HALL. Descriptions of New Species of Fossils, etc., p. 20. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 48, pl. 4, fig. 1. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

SHELL turreted, subfusiform, length less than twice the diameter. Volutions five or six, upper ones minute, the last two ventricose; one-half the height of each volution showing above the suture. Shell thick on all parts, especially near the aperture. Aperture longitudinally suboval, somewhat pointed below.

SURFACE marked by extremely fine lines of growth. Height of the largest individual seen, a little more than three-fourths of an inch.

This shell has all the characteristics of the genus MACROCHEILUS as it occurs in the Coal measures, and is one of two well-marked species of the genus that I have observed in the Hamilton group. It bears a near resemblance to *M. Newberryi*, of the Coal measures; but the last two volutions are more ventricose, the suture-line close, while the shell, of less length, has one more volution. From the *M. ventricosus* it differs in the larger and less attenuated spire, and in its last two volutions being ventricose. It appears to be an extremely rare species, as among all the later collections made in Central New York, no specimens of it have been observed.

Formation and localities. In the Goniatite limestone of the Hamilton group, at Manlius, N. Y., and in the arenaceous shales near Hamilton, N. Y.

MACROCHEILUS HAMILTONIÆ.

PLATE XII, FIGS. 8-14.

Macrocheilus Hamiltoniæ, HALL.	Descriptions of New Species of Fossils, etc., p. 21. 1861.
" " "	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 49, pl. 4, fig. 2. 1862.
" " "	Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

SHELL very ventricose. Spire short, consisting of four or five volutions, the last extremely ventricose, making nearly two-thirds the entire height of the shell. Aperture longitudinally oval, obtuse below. Shell distinctly striated by fine lines of growth; suture-line deeply impressed. Length about three-fourths of an inch, with a diameter nearly as great.

This shell resembles, in some features, the shorter and more ventricose forms of this genus in the Coal measures, the spire resembling that of *M. primigenius*. This species is almost equally rare with the preceding.

Formation and locality. In the coarse shales of the Hamilton group at Hamilton, Madison county, N. Y.

MACROCHEILUS (HOLOPEA) MACROSTOMUS.

PLATE XII, FIGS. 15-18.

Macrocheilus (Holopea) macrostomus, HALL.	Descriptions of New Species of Fossils, etc., p. 21. 1861.
" " " "	Fifteenth Rep. N. Y. St. Cab. Nat. Hist., p. 49, pl. 4, fig. 3. 1862.
" " " "	Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

SHELL short, subglobose. Volutions, about four or five, all above the last two minute, the last one extremely ventricose, so that the width from the columella is about two-thirds its height; greatest width of the shell equal to the height. Aperture rounded, a little extended on the lower side; umbilicus not closed.

SURFACE marked by fine equal striæ of growth, which are strongly directed backwards from the suture. Suture-line a little depressed below the plane of the convexity of the volution; the striæ sometimes crowded in fascicles.

This species resembles in form some of the Platyostomæ, but the texture of the shell and surface markings are not in accordance with the well-marked species of that genus. Its surface characters and general form are similar to

HOLOPEA; and in the absence of satisfactory knowledge of the aperture and columella, it is impossible to decide that it may not belong to that genus.

Formation and localities. In calcareous beds of the Hamilton group, at Pratt's Falls, Madison county, N. Y., and in the arenaceous shales of the same neighborhood; also in the Chemung group at Corning and Painted Post, N. Y.

MACROCHEILUS ? (PLEURONEMA ?) PRIMÆVUS.

PLATE XII, FIGS. 1-3.

Macrocheilus ? primævus, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

SHELL turreted; upper volutions small, the last one moderately ventricose. Aperture undetermined.

The few specimens seen are essentially casts of the interior, and have the appearance of having had a simple striated surface. On one of the specimens there are, near the aperture, some remains of simple curving striæ of growth which have not the peculiar bending of the striæ of LOXONEMA; nor do they resemble those of any species of PLEURONEMA. Although the material is extremely unsatisfactory, it appears to be sufficiently distinct from any other species known in the rocks of this formation to deserve notice.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

CYCLONEMA, HALL.

CYCLONEMA DORIS.

PLATE XII, FIG. 23, AND PLATE XIX, FIG. 1.

Pleurotomaria Doris, HALL. Descriptions of New Species of Fossils, etc., p. 15. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 43, pl. 5, f. 6. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 19. 1876.
Cyclonema crenistria, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

SHELL very depressed-conical or subglobose, the elevation of the spire being about two-thirds the width across the base of the shell. Volutions, three or four, gradually expanding,—their elevation above the suture-line being

greater than the width exposed; body-volution moderately ventricose and rounded above; the periphery a little contracted vertically, and the lower side rounded and expanded more abruptly towards the aperture, gently depressed towards the centre, which is partially umbilicate. Aperture nearly circular.

SURFACE marked by strong revolving striæ, which are crossed by fine and less conspicuous concentric striæ, giving sometimes a denticulate character at the crossing of the two series. Shell of moderate thickness. Suture neatly defined, not canaliculate.

This species is less distinctly conical above than the *P. Hebe*—the volutions being rounded without the angle on the periphery. It was originally described as PLEUROTOMARIA, which it resembles in form, but has no proper peripheral band. Other specimens coming under examination, it was properly referred to the genus CYCLONEMA, and thus published as a new species in *Illustrations of Devonian Fossils*, as cited above. A comparison with the original of *P. Doris* has proved the identity of the two. From the examination of a single imperfect specimen from the Schoharie grit, it seems probable that the figures given are from specimens which are more or less accidentally depressed, and that the spire is more elevated than represented.

Formation and locality. In the Schoharie grit of the Upper Helderberg group, at Schoharie, N. Y. The occurrence of the species in the Corniferous limestone (*Fifteenth Rep. State Cab.*) has not been verified by farther investigation.

CYCLONEMA LIRATA.

PLATE XII, FIGS. 27-29.

Cyclonema lirata, HALL. Descriptions of New Species of Fossils, etc., p. 19. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 47, pl. 5, fig. 15 (not 16). 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

SHELL robust, subdepressed-conical. Volutions about four, subangular, the last one becoming very ventricose, flattened from the suture to the first carinate elevation on their upper side, and marked by moderately elevated

carinate ridges, of which two or three are visible on the upper volutions, and about five on the body-whorl; those on the upper side of the volution more distant than those on the lower side.

Surface marked by fine, closely arranged striæ of growth, which are sometimes crowded in fasciculi, giving gentle inequalities; these striæ are directed a little backward from the suture.

The larger specimens are about an inch in diameter, with a height about one-fourth greater. The prevailing forms are about three-fourths of an inch high.

Formations and localities. In the coarse sandy shales of the Hamilton group, in Chenango and Madison counties, N. Y.

Cyclonema multilira.

PLATE XII, FIGS. 30-33.

Cyclonema multilira, Hall.			Descriptions of New Species of Fossils, etc., p. 20. 1861.
"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 48, pl. 5, fig. 17. 1862.
"	"	"	Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

Shell turbinate, ventricose. Volutions five or more; body-whorl very large and extremely ventricose,—its surface marked by fine concentric striæ of growth, which are directed backwards from the suture toward the periphery, and pass to the lower side of the volution without deviation, except in the slight undulation at the crossing of the revolving carinæ.

Surface of the volutions marked by strong, elevated, revolving lines or carinæ, of which there are about five or six upon the upper ones, and ten or twelve on the body-whorl; the space from the suture to the upper of these lines is greater than between the lines, those of the periphery being more closely arranged than those above or below.

This species is similar in form to *C. lirata*, with the last volution more ventricose, and all the volutions less angular; the revolving carinate lines are twice as numerous and not so strong. It is intermediate between the *C. Ham-*

iltonia and *C. lirata;* being a little more ventricose than either, without the flattened or concave band on the upper side of the volution.

Formation and locality. In the coarse shales of the Hamilton group at Smyrna, Chenango county, N. Y.

Cyclonema Hamiltoniæ.

PLATE XII, FIGS. 34-36.

Cyclonema Hamiltoniæ, Hall. Descriptions of New Species of Fossils, etc., p. 19. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 47, pl. 5, fig. 16 (not 15). 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

Shell subglobose-conical; height a little more than the width across the last volution. Volutions four or five; apex minute and gradually expanding to the body-whorl which is somewhat abruptly ventricose, flattened or a little concave for a short distance below the suture, and the space limited on the exterior side by a carina, which is the first of a series, marking the periphery of the volution.

Surface marked by extremely fine lamellose lines of growth, which are directed backwards from the suture without bending or curvature in passing the carinations. The volutions, except the narrow concave space above, are marked by strong revolving elevated carinate lines, of which there are from fourteen to eighteen on the body-whorl. These carinæ are usually simple and subequal, more or less distinctly defined, and sometimes alternately stronger and more subdued, or with two finer ones between the stronger. On each of the upper volutions there are three, four or five of these carinæ preserved, and they are distinctly crenulated by the passage of the concentric striæ, which are sometimes also bent forward on approaching the first carination.

This species has nearly the proportions of *Pleurotomaria capillaria*, except in the more abrupt ventricosity of the body-volution. The flat or concave belt on the upper side of the volution, which is without revolving striæ and marked

only by lines of growth, is a distinguishing feature; and also the absence of elevated concentric striæ and the band upon the periphery.

Formations and locality. In the shales of the Hamilton group, Cazenovia, N. Y.

Cyclonema obsoleta.

PLATE XII, FIG. 37.

Cyclonema obsoleta, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

Shell subglobose-conical. Volutions five or more in the entire condition, becoming gradually expanded, and the last very ventricose; the upper volutions marked by fine revolving carinæ, of which there are six or seven on the volution above the last; the carinæ are distinctly crenulated by revolving striæ. The outer volution, so far as preserved, is marked only by fine revolving striæ.

This species has the general aspect of the *C. Hamiltoniæ*, and may be only a variety of that species, in which the carinæ have become obsolete on the outer volution. The volution above the body-whorl shows six carinate lines, and partially a seventh. There is a faint indication of the flattened band upon the upper side of the last volution, which, in this specimen, is limited below by a depression or line of fracture.

Formation and locality. In sandstone of the Chemung group, from Southern New York,—the particular locality unknown.

Cyclonema concinna.

PLATE XII, FIGS. 38–40.

Cyclonema concinna, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

Shell subglobose below, conical above; spire rapidly tapering; volutions gradually increasing in size to the last one, which is very ventricose.

The figures are from gutta-percha impressions of the exterior mould left in sandstone. The upper volutions present a double carina on the periphery like

PLEUROTOMARIA. This feature is not observed on the last volution, which is marked on one specimen by a faint carination near the upper part; on the lower side of the volution are four or five revolving carinate bands.

The features preserved are altogether like those of CYCLONEMA, and in the absence of other evidence, it is thus referred.

Formation and locality. In a calcareous band of the Chemung group at Nichols, Tioga county, N. Y.

LOXONEMA, PHILLIPS.

In the Schoharie grit, and in the limestones above this rock, there are numerous casts of spiral univalves, which, though evidently belonging to forms like LOXONEMA or MURCHISONIA, cannot readily be distinguished in the absence of surface markings. Several species of these genera have been described (*Fourteenth Report on the N. Y. State Cabinet Nat. Hist.*) from specimens retaining the external characters. There are other forms still, which, although we have no examples with the shells preserved, nevertheless differ so widely in their form and proportions from those already described as to be distinguished by these characters alone.

One of these from the Schoharie grit has nearly the form and proportions of *L. attenuata* of the Upper Pentamerus limestone, and in the casts no positive means exist of pointing out characters which will distinguish the one from the other. Specimens resembling the *L. compacta*, of the same geological formation, upon a careful comparison, show the volutions to be more rotund, and the spire more rapidly ascending. The determination of species in this condition is attended with many difficulties, and in the end there must still remain some doubt, when the differences of form and proportions may have been disguised by pressure or accident. Under these circumstances, I have characterized several species among the specimens which are only known in the condition of casts; leaving a more satisfactory determination to the future, and a collection of better specimens.

LOXONEMA ? SUBATTENUATA.

PLATE XIII, FIGS. 1-6.

Loxonema ? subattenuata, HALL.	Descriptions of New Species of Fossils, etc., p. 24.	1861.
" " "	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 52.	1862.
" " "	Illustrations of Devonian Fossils: Gasteropoda, pl. 13.	1876.

SHELL turretiform, elongate; spire somewhat rapidly ascending. Volutions six or more, moderately convex, gradually expanding from the apex, the last one somewhat ventricose towards the aperture.

SURFACE unknown.

A cast of a species having proportions nearly similar to *Murchisonia Maia* occurs in the Schoharie grit; but the shell has tapered somewhat more rapidly, the volutions are more ascending and less convex, and the form of the aperture is subovate and narrowed below. In one specimen the length from base of aperture to top of the sixth volution is one inch and three-fourths, and the diameter of the last volution is about five-eighths of an inch. A larger individual, referred to the same species, has a length of two and a quarter inches.

In this species the volutions are less rapidly ascending, and the spire less attenuate than in *L. attenuata* of the Lower Helderberg group, which in many respects it resembles.

Formation and locality. In the Schoharie grit at Schoharie, N. Y.

LOXONEMA ROBUSTA.

PLATE XIII, FIGS. 4, 5, 6.

Loxonema robusta, HALL.	Descriptions of New Species of Fossils, etc., p. 24.	1861.
" " "	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 52.	1862.
" " "	Illustrations of Devonian Fossils: Gasteropoda, pl. 13.	1876.

SHELL robust, terebriform; spire rapidly ascending. Volutions moderately convex, the last slightly more ventricose, with a diameter of nearly an inch.

The length from the base of the aperture to the summit of the fourth volution, in a specimen which has been compressed, is three inches, and in a more rotund specimen the same number of volutions measure a little less than three inches; above this there have probably been three or four volutions to the summit, adding to the length about three-fourths of an inch.

This is a larger and more elongate species than any other of the genus in the Upper Helderberg rocks. The specimens are casts of the interior, rarely showing surface markings; but from the general character of the fossil, the moderately convex volutions and close suture-line, it may be recognized as belonging to the genus LOXONEMA.

This form is more gradually tapering, while the spire is more rapidly ascending than in *L. subattenuata*, and the exterior of the volution is a little more convex than the usual form of that species. A single specimen from the limestone at Clarence Hollow, in Erie county (fig. 6), bears the same proportions as those from the Schoharie grit in the eastern part of the State. The shell, when entire, has been nearly four inches long.

Formations and localities. In the Schoharie grit at Schoharie; and in the limestone of the Upper Helderberg group at Clarence Hollow, Erie county, N. Y.

LOXONEMA SOLIDA.

PLATE XIII, FIGS. 8, 9.

Loxonema solida, HALL.		Descriptions of New Species of Fossils, etc., p. 23. 1861.
"	" "	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 51, pl. 4, fig. 6. 1862.
"	" "	Illustrations of Devonian Fossils: Gasteropoda, pl. 13. 1876.

SHELL turretiform, elongate; spire gradually ascending. Volutions moderately convex, the height of each one about half the diameter of the spire at the same point.

In a specimen of moderate size, five volutions from near the base measure a little more than one inch in vertical height. This species, in its form and proportions, is intermediate between the *L. compacta* and the *L. obtusa* of the Lower Helderberg group, the volutions being slightly more convex than in either of these. The specimens are all casts of the interior, and are incomplete both at base and summit, and can only be distinguished by the form and proportions of the volutions.

Formation and locality. In the Schoharie grit at Schoharie, N. Y.

LOXONEMA ? TERES.

PLATE XIII, FIG. 10.

Loxonema teres, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 13. 1876.

SHELL turretiform. Volutions seven or more, gradually enlarging from the apex, the last one moderately ventricose, and all gently rounded on the periphery.

The specimen is essentially a cast of the interior, retaining some portions of the shell in a crystalline condition. The general aspect of the cast is that of LOXONEMA, and it is thus referred with some doubt. It is slightly fusiform, the upper volutions being proportionally more contracted than those below. The greatest diameter of the last volution is about equal to the height of the succeeding three volutions.

This form bears much resemblance to the *L. subattenuata*, but the volutions are a little more closely enrolled and slightly more convex on the periphery. It is possible, however, that a greater number of specimens may show a gradation, uniting these forms as a single species.

Formation and locality. In limestone of the Upper Helderberg group, at Clarence Hollow, Erie county, N. Y.

LOXONEMA PEXATA.

PLATE XIII, FIGS. 16, 18 (11, 12?).

Loxonema pexata, HALL. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 104. 1861.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 13. 1876.

SHELL elongate, terete or subfusiform. Volutions six or more, gradually expanding from the apex, somewhat flattened on the upper half, or a little concave just below the suture, and most convex below the middle; the last one moderately ventricose. Aperture subelliptical.

SURFACE marked by strong, regular, elevated striæ, which cross the volutions in a gentle curve, turning backward from the suture and again forward, making the curve at about one-third of the distance from the upper side

of the volution. On well preserved specimens the striæ are sharply elevated, but are subject to considerable variation which may be due to erosion or maceration before imbedding.

A critical comparison of specimens originally referred to this species has led to the conclusion that some of them should be separated, and the specific term restricted in its application to such forms as are here illustrated.

Formation and localities. In limestone of the Upper Helderberg group, near Columbus, Ohio, and in some doubtful specimens from Genesee and Erie counties, N. Y.

LOXONEMA PEXATA var. OBSOLETA.

PLATE XIII, FIG. 13.

Loxonema pexata var. *obsoleta*, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 13. 1876.

The specimen figured retains a part of three volutions—the last nearly entire. The form is the same as in typical specimens of *L. pexata.* The surface is marked by obscure or obsolete striæ, which condition may be due to age or to maceration and erosion before imbedding.

Formation and localities. In limestone of the Upper Helderberg group, at quarries north of Columbus, Ohio.

LOXONEMA SICULA n. sp.

PLATE XXVI, FIG. 1.

SHELL small, slender, very gradually enlarging from the apex. Volutions short and moderately convex; fourteen in an entire specimen of seven-eighths of an inch in length; a narrow, flattened space at the upper margin of each one, which is limited below by an undefined line parallel to the suture.

SURFACE marked by comparatively strong and coarse elevated striæ, which curve gently backward from the suture to the middle, and thence forward to the base of the volution.

Formation and locality. In decomposing chert of the Upper Helderberg limestone, near Jamesville, Onondaga county, N. Y.

Loxonema hydraulica.

PLATE XIII, FIG. 14.

Loxonema hydraulica, H. & W. Twenty-fourth Rep. N. Y. State Mus. Nat. Hist., p. 193. 1872.
" " " Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., pl. 13, f. 15. 1875.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 13. 1876.

Shell turreted. Volutions rounded, six in the length of one inch and a quarter from the base; greatest convexity about the middle of each; upper ones unknown. Suture deep, giving a constricted aspect at the junction of the volutions.

Surface marked with distinct, angular striæ, bending gently backward from the suture to the periphery, and with a longer forward curve to the base of each volution; those of the last volution bending more abruptly backward, and making a second abrupt retral curve to the columellar lip.

This species, in the rotundity of the volutions, and the constriction at the suture, contrasts with all the other species here described.

Formation and localities. In the hydraulic beds of the age of the Upper Helderberg group, at Louisville, Ky. Communicated by Dr. James Knapp.

Loxonema ? coapta.

PLATE XIII, FIG. 7.

Loxonema coapta, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 13. 1876.

A fragment, preserving about six volutions, has a length of a little more than three-fourths of an inch. The volutions are close, very gradually ascending, and slightly convex on the exterior. The surface is unknown.

The specimen figured, in its form, rate of increase from the apex, and slightly convex surface of the volutions, presents characters which distinguish it from any one in this geological horizon.

Formation and locality. In the Crinoidal limestone of the Hamilton group at Eighteen-mile creek, in Erie county, N. Y.

Loxonema Hamiltoniæ.

PLATE XIII, FIGS. 15, 17.

Loxonema nexilis, Phil. Hall: Geol. of N. Y. Surv. Fourth Geolog. Dist., p. 201. 1843.
Not *Loxonema nexilis* of Phillips. Palæozoic Fossils. 1841.
Loxonema Hamiltoniæ, Hall. Descriptions of New Species of Fossils, etc., p. 25. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 53, pl. 4, f. 8. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 13. 1876.

Shell elongate, subulate. Volutions moderately convex, about thirteen in the largest specimens known, very gradually increasing in size from the minute apex, the last one ventricose. Aperture ovate, narrowing below; columella extended.

Surface marked by longitudinal sharp, curving striæ, which bend gently backward from the suture, and forward towards the base of the volution, having the greatest curve near the middle, those of the last volution curving abruptly backward to the columellar lip. Striæ separated by distinctly defined grooves, which are a little wider than the ridges; the striæ increasing in distance as the shell grows older.

A single specimen, preserving thirteen volutions, measures less than one inch and a half in length; the diameter of the last volution is less than half an inch.

Specimens, imperfect at the apex, and having six or seven volutions, measure about one inch and a quarter in length, with the diameter of the last volution less than half an inch. The striæ on the upper part of the volution are not unfrequently vertical or nearly so, and vary considerably in their degree of curvature even in the same individual.

This species is a common form in the Hamilton group, and differs from the *L. delphicola* in the more numerous and more convex volutions, the more strongly arched striæ, the more extreme attenuation of the shell and less rapid expansion towards the aperture.

I have heretofore (*Survey of Fourth Geological District*) identified this species with the *Loxonema nexilis* of Phillips; but its form and proportions are inter-

mediate between that and *L. sinuosa*, while the striæ are curved as in the latter species. The figures of PHILLIPS represent the striæ a little curved backwards at their upper extremities, with an enlargement just below,—features which our species does not possess.

Formation and localities. In shales of the Hamilton group, at Seneca and Cayuga lakes; at Eighteen-mile creek; and more commonly in the shales east of Cayuga lake, at Delphi and other places.

LOXONEMA BELLONA.

PLATE XIV, FIGS. 3, 4, 5.

Loxonema Bellona, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 14. 1876.
Loxonema sp. ? HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 14. 1876.

SHELL turreted, robust, somewhat rapidly expanding from the apex. Volutions in the entire shell probably nine or ten, convex, the last one ventricose; columellar lip somewhat rapidly contracted at the base of the volutions, and pointed below.

SURFACE marked by distinct, closely arranged, elevated striæ, which, for a short distance below the suture, are nearly vertical, and then, bending gently backwards, are recurved upon the periphery at about the middle of the volution. On the last volution the striæ are very abruptly recurved to the columellar lip.

The specimens examined are all imperfect, and essentially casts of the interior, preserving portions of the exterior shell. The general form resembles the *L. subattenuata* of the Schoharie grit; but the volutions are more rotund and the last one more ventricose; these features appear more conspicuous in the comparison of specimens than in the figures. This form also resembles the *L. teres*, but is more rapidly tapering, and the proportion of width and height of the volutions is also a distinctive feature.

Formation and locality. In some calcareous layers of the Hamilton shales at Bellona, Yates county, N. Y.

LOXONEMA DELPHICOLA.

PLATE XIII, FIGS. 19–25, AND PLATE XIV, FIGS. 1, 2.

Loxonema delphicola, HALL. Descriptions of New Species of Fossils, etc., p. 24. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 52, pl. 4, f. 9. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, plates 13 and 14. 1876.

SHELL turretiform; spire somewhat rapidly ascending. Volutions eight or more in the entire shell, flattened upon the sides, the last one slightly ventricose. Aperture ovate, narrowed and attenuated at the base; columella thickened and extended below.

SURFACE marked by strong, not prominent, longitudinal striæ, which are bent slightly back for a short distance below the suture, and continue in a nearly direct or slightly curving line almost to the base of the volution, where they bend forward to the suture-line. Suture banded, or the upper edge of the volution overlapping the next preceding, and constricted just below the margin, which is but faintly or not at all marked by the longitudinal striæ.

This species differs from the more common form of the LOXONEMA of the Hamilton group in the lesser convexity of the volutions, and more rapid expansion from the apex, straightness of the striæ (which, however, are more abruptly bent on the last volution) and the overlapping or banding of the upper margin of the volution at the suture-line. One specimen examined retains nearly six volutions, and has a length of one inch and a half, which would have been slightly increased, had the lower extension of the columella been entire; diameter of last volution a little more than half an inch. A specimen of the ordinary form (*L. Hamiltoniæ*), possessing six full volutions, measures one inch and a quarter in length; the six volutions, from the aperture reaching to the height of the fourth volution in the species under consideration. In the ordinary flattened or crushed condition of these fossils, as they occur in the finer shales of the group, the distinction between the two species is not always easily recognized.

Formation and localities. In shales of the Hamilton group; Delphi, Onondaga county, Bellona, Yates county, and shores of Cayuga lake, N. Y.

Loxonema terebra.

PLATE XIV, FIGS. 6, 7.

Loxonema terebra, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 14. 1876.

Shell elongate, terebriform; spire rapidly ascending. Volutions slightly convex, regularly increasing from the apex, the last one scarcely ventricose, about nine or ten in a length of two inches and a quarter from the base.

Surface marked by strong, elevated, obtusely angular striæ which bend backward abruptly a little below the suture, and make a more gentle curve forward to the base of the volution.

The specimens of this species occur as imperfect casts of the interior, or impressions of the exterior surface. The figures are made from gutta-percha casts, taken in the moulds of the exterior. The species is well marked, and quite distinct from any of those in the Hamilton group.

Formation and localities. In the Upper Chemung, in Tioga and Chemung counties, N. Y.

Loxonema styliola.

PLATE XIV, FIGS. 8, 9.

Loxonema styliola, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 14. 1876.

Shell elongate, terebriform; spire rapidly ascending. Volutions flattened, regularly increasing from the apex, the last one scarcely ventricose, or but slightly ventricose; about nine in the length of two inches and a half from the base. Aperture subelliptical; the columellar lip extended below.

Surface showing remains of fine striæ of growth, without evidence of other surface-markings; suture banded.

In figure 9, the form of the aperture is preserved, and the columellar lip should be a little more extended in the figure. This specimen shows some slight differences in the form and degree of expansion of the volutions, and an indication on the last two volutions which may prove of distinctive importance.

Since, however, we have only gutta-percha casts of the exterior moulds, there is no satisfactory means of separation.

Formation and locality. In semicalcareous bands in the Upper Chemung, at Nichols, Tioga county, N. Y.

Loxonema laxa, n. sp.

PLATE XVIII, FIG. 12.

Loxonema terebra? Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 18. 1876.

Shell thick, elongated, terebriform; spire very rapidly ascending. Volutions rounded, gradually expanded to the last one which is ventricose; columellar lip greatly extended, making the lower part of the aperture very acute; about four and a half volutions in the length of two inches and three-fourths from the base—the entire shell having had about one or two more.

Surface marked by coarse, obtuse, elevated striæ, which are obsolete on the upper part of the volution, and make a very gentle curve over the periphery.

The specimens examined are essentially casts of the interior, sometimes preserving portions of the shell which is crystalline and adhering to the matrix. Slight indications of the surface markings are sometimes preserved on the cast; and in one individual may be seen the strong elevated striæ characteristic of the genus. The species has been abundant in the locality where it occurs, since, in a single specimen of the rock therefrom, of the size of two by three inches, and scarcely more than an inch thick, fragments of as many as eight or nine individuals are to be seen. It is associated with numerous specimens of Bellerophon, Pleurotomaria and Platyostoma; and the *Macrocheilus* (*Holopea*) *macrostomus*, known elsewhere only in the Hamilton group, occurs in the same position.

Formation and locality. In the higher beds of the Chemung group, at Nichols, Tioga county, N. Y.

CALLONEMA, n. gen.

Shell subglobose, turbinate or ovoid-conical. Volutions rounded or sometimes subangular above and below; outer lip apparently thin; columellar lip thickened and spreading over the volution above and extended below; axis umbilicate.

Surface marked by fine even striæ which extend equally over the volutions, rarely divided, and sometimes merging into the ordinary striæ of growth, and extending into the umbilicus.

This generic name is proposed to include such forms as *Isonema bellatula*, *Isonema Lichas* (if these two prove distinct), *Pleurotomaria* (*Isonema*) *imitator*, and similar forms; the chief external characters being the sharply elevated, even, thread-like concentric striæ traversing the volutions above and below, a distinct columellar lip, and an umbilicate axis.

I had accepted, without critical examination, the determination of Mr. Meek (Meek & Worthen), referring *Loxonema bellatula* to the genus Isonema; but while this volume is passing through the press, a comparison of the generic description and the characteristic figure of the type species (*I. depressa*), shows that this reference cannot be sustained. The generic description of Isonema is as follows:

"Shell depressed subglobose, turbinate, or conical-subovate, obtusely angular around the middle of the body-whorl. Aperture subrhombic; outer lip thin, entire; inner lip a little flattened or impressed in the umbilical region, apparently for the support of an operculum, very thin, or scarcely continuous above; axis imperforate. Surface ornamented with transverse, very regular lines on the upper side of the volutions.

In 1865 we proposed the name Isonema for this type, as a subgenus under Holopea. Farther comparisons, however, have since led us to regard it as generically distinct from Holopea, from which it differs in its angular instead of rounded volutions, as well as in its imperforate axis, flattened inner lip, rhombic instead of rounded aperture, and strong regular lines of growth. From Pleurotomaria it will be at once distinguished by its entire lip, and the absence of a revolving band on the whorl. From Cyclonema it differs, in being entirely without the characteristic revolving lines of that genus, and marked by strong transverse striæ.

In addition to the typical species here described, this genus includes *I. bellatula* (*Loxonema bellatula*, Hall: Fifteenth Report Regents Univ. N. Y., p. 163, figs. 4 and 5)."—*Geol. Survey of Illinois*, Vol. III, pp. 442, 443. 1868.

Isonema depressa is described as being "but little convex between the angular periphery and the imperforate umbilical region;" and the striæ below the periphery "suddenly become obsolete."

The above features of genus and species are quite incompatible with the following forms.

CALLONEMA BELLATULA.

PLATE XIV, FIGS. 10-15.

Loxonema bellatula, HALL. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 104. 1861.
Isonema bellatula (H.) MEEK. Proc. Acad. Nat. Sci. Phila., p. 252. 1865.
" " " " Geol. Survey of Illinois, vol. 3, p. 443. 1868.
" " " H.-W. Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., pl. 13, f. 12. 1875.
" " " Hall: Illustrations of Devonian Fossils: Gasteropoda, pl. 14. 1876

SHELL subovoid-conical; spire elevated and rapidly expanding below. Volutions about six or seven, the upper ones minute and somewhat gradually expanding to the third or fourth, and more rapidly below, the last one being very ventricose, regularly rounded or obtusely subangular towards the base. Aperture apparently transverse—its extension below not fully known; columellar lip thickened, spreading above and extended anteriorly.

SURFACE marked by regular, even, sharply-elevated striæ, with about equal interspaces, which are slightly turned backwards from the suture and gently curved to the base of the volution, and on the last one curving over the periphery with equal strength—a portion becoming obsolete, and others coalescing and becoming stronger as they enter the umbilical depression.

The species presents the external characters shown in the figures 10–15 of plate 14, and I can find no means of separation between those showing an obtuse angularity at the base of the last volution and those which are regularly rounded and ventricose. The surface striæ are alike in the several examples.

In figure 10, which seems to me not to be specifically distinct from the others, the volutions are flattened upon the upper side for a narrow space

below the suture, and moderately rounded below, leaving a distinct angle, over which the striæ pass without deflection. On the last volution towards the aperture this angularity of the upper side becomes gradually obsolete, while the base of the volution is marked by a distinct carina in continuation of the suture-line.

In figures 11 and 12 the penultimate volution, as represented, is not quite sufficiently convex, while the angularity at the base of the last volution is conspicuous. In the specimen, fig. 13, there is no perceptible angularity of the last volution; while in the specimen represented in figure 14 there is an obtuse angularity, which appears more as if due to accidental pressure from above, flattening the base of the last volution. In the same specimen, however, there is a distinct angularity and flattened space on the summit of the next two volutions above. In the specimen, fig. 15, the upper volutions are moderately rotund, and the last one rounded and ventricose.

From this form to those figured on plate 12, as *Callonema Lichas*, there seems to me an easy passage. However, I have, for the present, preserved the latter name and references, which, if the species prove identical, will supersede the name of *bellatula*.

Formation and localities. In limestone of the age of the Upper Helderberg, near Columbus, Ohio, and at the Falls of the Ohio river.

Callonema Lichas.

PLATE XII, FIGS. 19-22.

Platyostoma Lichas, Hall. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 106. 1861.
Isonema " " Illustrations of Devonian Fossils: Gasteropoda, pl. 12. 1876.

Shell obliquely subconical ovate; spire elevated. Volutions about four or more, rounded upon the exterior, the earlier ones moderately expanding, and the last one becoming very ventricose. Aperture subovate, extended below.

Surface marked by fine even striæ of growth, which, on the last volution, continue over the periphery and disappear in the umbilicus.

The specimens observed are essentially casts, figure 19 partially retaining the shell, and figures 20 and 21 showing some small portions which are strongly striate. The species may prove to be only a larger growth of that described as *C. bellatula;* but we have at present no means of determining this question.

Formation and localities. In limestone of the Upper Helderberg group, at Clarence Hollow, N. Y., and near Columbus, Ohio.

Callonema imitator.

PLATE XIV, FIGS. 16, 17.

Pleurotomaria imitator, H.-W. Twenty-fourth Rep. N. Y. State Mus. Nat. Hist., p. 195. 1872.
" (*Isonema*) *imitator*, H.-W. Twenty-seventh Rep. State Mus. N. H., pl. 13, figs., 9, 10. 1875.
" " " " Hall: Illustrations of Devonian Fossils: Gasteropoda, pl. 14. 1876.

Shell depressed-hemispherical; spire moderately elevated, consisting of five or more rounded volutions, regularly increasing from the apex to the aperture, which is subcircular, its lower extension unknown; rounded below and broadly umbilicate: suture slightly depressed, not canaliculate, and marking the periphery of the preceding volutions.

Surface marked by strong elevated simple striæ, which have a slight bend just below the suture and curve gently backward to the periphery, gradually increasing in strength from the apex to the outer volution, on the middle of which there are about twenty in the space of an inch. In one specimen, on the outer half of the volution, they become gradually obsolete or merge into the ordinary striæ of growth.

The lower side of the last volution in one specimen is broken away, and the small portion of that part remaining in another is denuded of the shell, so that we have no actual knowledge of the surface on the lower side, though the characteristic striæ continue below the periphery.

This species, in its general aspect, resembles *Pleurotomaria Lucina;* but the spire is more depressed and the volutions are less rapidly increasing, and the last one less ventricose. The surface markings are similar to those of *P. arata*, of the Schoharie grit, while the volutions are more ventricose on the upper

side. The absence of a band or sinus on the periphery is, however, a distinctive feature.

Formation and locality. In limestone below the "Hydraulic beds" at the Falls of the Ohio. Communicated by Dr. JAMES KNAPP, of Louisville, Ky., and Major S. S. LYON, of Jeffersonville, Ia.

EUOMPHALUS, SOWERBY.

STRAPAROLLUS, *Montfort;* PHANEROTINUS, *Sowerby.*

The material for the study of this group of fossils, in my possession, is so meagre and unsatisfactory that I am not prepared to express any decided opinion regarding the separation of the genera EUOMPHALUS and STRAPAROLLUS.

The typical forms of the first, with angulated volutions and depressed spires, begin their existence in the Calciferous sandstone and continue, with wide interruptions, to the Chemung period. The genus ORTHILETA of the primordial rocks is, in some of its forms, not very different from the Devonian species with rounded volutions, which are referred to STRAPAROLLUS or to EUOMPHALUS indifferently. In habit of life and mode of growth the two forms were similar; both become septate and decollate in their earlier volutions. In one of the angulated forms under consideration, the early volutions were rounded and decollated by septation—the angularity being gradually acquired and increasing to the aperture.

I have preferred to adopt the name EUOMPHALUS for this group of fossils, using the name STRAPAROLLUS in a subgeneric sense for those with close rounded volutions, where the spire rises moderately above the plane of the outer volution.

These again, by almost insensible gradations, pass into those forms where the volutions are disjoined, constituting the genus PHANEROTINUS of SOWERBY. The figures on plate 16 offer examples of these phases, where it becomes extremely difficult to draw a line of specific distinction between those with the volutions in contact and those where they are perceptibly disjoined.

Under such conditions it is certainly impracticable to indicate a strict generic separation, and, in the present mode of stating similar questions, I see no good reason why all these forms may not be included under one generic term, indicating the others as of subgeneric value.

Euomphalus Decewi.

PLATE XV, FIGS. 1-8.

Euomphalus Decewi, Billings. Canadian Journal, p. 358. July, 1861.
" *Conradi*, Hall. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 107. 1861.*
" *Decewi*, B., Meek: Geol. Surv. Ohio: Pal., vol. 1, p. 220, pl. 19, figs. 3 a, b; and pl. 20, fig. 1. 1873.
" " Hall: Illustrations of Devonian Fossils: Gasteropoda, pl. 15. 1876.

Shell discoid, upper side moderately concave or sometimes nearly flat, the lower side broadly and deeply concave; periphery moderately convex or nearly flat, and slightly oblique to the plane of the shell: sometimes, in the casts of young shells, gently rounded from the upper margin to the edge of the umbilical depression. Volutions three or four (rarely more than two or three preserved in the casts), inner ones rounded, gradually becoming depressed on the upper and lower sides. The periphery, at first rounded and undefined, becomes more flattened and distinctly limited by a defined angularity above and below, becoming more flattened towards the aperture; the upper side being gently depressed, while the lower side gradually assumes a more abruptly concave aspect, forming a broad umbilicus. Aperture unknown; section of the outer volution subquadrilateral, or triangular with the inner angle truncated.

Surface (in young specimens) marked by fine elevated striæ of growth. The fossil has a diameter of from one to four inches or more.

This species, originally described by me as *E. Conradi*, occurs in several localities in Western New York, and notably at Stafford and Batavia, where casts of the interior are common. Among all those examined from these localities I have seen but one or two which retain any portion of the shell. In the

* A note by the Secretary of the Board of Regents, preceding the Fourteenth Report, is as follows: "The Fourteenth Report is published, August, 1861. Some copies of the Descriptions of New Species [of Fossils], by Prof. Hall, were distributed in July."

young shells the volutions are closely coiled, as shown in figure 2 of plate 15. In the casts of older specimens the apex is decollated and the termination smoothly rounded, as if separated by a septum, no evidence of a continuation above being perceptible. Figures 3, 4 and 5, of plate 15, represent this feature. The interior volutions being rounded, the angularity on the upper side is scarcely perceptible before the end of the second volution, and that of the lower side about the same time or a little later. In some of the casts of the interior there is a low, undefined angularity upon the back of the shell, as shown in fig. 6 of plate 15.

This species appears to be very nearly identical with *Euomphalus Wahlenbergii* of GOLDFUSS (*Petrefacta*, vol. 3, page 82, plate 189, figs. 7 a, b), from the Eifel. That species also presents the same features in the decollation of the earlier volutions, and the rounded apicial extremity, as shown in figures 3, 4 and 5 of plate 15. The European form is associated with *E. planorbis*, a species much resembling *E. clymenioides*, which occurs in the same beds with *E. Decewi* in western localities, and with other forms similar to those of New York.

The specimens of this species retaining the shell, figured in the *Geological Survey of Ohio* (Vol. I, plates 19 and 20), reveal characters of the surface not shown in the New York and Canadian specimens. A single remarkable specimen, communicated by Dr. C. ROMINGER, preserves still other features not illustrated in the Ohio specimens. (See plate 27 and supplementary notice of the species.)

Formation and localities. In limestone of the Upper Helderberg group, at Stafford, Batavia, and other places in Western New York; a single specimen of the species has been found at Schoharie. It is of common occurrence in the same limestone near Cayuga, Ontario.

EUOMPHALUS TIOGA.

PLATE XV, FIGS. 9, 10, AND PLATE XXVII.

Euomphalus Tioga, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 15. 1876.

SHELL discoid; upper side moderately concave from the dorso-lateral angle; lower side broadly umbilicate, the dorso-basal margin acutely angular.

Periphery flattened, oblique to the plane of the shell, and sloping outwards from the upper margin. Volutions probably three or more, gradually enlarging from the apex; the remains of two only are shown in the specimen figured, in which the extremity of the outer volution is much wider than high. Aperture unknown; transverse section triangular, with the inner angle truncated.

SURFACE of the upper side and periphery preserving the remains of striæ, which bend abruptly backwards at the lower carina.

The specimen is essentially a cast of the interior, and somewhat worn. The species is extremely similar to the *E. Decewi*, with more slender volutions, and the dorso-basal margin more acutely angular.

Formation and locality. In the upper part of the Chemung group in the town of Nichols, Tioga county, N. Y.

EUOMPHALUS PLANODISCUS.

PLATE XVI, FIGS. 1-4.

Euomphalus planodiscus, HALL. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 109. 1860.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 16. 1876.

SHELL discoid planorbicular; spire depressed, the apex being below the plane of the outer volution; lower side broadly concave; periphery rounded. Volutions about four or five, slender, barely contiguous, very gradually enlarging from the apex, and regularly rounded, the adjacent sides not being perceptibly flattened; the last one near the aperture somewhat flattened above. Aperture slightly expanded, subcircular, a little transverse.

SURFACE marked by fine close striæ, which are sometimes crowded in regular fascicles, giving the appearance of annular ridges, which bend a little forward at the edge of the periphery.

This species presents few strong features of distinction; but the surface markings, when preserved, seem to be sufficiently characteristic.

Formation and localities. In the Goniatite limestone of the Marcellus shale (Hamilton group), at Manlius, and other places in Western New York.

EUOMPHALUS (STRAPAROLLUS) INOPS.

PLATE XVI, FIG. 5.

Euomphalus inops, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 16. 1876.

SHELL discoid; spire depressed-convex, the apex slightly elevated above the plane of the outer volution; lower side broadly and deeply concave. Volutions three or more, curving gently inwards from the periphery, without angularity at the dorso-basal margin. Upper side of volutions convex, the last one rounded; a transverse section near the aperture distinctly broad oval, with the lower side making a longer curve than the upper.

SURFACE concentrically striated.

This species is known at present in a single specimen which differs sufficiently from all the others in the New York rocks to be readily distinguished by the peculiar concavity of the umbilical area. In general aspect this form resembles the young of *E. Decewi*, but the volutions increase in size less rapidly, the umbilical depression is comparatively deeper, and there is no evidence of angularity of the outer volution. Compared with *E. Hecale* of the Chemung group, the lower side of the volution is more abruptly curving into the umbilicus, and not flattened as in that species (fig. 10, plate 16).

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

EUOMPHALUS (STRAPAROLLUS) RUDIS.

PLATE XVI, FIGS. 6, 7.

Euomphalus rudis, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 16, figs. 6, 7. 1876.

SHELL discoid. Volutions about four when entire, rounded above and slightly less convex below, curving abruptly from the inner side into the broad umbilicus; periphery rounded; section near the aperture broadly oval; inner volutions rising above the plane of the outer one.

SURFACE marked by fine striæ of growth, which are often irregular and crowded in fascicles, and sometimes become sharply defined towards the aperture.

The specimens of this species are imperfect, and the entire characters cannot

be determined. The inner volutions are moderately elevated above the plane of the outer one, differing in this respect from *E. inops*, while the abrupt depression of the umbilicus from the inner margin of the volution is a distinctive feature. The spire is a little more elevated than that of *E. Hecale*, and the base of the outer volution is rounded and not flattened as in that species. It differs very little from entire specimens of *E. Eboracensis*, except in the contact of its volutions.

Formation and locality. In the shales of the Hamilton group, at West Bloomfield, Ontario county, N. Y.

Euomphalus (Straparollus) Hecale.

PLATE XVI, FIGS. 10–14.

Euomphalus Hecale, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 16, figs. 10–14. 1876.
Compare *Euomphalus depressus*,* Hall (non Gold.). Geol. N. Y. Surv. Fourth Geolog. Dist., p. 291. 1843.

Shell discoid, spire depressed. Volutions about three or four, contiguous, rounded, the inner ones slightly elevated above the plane of the outer one, gradually enlarging from the apex, very slightly expanding at the aperture and flattened on the lower side. Umbilicus broad, descending abruptly from the inner basal margin of the volution, which is rounded on that side.

Surface concentrically striated—the striæ often crowded in fascicles or ridges towards the aperture.

This is probably the same species described in the Report of the Fourth Geological District as *Euomphalus depressus* (not *E. depressus* of Goldfuss).* Comparatively few specimens of this form have occurred among large collections of other fossils from the same formation, and these are principally casts of the interior, which sometimes preserve marks of the external striæ, and ridges left by the stronger fascicles, near the aperture. In form and proportions it resembles *E. laxus* of the Hamilton group, from which it differs in having the volutions in contact.

Formation and localities. In the Chemung group at Rockville, Allegany county, near Ithaca and Elmira, N. Y., and at Meadville, Penna.

* The original of *E. depressus*, Hall, is not now accessible to the author for comparison.

EUOMPHALUS (PHANEROTINUS) LAXUS.

PLATE XVI, FIGS. 8, 9, 16–18.

Euomphalus laxus, HALL. Descriptions of New Species of Fossils, etc., p. 26. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 54, pl. 6, fig. 2. 1862.
" (*Ecculiomphalus?*) *laxus*, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 16. 1876.
Ecculiomphalus comes, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 16. 1876.
Compare *Phanerotinus paradoxus*, WINCHELL. Proc. Acad. Nat. Sci. Phila., p. 21. 1863.

SHELL discoid; lower side broadly umbilicate. Volutions about four, nearly in the same plane, the inner ones rising moderately above the plane of the outer one, disjoined throughout their entire extent, very gradually and regularly expanding from the apex; section circular. Aperture (so far as known) subcircular, scarcely expanded.

SURFACE marked by crowded concentric striæ, which are sometimes regular and equal, and on some parts of the shell more closely arranged, and all directed a little forward, from the inner side of the volution.

The greatest diameter of the largest specimen seen, is one inch and five-eighths; the prevailing forms have a diameter of about one inch, while many are of smaller size.

This species differs from any other in this series of strata, except the following one, in the distinct separation of the volutions throughout their entire extent. The impressions in stone are strongly marked by the transverse striæ, which are often crowded in fascicles, and the casts preserve fainter impressions of the same markings.

Recent examinations of the specimens illustrated (ut. cit.) as *Ecculiomphalus comes* have satisfied me that they are imperfect conditions of *E. laxus*, having all the external characters of that species except the inner volutions, which have been decollated or removed during the maceration of the shells. I therefore propose to unite these two imperfect forms, figs. 8 and 9, with the typical forms of the species, figs. 17 and 18.

The *Phanerotinus paradoxus* (plate 16, fig. 16), described by Prof. WINCHELL, from the Burlington sandstone of Iowa, is an extremely similar form with *E. laxus*. The perceptible difference, on comparing casts of that species, is a

more abrupt convexity on the lower side of the volution, while the species of the Hamilton shales is often, or usually, only moderately convex, and never raised above a circular curve.

Formations and localities. In the Corniferous limestone at Schoharie, and in the Hamilton group at Eighteen-mile creek, at Alden in Erie county, and in the same formation in Otsego county, N. Y.

Euomphalus (Phanerotinus) Eboracensis.

PLATE XVI, FIGS. 19–23.

Euomphalus Eboracensis,	Hall.		Descriptions of New Species of Fossils, etc., p. 27. 1861.
"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 55. 1862.
"	"	"	Illustrations of Devonian Fossils: Gasteropoda, pl. 16. 1876.

Shell discoid. Volutions subrotund; the section very obtusely pentahedral; the upper side a little flattened along a narrow space, regularly curving on the inner side, somewhat flattened or depressed-convex on the lower side; the dorsum is flattened or truncated, and between this and the summit is a narrow flattened space. The dorsal side, separated by an obtuse angle, is nearly vertical to the plane of the volution; towards the aperture the inner side becomes straight, and the lower side scarcely flattened.

Surface marked by closely arranged lamellose striæ, which are crowded and fasciculate, giving a somewhat rough exterior on the outer volution, while the tube is constricted at irregular intervals, and the dorsum is marked by cicatrices from the attachment of fragments of shells or other bodies, which have left their impressions after removal or are still found adhering.

These cicatrices have sometimes great regularity, but they are usually at irregular distances, and the interspaces are sometimes distinctly constricted; at other times slightly swelling. The general form of this species is essentially the same as *E. laxus*, the marked differences being in the cicatrices upon the dorsum, which is also flattened—a feature not observed in the other species.

The habit of the shell in attaching other objects is like the Tertiary and recent genus Phorus, but, in all other respects, is similar to Euomphalus or

PHANEROTINUS—the latter name being more properly applicable than ECCULIOMPHALUS.

The species has lived in a soft calcareous mud, which has been largely composed of organic exuviæ. The specimens are usually in a fragmentary and unsatisfactory condition. The only nearly entire specimen has, in addition to the dorsal cicatrices, almost the whole upper surface covered by small fragments of other organisms.

Formation and locality. In the shales of the Hamilton group at York, in Livingston county, N. Y.

EUOMPHALUS (STRAPAROLLUS) CLYMENIOIDES.

PLATE XVI, FIG. 15, AND PLATE LXX, FIGS. 1-5.

Euomphalus clymenioides, HALL. Descriptions of New Species of Fossils, etc., p. 26. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 54. 1862.
" (*Straparollus*) *clymenioides*, HALL. Id., p. 166, pl. 6, figs. 1 and 2. 1862.
" *clymenioides*, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 70, figs. 1–5.* 1876.
— — — Illustrations of Devonian Fossils: Gasteropoda, pl. 16, fig. 15. 1876.

SHELL discoid. Spire depressed below the plane of the outer volutions. Volutions about four or five, lying nearly in the same plane, slender and very gradually expanding, rounded above and below, the lower side the more convex; the section transversely ovate, narrower on the ventral or inner side of the volutions; the vertical and transverse diameters about as twelve to thirteen. Aperture transverse, subovate. Diameter of shell in the largest specimen seen, about two inches.

SURFACE unknown.

This species is known to me in the condition of casts only, but its form and proportions furnish marked characters. The casts sometimes show impressions of transverse striæ, which at intervals have apparently been crowded in fascicles. The spire is more depressed than in *E. planodiscus* of the Goniatite limestone, while in that species the section of the volutions is nearly circular. The inner volutions are much more depressed than in *E. Hecale* of the Chemung group.

* The arrangement of this species with the Cephalopoda was made without the author's knowledge—the lithographer having completed his work before attention had been called to the subject.

It differs from the *E. inops* in a more gradual enlargement of the volutions, a more regularly convex surface on the lower side, and a shallower umbilical depression.

Several of the specimens are decollated, and the inner volution rounded at its upper extremity as if terminated by a septum. A similar feature has been noticed in *E. Decewi*. The species under consideration has none of the aspects of a Cephalopodous shell, except in this single feature; and no evidence of septa can be seen in any part of the shell below the smooth, rounded, upper extremity.

Formation and localities. In the Schoharie grit at Schoharie, N. Y., and in the upper Helderberg limestone, near Cayuga, Ontario.

The small group of species of Euomphalidæ above described, present many characters in common with those described by D'ARCHIAC and DE VERNEUIL, from the older deposits of the Rhenish Provinces; and notably among those may be mentioned *E. lævis*, *E. planorbis*, *E. annulatus* (*E. annulosus*, PHILIPS,) and *E. serpula*, DE KONINCK. The last named is cited as occurring also in the mountain limestone of Belgium and Ireland. The same group of species is illustrated by GOLDFUSS (*Petrefacta*, vol. iii), and cited as occurring in the Eifel Nassau, etc. As already stated, the *E. Wahlenbergii* is closely allied to *E. Decewi*, and the figures alone do not offer sufficient evidence of specific distinction.

DE KONINCK recognizes, essentially, the same group of species in the carboniferous rocks of Belgium (*Descriptions des Animaux Fossiles qui si Trouvent dans le Terrain Carbonifére de Belgique*).

SANDBERGER has recognized the *E. annulosus*, *E. lævis*, D'A.–DE V., *E. rota*, SAND., and *E. serpula*, associated with other Gasteropoda and Cephalopoda of similar character to those of our Upper Helderberg, Hamilton and Chemung groups (*Die Versteinerungen des Rheinischen Schichtensystems in Nassau*).

The species figured on plates 15 and 16 of this volume, are distributed through a vertical thickness of about three thousand feet. Similar forms occur at the base of the carboniferous rocks in Iowa, Illinois and Missouri, and especially in the yellow sandstone of Burlington, and the succeeding limestones.

PLEUROTOMARIA, De France.

Pleurotomaria arata.

PLATE XVII, FIGS. 1-8.

Pleurotomaria arata, Hall. Descriptions of New Species of Fossils, etc., p. 14. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 42, pl. 5, fig. 13. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 17. 1876.

Shell depressed-suborbicular or obliquely hemispheric. Spire moderately elevated; volutions four or more in the entire shell, depressed-convex or flattened upon the upper side, and rounded below, gradually enlarging from the apex—the outer half of the body-volution being ventricose. Aperture somewhat transverse.

Surface, on the upper side of the volutions, usually marked by strong, regular, distinct striæ, which often rise in sharp, elevated ridges; occasionally finer and more subdued. These striæ are parallel to the lines of growth, and sometimes appear to have been crenulated by finer revolving striæ. A well-defined revolving band marks the periphery of the shell, but usually (owing to compression of the specimens) this cannot be traced in the higher volutions. The lower side of the outer volution is marked by fine, equal, revolving striæ.

This species is abundant in the Schoharie grit, in the condition of casts of the interior. Individuals retaining the shell are rarely found, but some of the stronger markings are not unfrequently preserved on the casts, or as impressions of the exterior upon the enclosing matrix. The diameter of the shell is from one inch to two inches and a quarter (smaller specimens are sometimes seen); occasional examples of the vertically compressed specimens, attain a diameter of two inches and a half; the vertical height in the largest of these is about one inch and a quarter. A single rotund form measures one inch and three-fourths in height, and a little more in its greatest diameter. The shell appears to have been distinctly umbilicate. The casts, if not distorted, always present a large, circular, umbilical cavity which extends to

the apex of the shell, and the specimen retaining the shell (fig. 3, plate 17) shows a well defined umbilical depression. One example, broken across the spire, and still preserving the columella, shows an umbilical passage extending above the second volution.

The specimens are usually much distorted by pressure, and most of them are vertically compressed, so that the entire elevation is less than one inch. Owing to this vertical pressure, the volutions are often angulated at the margin of the periphery. Individuals are occasionally found like figure 4 of plate 17; and another still more rotund form is figured on plate 28. It is quite possible that these may prove a distinct species, but the specimens before me offer no means of a satisfactory separation.

Formation and localities. In the Schoharie grit of the Helderberg mountains, and at Schoharie, N. Y. A few specimens—casts of the interior—from the Upper Helderberg limestone in Western New York, preserve the form and proportions of the compressed specimens from the Schoharie grit of the Helderberg mountains.

PLEUROTOMARIA ARATA var. CLAUSA.

PLATE XVII, FIGS. 9, 10.

Pleurotomaria sp.? HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 17. 1876.

The specimen figured is a cast of the interior, preserving the general form of *P. arata*, and is especially similar to that species in the depressed convexity of the upper side of the volutions. The aperture is transverse, broad oval. There is scarcely any evidence of an umbilical opening. Some portions of the shell in a crystalline condition still remain upon the lower side.

Formation and locality. In limestone of the Upper Helderberg group, at Clarence Hollow, N. Y.

This form occurs in a fine grained limestone, associated with *P. Lucina* and *P. Hebe*, and preserves distinctive features in the form of its volutions and elevation of the spire, which more nearly resemble *P. arata*, to which species I have provisionally referred it.

Pleurotomaria plena.

PLATE XVII, FIGS. 11, 12, 13.

Pleurotomaria plena, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 17. 1876.

Shell ovoid-conical, rotund; spire elevated; apex minute. Volutions five or six, gradually expanding, rounded above, and somewhat abruptly curving downward at the sides, the last one becoming very ventricose. The periphery along the line of the band is apparently a little projecting beyond the regular curve of the volution; lower side very convex in the middle, and thence abruptly curving inward to the umbilical region.

Surface marked by somewhat coarse, regular striæ, about equal to the spaces between, which are directed gently backward from the suture almost to the limit of the peripheral band, being abruptly deflected at the junction. The peripheral band is crossed by abruptly curving striæ, and, on the volutions preceding the last one, scarcely rises above the suture-line. No revolving striæ have been observed upon the body of the shell, though in better preserved specimens they may exist.

This species, in general form, differs from *P. Lucina* in that it is a more erect shell, the spire is more elevated, and the volutions more gradually expanding, while the latter presents a slight difference in its rotundity, and, in the same way, a scarcely describable difference in the convexity of the higher volutions; it has also the two sets of striæ almost equally conspicuous. From the forms of *P. arata* known, *P. plena* differs in the greater elevation of the spire, and the finer concentric striæ, of which there are twice as many in a given space.

The shell is imperfectly preserved in the specimen figured, and the peripheral band is much obscured, especially on the higher volutions. The peristome is broken away to a considerable extent, and the form of the aperture can only be inferred from a section of the volution, which is subcircular and slightly transverse.

Formation and locality. In limestone of the Upper Helderberg group, Helderberg mountains, Albany county, N. Y.

Pleurotomaria Lucina.

PLATE XVIII, FIGS. I-II.

Euomphalus? rotundus, Hall. Geology of N. Y. Surv. Fourth Geolog. Dist., p. 172, f. 4. 1843
Not *Pleurotomaria rotundata*, Munster.
Pleurotomaria Lucina, Hall. Descriptions of New Species of Fossils, etc., p. 14. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 42, pl. 5, f. 12. 1862.
" *rotunda* and *P. Lucina*, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 18. 1876.

Shell subglobose, or obliquely ovoid-conical. Spire moderately elevated; apex minute. Volutions about four, gradually expanding to the last one, which becomes very regularly ventricose, with the aperture expanded and nearly round, extended on the lower side, with a shallow notch on the anterior margin; upper side of the volutions very symmetrically convex; suture neatly defined, slightly canaliculate; lower side of the body-volution convex in the middle, and abruptly curving into the umbilical depression.

Surface beautifully cancellated by concentric and revolving striæ, which, in many specimens, are of equal strength. Periphery marked by a moderately wide band, on which the striæ are turned abruptly backwards; this band is limited by stronger striæ or narrow ridges on each side, sometimes with one or two slender revolving striæ within the limits of the band, marking a narrower space, which is often crenulated by the concentric striæ.

This species is well marked by its symmetrically rotund form, with moderate elevation of the spire, and the regular convexity of the volutions, even in casts of the interior, when not compressed. There is some variety in the surface markings of specimens apparently belonging to this species. The concentric striæ are sometimes much coarser than the revolving ones; and finer striæ are implanted between the stronger ones, and do not reach the suture-line. In old individuals the revolving band is sometimes nearly a quarter of an inch in width.

A very symmetrical specimen has a diameter of a little more than two inches, and is nearly an inch and three-fourths in height. Another specimen, which has suffered some compression, has a breadth of about three inches, with nearly the same height of spire.

The specimen originally described as *Euomphalus? rotundus* still retains a portion of the shell, bearing the same characters as authentic examples of *Pleurotomaria Lucina*—preserving, however, an unusually broad and deep umbilical depression.

The species has had a wide geographical distribution, and its vertical range is not less than one thousand feet from the base of the Upper Helderberg limestone to the higher members of the Hamilton group.

Formations and localities. In the Corniferous limestone; Helderberg mountains, Williamsville, Clarence Hollow, N. Y., and Falls of the Ohio river; in the Hamilton group, York, Moscow, Geneseo, Skaneateles lake, etc., N. Y.

Pleurotomaria Hebe.

PLATE XIX, FIGS. 2-7.

Pleurotomaria Hebe, Hall. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 105. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., pl. 5, figs. 7 and 8. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 19. 1876.

Shell subhemispheric, conical above, rounded upon the lower side; the volutions flattened on the upper side, and nearly in the same plane from the apex to the outer edge of the last one; the spire above the aperture about equal to the height of the aperture. Volutions four or more, very gradually expanding to the last one, which is moderately ventricose and subangular at the limit of the periphery with the upper sloping surface. Aperture somewhat transverse, broadly subelliptical.

Surface marked by strong, revolving striæ, and finer transverse ones, which are strongly bent backwards on the carina of the outer volution; striæ not so strong below the peripheral band.

This species is smaller than either of the preceding, but is larger and more rotund than the *P. sulcomarginata* of the Hamilton group. The specimens examined are all imperfect, and the shell, where remaining, is crystalline, impairing the surface characters. The rotundity of the lower side and the depressed conical form above, are characteristic features of distinction.

Formation and locality. Upper Helderberg group, Clarence Hollow, N. Y.

Pleurotomaria sulcomarginata.

PLATE XIX, FIGS. 8-17.

Pleurotomaria sulcomarginata, Conrad. Jour. Acad. Nat. Sci. Phil., vol. 8, p. 272, pl. 16, f. 13. 1842.
" " " Hall: Descriptions of New Species of Fossils, etc., p. 18. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 46, pl. 5, figs. 9 and 10. 1862.
" " " " Illustrations of Devonian Fossils: Gasteropoda, pl. 19. 1876.

Shell depressed-trochiform; spire moderately elevated; apex minute. Volutions four or five, very depressed-convex on the upper side, gradually enlarging to the last one which becomes somewhat ventricose. Aperture subquadrate, somewhat wider than high, the columella much extended below.

Surface marked by two distinct, narrow, revolving carinæ on each volution, one just below the suture, and the other near the periphery, with finer intermediate striæ which are rarely visible; the entire surface marked by strong, regular and even concentric striæ which crenulate the revolving carinæ, and, passing over the lower one, bend backward to the concave peripheral band. Suture sometimes sharply canaliculate.

In entire specimens the apex is very minute, and, when the outer carination is crenulated by the strong concentric striæ, the shell has a coronate aspect. This carination, however, is often obsolete on the outer volution, and more rarely on the next above, and the striæ then continue uninterruptedly bending backward to the peripheral band, and continuing on the lower side often very nearly of the same strength as above. There is frequently a narrow depressed band just below the peripheral band on the last volution, causing a slight deflection of the striæ. The striæ are usually finer, and sometimes become nearly obsolete below the outer carination, and more rarely on other parts of the shell, especially near the aperture.

Mr. Conrad's description of the species is as follows:

"Trochiform; outer margin of the large volution bicarinated, with an intermediate sulcus; volutions with two distant spiral lines, and crossed by oblique striæ."

This is the most common species of PLEUROTOMARIA in the Hamilton group, occurring in all places east of Seneca lake, and often abundant in the coarser shales of Madison county. To the west of Seneca lake it is very restricted in its vertical range, and is comparatively rare. The form is usually depressed-trochiform, although sometimes it attains an elevation of seven-eighths of an inch, with a diameter of one inch. The retral bending of the sharp concentric striæ, the distinct carina just above the suture on the upper volutions, and the concave spiral band on the angular periphery, are distinguishing features. The casts are, however, often rounded or obtusely subangular on the periphery: some specimens in this condition from Maryland measure one inch and a half in diameter, and one inch and three-eighths in height, and consist of about five distinct volutions.

Formations and localities. This species has been found in limestone of the Upper Helderberg group, at the Falls of the Ohio. In the State of New York it occurs in the Hamilton group at Delphi, Pratt's Falls, at Pompey Hill and other places in Onondaga county—at the two former places more abundantly than elsewhere in the State. It also occurs in numerous localities in Madison and Otsego counties, and less frequently in Schoharie county. It is often found on the shores of Seneca and Cayuga lakes, but rarely farther westward. Its favorite habitat has been in semi-arenaceous sediments of the central portion of the group, with conditions intermediate between the arenaceous shales of the east and the soft calcareo-argillaceous muds of the western part of the State and Canada. In similar association, this species extends in a southwesterly direction to Maryland and Virginia.

PLEUROTOMARIA DELICATULA.

PLATE XIX, FIGS. 18, 19.

Pleurotomaria delicatula, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 19. 1876.

SHELL trochiform; spire depressed-conical, moderately elevated. Volutions four or more, gradually enlarging from the apex, the last one becoming ventricose towards the aperture, which is somewhat rhomboidal.

Surface marked by fine, even, concentric striæ which bend gently backward from the suture to near the peripheral band, where they are more abruptly deflected, and below which they appear as fine striæ of growth.

This species has the form and proportions of *P. sulcomarginata*. The concentric striæ are much finer than those of the prevailing forms of that species, and no revolving striæ are visible. A careful examination of the specimen shows some evidence of the exterior revolving carina, almost obsolete.

A single specimen only, of the form and characters described, has been observed, and, notwithstanding the differences indicated, additional examples may show a gradation to some of the varieties of form seen among the large collections of *P. sulcomarginata* from the Hamilton group.

Formation and locality. In the limestone of the Upper Helderberg group, in New York—the particular locality unknown.

Pleurotomaria rotalia.

PLATE XIX, FIGS. 20-25.

Pleurotomaria rotalia, Hall. Descriptions of New Species of Fossils, etc., p. 18. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 46, pl. 5, fig. 11. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 19. 1876.

Shell small, depressed-trochiform; apex minute. Spire consisting of about four volutions, which gradually expand to the aperture; slope of the spire from the apex to the periphery nearly in the same plane, being very slightly convex. Aperture subquadrate; lower side concave, with a comparatively large umbilical depression, which is surrounded by a distinct areola.

Surface very finely and closely striate parallel to lines of growth; striæ not prominent, sometimes obscurely fasciculate, and always bending abruptly backward as they approach the narrow peripheral band; obscure indications of revolving striæ are sometimes visible under a magnifier. Suture-line depressed and narrowly canaliculate, with sometimes a subdued or

obsolescent revolving carina just below, near the upper margin of the volution.

This species has nearly the form of *P. sulcomarginata*, but the spire is less elevated and the volutions more convex, while it is distinctly more concave on the lower side. The band of the periphery is scarcely depressed; there is no carination above the suture-line, and there are no sharp elevated striæ as in that species. The largest specimens seen are half an inch in diameter. The relative elevation of the spire in these two species is shown by a comparison of figure 21 with figures 9 and 13–16—the latter being much larger shells. Fig. 25 is an enlargement of *P. rotalia*, introduced for comparison with fig. 17, a young specimen of *P. sulcomarginata*, enlarged to the same degree.

Formation and locality. In the compact shale or calcareous rock of the Hamilton group, at Pratt's Falls, Madison county, N. Y.

Pleurotomaria Ella.

PLATE XX, FIGS. 22–25.

Pleurotomaria Ella, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 19, figs. 26–29. 1876.

Shell depressed-trochiform; spire moderately elevated; the entire height equal to about four-fifths the greatest width. Volutions four or five, depressed-convex on the upper side, gradually enlarging to the outer one, which becomes expanded and moderately ventricose towards the aperture; lower side gently convex for half its extent, and more rounded towards the aperture. Umbilicus closed; columella apparently not extended; periphery somewhat obtusely angular. Aperture transverse, subrhomboidal.

Surface cancellated by revolving and concentric striæ,—the former strong, defined and continuous, and about eight or ten on the upper side of each volution, as shown in the two exterior volutions; these are crenulated by the finer transverse or concentric striæ, which are usually directed backward, without curving, till close to the peripheral band, where they make an abrupt retral curve. The peripheral band is simple, narrow, concave.

The revolving striæ below the periphery are somewhat irregular and less conspicuous than on the upper side of the volutions, and the concentric striæ are much subdued.

This, so far as known, is a rare species. It may be distinguished from *P. sulcomarginata* by the numerous strong revolving striæ upon the upper side of the volutions, and the fine cancellating striæ: the apex is less acute, and the volutions more regularly expanding. The columella is not extended and thickened as in that species, and the lower side of the volution preserves the two sets of striæ. In the character of surface-striæ it resembles *P. Hebe*, but the spire is less oblique, the upper margin of the periphery is not carinate, and the body of the shell is less ventricose below, as may be seen by comparison with figures 5 and 6 of plate 19.

The species bears considerable resemblance to *P. radula* of DE KONINCK, but it seems quite distinct from any other described American species.

Formation and locality. In the shales of the Hamilton group, at York, Livingston county, N. Y.

PLEUROTOMARIA FILITEXTA.

PLATE XX, FIGS. 26, 27, AND PLATE XXVIII.

Pleurotomaria filitexta, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 19. 1876.

SHELL trochiform, substance thin; spire depressed-conical, height about one-sixth less than the width. Volutions four, five or more; very depressed-convex, scarcely rising above the plane of the spire, gradually enlarging above, the last one or two more rapidly expanding, and becoming very ventricose towards the aperture, which is somewhat rhomboidal. Periphery obtusely angular; lower side very convex, and abruptly depressed towards the umbilical region; columella extended.

SURFACE marked by fine, regular, concentric and revolving striæ, which are nearly equal in strength on the upper part of the shell, while the concentric striæ are more conspicuous on the lower volutions, and especially towards the aperture. From the suture the concentric striæ extend, with

a very gentle retral curve, abruptly bending backward as they approach the peripheral band, crossing which they are continued of nearly or quite the same strength as above. The band is simple, limited on each side by a slender carination, and marked only by the curving transverse striæ. The revolving striæ below the periphery are often undulating, and in some examples stronger than the transverse striæ, while the latter are usually predominant.

This species, when preserving the surface-markings, is well characterized and readily distinguished from any other form. The spire is more elevated than in *P. Ella*, and the volutions less rounded; the revolving striæ are finer, and the regular cancellation by the concentric striæ gives a textile appearance to the surface.

The substance of the shell is more delicate than in either of the preceding species, except *P. delicatula*, and all the specimens seen are crushed or otherwise distorted; the one figured, more nearly preserves the natural proportions. All the smaller specimens observed are flattened from above, as shown on plate 28, where the spire scarcely rises above the plane of the outer volutions. A single large specimen, figured on plate 28, is laterally compressed so that the true proportions cannot be represented. The diameter of the specimens in the collection examined, ranges from three-fourths of an inch to about two inches.

In form and proportions, as well as in the cancellate surface, this species may be compared with *P. clathrata* of Munster, but differs conspicuously in the absence of the elevated band at the summit of each volution. In its surface markings this species has much resemblance to the figures of *P. turbiniformis*, Meek & Worthen, from the Coal measures of Illinois; but the New York species has a less elevated spire, greater proportional width and ventricose volutions.

Formation and localities. This species occurs in fine shales of the Hamilton group at Bellona, in Yates county, N. Y., and at Monteith's Point on Canandaigua lake. A single specimen, apparently a cast of this species, has been found at Fultonham in Schoharie county, N. Y.

Pleurotomaria rugulata.

PLATE XX, FIGS. 1-7.

Pleurotomaria rugulata, Hall.		Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 108. 1860.
"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., pl. 5, figs. 4, 5. 1862.
"	"	Illustrations of Devonian Fossils: Gasteropoda, pl. 20. 1876.

Shell depressed-turbinate, ovoid-conical, wider than high; spire moderately elevated. Volutions four or five, very rapidly expanding, rounded exteriorly, the body-whorl forming almost the entire bulk of the shell. Periphery broadly banded, and in the casts obtusely angular, especially towards the aperture; lower side very convex and abruptly depressed to the umbilical area. Aperture broadly expanded, and the lip somewhat reflexed on the lower side.

Surface finely marked with closely arranged striæ parallel to the lines of growth, which turn a little backward from the suture, and thence in a vertical direction over the convexity of the volution, curving gently backward till they approach the peripheral band, when they are abruptly deflected and gradually merged in the carina which borders the band. The peripheral band is simple, comparatively wide, margined above and below by a sharply defined carina, the intermediate space marked by fine, curving striæ. The lower side of the volution is as finely and closely striated as on the upper side. The striæ are often crowded in fasciculæ, and towards the aperture form distinct folds, which affect the entire thickness of the shell, producing the wrinkled aspect shown in figure 2, plate 20. Similar but less conspicuous ridges often mark the whole surface of the shell. The faint indication of revolving striæ sometimes seen, are quite superficial.

The species usually occurs as casts of the interior, and may be distinguished from the following, or other similar forms, by the low spire and extremely expanded outer volution. The obtuse angularity of the periphery is not always noticeable, and in such conditions it differs little, except in the elevation of the spire, from casts of Platyostoma. There is also a considerable difference

in the elevation of the spire in different individuals, so that two varieties of form might be indicated—one with the spire elevated and the volutions regularly rotund, and the other with a lower spire and volutions less convex on the upper side, with a subangular periphery.

Formation and localities. This species occurs in the Goniatite limestone at Marcellus, Manlius, and other localities of this limestone in Central New York.

Pleurotomaria Itys.

PLATE XX, FIGS. 8-17.

Turbo lineatus, Hall. Geology of New York. Surv. Fourth Geol. Dist., p. 198, fig. 1. 1843.
Pleurotomaria lineata, Hall. Descriptions of New Species of Fossils, etc., p. 16. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 44, pl. 5, fig. 3. 1862.
Not *Pleurotomaria lineata*, Goldfuss. Petrefacta.
Pleurotomaria Itys, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 20. 1876.

Shell turbinate; spire ascending, higher than wide. Volutions four or five, regularly and evenly convex, gradually expanding to the body-whorl, which is ventricose, rounded below and concave in the middle; umbilicus small or none. Aperture broadly oval, somewhat higher than wide.

Surface marked by strong, regular, revolving striæ on the upper and lower sides of the volutions, crossed and cancellated by fine, concentric striæ, which are directed gently backward from the suture, and scarcely showing any greater curve as they approach the peripheral band; the band is of moderate width, simple, and limited on the two sides by a linear carina, within which the simple concentric striæ make an abrupt retral curve; the concentric striæ above and below the band are of similar character, while the revolving striæ are finer on the lower side.

This species varies in form and proportions, both from natural causes and from compression and accident, so that some specimens are proportionally much more elevated than others. In the soft calcareous shales of the Hamilton group, this fossil frequently occurs in the condition of casts, the shell having been removed during the process of decomposition by iron pyrites; and it is often covered by an incrusting Bryozoan. In its greatest height it measures nearly an inch and a half, but the prevailing size is scarcely

more than half an inch. Two symmetrical specimens measured have the proportions of width and height as 5 to 7 and 9 to 13. The casts of the interior, when well preserved, show a narrow, slightly elevated band on the periphery of the outer volution.

Formation and localities. In the soft calcareous shales of the Hamilton group, on the shores of Skaneateles, Seneca, Cayuga and Canandaigua lakes; at Bellona, Yates county; at York, Moscow and other places in the western counties, and more rarely on the shore of Lake Erie. It occurs in the condition of casts in Madison and Otsego counties, and in the same form in Maryland and Virginia.

PLEUROTOMARIA CAPILLARIA.

PLATE XX, FIGS. 18-21.

Pleurotomaria capillaria, CONRAD. Jour. Acad. Nat. Sci. Phil., vol. 8, p. 271, pl. 16, fig. 11. 1842.
" " " HALL: Descriptions of New Species of Fossils, etc., p. 17. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 45, pl. 5, fig. 2. 1862.
" " " " Illustrations of Devonian Fossils: Gasteropoda, pl. 20. 1876.

The following is the description of this species, as given by Mr. CONRAD, loc. cit.:

"Turreted, volutions slightly angulated below the middle, with spiral carinated lines; the second and third lines from the suture, on the upper part of the volutions, more distant from each other than from the adjoining striæ; upper part of the volutions very obliquely rectilinear. Surface with equal sharp lines which cross the volutions obliquely."

The fossil which I have identified with Mr. CONRAD's species possesses the following characters:

SHELL turreted, one-fourth to one-third higher than wide. Volutions four or more, somewhat rapidly increasing in size, the last one ventricose, subangulated above by two or three prominent revolving carinæ, and rounded on the lower side. Aperture subrhomboidal.

SURFACE on the upper side of the volutions marked by two or three revolving carinæ, with finer intermediate ones or strong striæ, and all are crenulated by finer distant transverse striæ; lower side of volutions

marked by regular, strong, revolving cariniform striæ, which are more approximate as they approach the umbilical depression, and all crenulated by concentric striæ. Peripheral band narrow and prominent, margins carinate, and the intermediate space marked only by curving striæ. Above and below the band, there is usually a broader smooth space than between the cariniform striæ.

In some specimens the transverse striæ are conspicuous only in crossing the revolving striæ, while in others they are conspicuous and dominate the revolving striæ. In nearly all the specimens there is a distinct alternation in the strength of the revolving lines, and the finer ones become sometimes obsolete.

A critical comparison with the figure given by Mr. CONRAD leaves some doubt whether the proper identification has been made; and since no peripheral band is mentioned in the description or represented in the figure, it is possible that the fossil described is a species of CYCLONEMA, of the form of *C. Hamiltoniæ* or *C. multilira*. See illustrations on plate 12.

The species here indicated never has the revolving striæ equal. It approaches, in its general aspect, *P. Itys*, but the volutions are not so rounded on the upper side; in some examples, where the subordinate carinæ are developed to nearly equal strength with the others, the resemblance is quite close to some varieties of that species.

In the usual imperfect and fragmentary condition of specimens, it becomes very difficult to distinguish this form from *Cyclonema Hamiltoniæ*. The character of the crenulated revolving carinæ is very similar, and, in the absence of the peripheral band, the only distinguishing feature observed is the wider space below the suture, in *C. Hamiltoniæ*, which is free from revolving lines, and marked only by finer concentric striæ,—a condition not characteristic of this species of PLEUROTOMARIA.

It is distinguished from the following species by its numerous revolving carinæ and the simple bicarinate peripheral band.

Formation and localities. In the shales of the Hamilton group, at Fultonham, Schoharie county, and on the shores of Cayuga and Canandaigua lakes, N. Y.

Pleurotomaria trilix.

PLATE XXI, FIGS. 13-15.

Pleurotomaria trilix, Hall. Descriptions of New Species of Fossils, etc., p. 17. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 45, pl. 5, fig. 1. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 20. 1876.

Shell turreted, subconical, higher than wide, consisting of four or more volutions, the apical ones of which are small, the last one ventricose, angular on the periphery, and concave below, with a distinct umbilicus. Aperture broadly suboval, higher than wide.

Surface marked by a single sharp revolving carina between the suture and the peripheral band, and on the last volution by a similar carina, and sometimes a second less conspicuous one, below the band. The volutions are crossed by distinct, acute, concentric striæ, which are usually distant more than their width, and sometimes closely arranged and little elevated. The peripheral band is triply carinate, inclosing two depressed spaces upon which the concentric striæ are abruptly bent backwards from the aperture to the medial line on the upper side, and a little less abruptly forward below.

This species, though observed only in imperfect specimens, is readily distinguished from any others of the group by its tricarinate peripheral band, and the single revolving carination above, and one, with a second subdued or obsolescent one below.

The form of this species is less rotund than the preceding, but, from the crushed and distorted condition in which it usually occurs, it can be distinguished only by the surface markings. The carinæ above indicated are less conspicuous than those of *P. capillaria*, and the striæ are finer; and the well marked peripheral band with three revolving lines and with the carination below it in the line of the suture, in the higher volutions, is also a distinguishing feature.

This species is far less numerous than the preceding form, and scarcely more than half a dozen specimens altogether have been observed.

In the general aspect of its surface markings this species resembles *P.*

quadrilineata of SANDBERGER, but it differs in the compound peripheral band, in which feature it may be compared to *P. subclathrata* of SOWERBY, which is somewhat similar in form, but has several cariniform revolving striæ above and below the peripheral band. In the comparative elevation of the spire this species is intermediate between the two mentioned. It may also be compared with the *P. conica* of PHILLIPS, which has a tricarinate peripheral band, but no carina above or below.

Formation and localities. In shales of the Hamilton group, near Fultonham, Schoharie county, the shores of Cayuga, Seneca and Canandaigua lakes, and in the Genesee valley near Geneseo, N. Y.

PLEUROTOMARIA ADJUTOR, n. sp.

PLATE XXI, FIG. 16.

Pleurotomaria trilix, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 20. 1876.

SHELL depressed-turbinate, obliquely ovoid-conical, wider than high. Volutions convex, about four or five in the entire shell, gradually increasing in size in the upper ones, and more rapidly below, the last one much expanded laterally and ventricose; lower side convex, becoming more gibbous towards the aperture, and somewhat abruptly depressed into the umbilical cavity. Aperture transverse, broadly oval.

SURFACE marked by a simple, strong, revolving carina on the upper side of the volution, a little nearer to the periphery than to the suture, and another similar, but a little less strongly marked carina, at an equal distance below the peripheral band, which is bicarinate, with a narrow depressed space between, crossed by the slightly curving concentric striæ; strong, distinct, and somewhat distant transverse striæ rise from a thickened band just without the suture, and extend in an almost vertical direction to the carina, passing which they bend backwards somewhat abruptly to the margin of the peripheral band, which is crossed by finer striæ, and below which the coarser striæ resume their character, and, passing the lower carina, are almost as conspicuous on the lower side of the volution

as above; turning first a little backward and then forward, they make a more abrupt retral curve into the umbilical depression. The spaces above the upper carina, and between the two carinæ and the periphery, are distinctly concave, giving prominence to the peripheral band.

This species was supposed to be only a variety of form of *P. trilix*, but a more critical examination shows it to be quite distinct. The spire is less elevated, the last volution more expanded, and the aperture of different form. The revolving carinæ are much nearer to the peripheral band, which is a simple concave space narrower than that above and below it, and limited on the two sides by a strong carina. There is no indication of a central line, and the curvature of the striæ within the band is very different from *P. trilix*. The transverse striæ are much stronger, more nearly vertical and distinctly bent backward in crossing the carina. It differs conspicuously from *P. capillaria* in the absence of the several cariniform revolving striæ above and below the periphery, as well as in its stronger concentric striæ.

Formation and localities. In limestone of the Upper Helderberg group, near Williamsville, N. Y., and in the same position near Dublin, Ohio.

Pleurotomaria insolita.

PLATE XXI, FIG. 17.

Pleurotomaria insolita, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 20, f. 26. 1876.

Shell turreted; spire elevated, higher than wide, nearly erect. Volutions convex, four or five in the entire shell, gradually enlarging from the apex, and the last one moderately ventricose with little lateral expansion; lower side and aperture unknown.

Surface, above and below the periphery, marked by a sharply defined revolving carina, between which and the peripheral band there is a narrow depressed space. Above the band the strong transverse striæ curve a little backward, scarcely changing their direction or strength in crossing the upper carina, and terminating at the peripheral band; below the band the striæ are nearly vertical to the lower carina, crossing which they

bend gently backward. These transverse striæ are cancellated by somewhat finer revolving ones which mark the entire surface, except the peripheral band, and notably the narrow depressed space between this band and the lower carina. The peripheral band is narrow, strongly limited on the two sides by slender carinæ, and crossed by fine curving striæ.

In the upper volutions the lower carina is a little above the suture-line, in which respect it differs conspicuously from *P. trilix* or *P. capillaria*. It differs from these also in the proportionally greater elevation of the spire, and the less expansion of the last volution, as well as in the numerous fine revolving striæ.

Formation and locality. In the shales of the Hamilton group, at Monteith's Point, Canandaigua lake, N. Y.

Pleurotomaria planidorsalis.

PLATE XXI, FIGS. 21, 22.

Pleurotomaria planidorsalis, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 20, figs. 28, 29. 1876.

Shell depressed-trochiform, subdiscoidal; spire moderately elevated. Volutions (entire number unknown) subangular on the upper side, rounded below, the last one ventricose towards the aperture, which is transverse, subrhomboidal, straight upon the upper side, and somewhat rounded below.

Surface on the upper side of the volutions marked by a strong revolving carina, which is about twice as far from the suture as from the peripheral band; upon the lower side, at about the same distance from the periphery, is a similar carina, and at about one-third the distance between this and the umbilicus there is another less conspicuous ridge which becomes obsolete towards the aperture. Strong concentric striæ extend from the suture obliquely to the carina, and thence bend more abruptly backward to the peripheral band. Below the band the striæ are directed forward to the first carina, and thence passing more directly over the lower side

of the volution, with no important change at the second carina, curve into the umbilical depression. The peripheral band is a simple concave space, limited on either side by narrow carinæ, which, in the specimen described, are partially obliterated and much obscured by the crushing of the shell.

The specimen described and figured preserves less than two volutions, the spire above having been broken off. It is, however, so different from any other species known in these strata, that there can be no difficulty in its identification. The great expansion of the outer volution (partly due to pressure in the specimen figured) is a distinguishing feature, while the carination of the upper side differs from any other species, except *P. adjutor*, which is otherwise quite distinct from this. The spire has probably had five or more volutions, of which the upper ones were small, inferring from the rapid contraction above the outer one, in this and another specimen where portions of the higher volutions are preserved, but in too imperfect a condition to be fully described.

Formation and localities. In the calcareous shales of the Hamilton group, at Hamburgh, on the shore of Lake Erie; at Darien, Genesee county, and (doubtfully) at York, Livingston county, N. Y.

Pleurotomaria Lucina var. perfasciata.

PLATE XXI, FIGS. 19, 20.

Pleurotomaria Lucina var. *perfasciata*, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 20. 1876.

This form has the general character and proportions of *P. Lucina*, and, in the higher volutions, the surface markings are similar to well-determined specimens of that species in the shales of the Hamilton group. The striæ are somewhat stronger than in the prevailing forms, but they offer no features to mark a specific distinction. The peripheral band has the same character, being limited by revolving striæ of essentially the same strength as those on other parts of the surface. The band is also marked by one or more finer revolving striæ, as in all specimens referred to this species. On the last

volution both the concentric and revolving striæ become strong and coarse, the latter in fascicles, and where crossing the strong transverse striæ produce a nodose surface, giving the shell a coarse, rude aspect, quite unlike the ordinary forms of the species, and especially differing from the typical character of those in the limestone of the Upper Helderberg group, as illustrated in figures 8 and 9 of plate 18. Several other specimens possessing similar characters, in a less degree, have been observed. In these modifications of the surface markings, where the revolving striæ are subdued or obsolete and the concentric striæ become strongly developed, the shell has the aspect of *P. arata.*

Formation and locality. In the shales of the Hamilton group near Skaneateles lake and at Bellona, Yates county, N. Y.

Pleurotomaria disjuncta.

PLATE XXI, FIG. 18.

Pleurotomaria disjuncta, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 20, fig. 32. 1876.

Shell depressed-trochiform; spire moderately elevated. Volutions (number unknown) subangular on the upper side, and rounded below, the last one moderately ventricose. The form of aperture not fully known.

Surface on the upper side marked by revolving carinæ, the first of which is nearly midway between the suture and the periphery, beyond which are two others more conspicuous than the inner one. Below the periphery are numerous strong revolving cariniform striæ. The peripheral band is a simple concave space with curving striæ. The concentric striæ are acute, strongly defined and directed backward from the suture, scarcely changing their direction in passing the first carinate band, but sometimes become a little nodulose; after crossing the second ridge the striæ make a more abrupt retral bend, and curving over a narrow carina to the peripheral band, where they are much subdued, are continued on the lower side in the same strength as above, directed slightly forward. In crossing the stronger revolving striæ they become a little nodulose.

A single individual only has been observed, but the characters are so different from any other in the group that it may readily be distinguished.

Formation and locality. The specimen is from a loose fragment of calcareous shale, found in the drift at Sexton's, in the town of Catharine, Schuyler county, N. Y., associated with numerous characteristic fossils of the Hamilton group.

Pleurotomaria nitella, n. sp.

PLATE XXX, FIG. 19.

Shell turbinate; spire suberect, conical, elevated, higher than wide. Volutions six or more, moderately convex above, and obscurely subangular on the periphery, gradually enlarging to the last one which is ventricose; lower side very convex, and abruptly depressed into the umbilical cavity.

Surface marked by a revolving carina above and below the peripheral band; the band is very narrow and prominent, leaving a narrow depressed space above and below it, which gives a carinate aspect to the outer volution. Concentric striæ directed backward in a gentle curve from the suture to the upper carina, crossing which they are a little more nearly vertical, and then directed backward to the narrow peripheral band; below the band they are nearly vertical to the lower carina, where they are directed gently backward. Striæ on the lower side a little less distinctly defined than those above.

This species somewhat resembles the *P. adjutor*, but is less robust, the spire proportionally higher, the volutions less spreading laterally, the carina above and that below the periphery less prominent, and the upper side of the volution more convex. The concentric striæ are much finer, and very different, in their gentle retral curving upon the upper side of the volution, from the straight rigid striæ of that species. This fossil is a rare form occurring with a species of Loxonema, a Bellerophon and a Coleoprion, which are unknown in any other locality.

Formation and locality. In decomposing cherty beds of the Upper Helderberg limestone near Jamesville, Onondaga county, N. Y.

Pleurotomaria quadrilix, n. sp.

PLATE XXX, FIG. 18.

Shell trochiform, depressed-conical, a little higher than wide. Volutions five or six, moderately convex on the upper side, the higher ones minute, or gradually increasing in size from the apex and becoming somewhat ventricose. Aperture unknown.

Surface marked by simple sharp equal concentric striæ, which make a slight curve just below the suture, and are thence directed backward to the upper margin of the peripheral band. The striæ are about equal to half the space between them; below the peripheral band on the outer volution they are nearly vertical for a short distance. The band is compound, being limited above and below by a canaliculate belt, which includes a somewhat wider depression between. There are no visible revolving striæ.

This species differs conspicuously from any of those described in this volume by the character of the peripheral band, which presents the appearance of being limited above and below by a sharply grooved carina leaving a narrow intermediate space. The absence of revolving carinæ, other than those of the periphery, is also a distinguishing feature. In the strength of the concentric striæ it is intermediate in character between the *P. nitella* and *P. adjutor*. In the character of surface striæ and the peripheral band it is similar to *P. costulato-canaliculata* of Sandberger; the volutions are about equally convex, but the spire is more elevated, and the band appears entirely above the suture-line in the higher volutions. In all its essential features, except in the greater elevation of the spire, this species corresponds to the *P. lenticularis* of Goldfuss, from the Devonian rocks of Nassau.

This fossil is extremely rare in the rocks of New York, since, at the present time, we know but a single example.

Formation and locality. In the Upper Helderberg limestone at Babcock's Hill, town of Bridgewater, Oneida county, N. Y.

Pleurotomaria Itys, var. tenuispira.

PLATE XXX, FIG. 25.

Shell turbinate; spire elevated, suberect, higher than wide. Volutions seven or more, minute above and rapidly expanding below, the last one very ventricose; the exposed portions regularly rounded.

Surface marked by somewhat distant, strong, revolving carinate striæ, which are crossed by strong concentric striæ, producing a nodulose or crenulate character. The revolving striæ are regular and equidistant above and below the peripheral band, which is simple, comparatively wide, and marked only by the retrally curving concentric striæ.

The specimen is small and apparently a young form, possessing all the essential characteristics of *P. Itys* in its surface markings, except that the revolving striæ are stronger, and the crenulations coarser. It has a larger number of volutions than any other specimen observed, and the rotundity of the last two volutions is greater than in any of the smaller individuals of that species in the collections.

Formation and locality. In the shales of the Hamilton group, at Hamburgh, shore of Lake Erie.

Pleurotomaria capillaria, var.

PLATE XXX, FIGS. 20, 21.

Spire small above, with the last volution greatly expanding. The upper side of the volutions marked by the characteristic revolving and concentric striæ of the species—the former being few and of unequal strength. On the lower side there are two, three or four of the revolving cariniform striæ just below the peripheral band; the remaining portion of the lower side of the volution is marked only by the concentric striæ which are sometimes obsolete.

All the specimens of this form which have been observed are vertically compressed, and the last volution has a great lateral expansion. The only

difference in the surface marking of this form and that of authentic specimens of *P. capillaria* is the absence of the revolving striæ upon the lower side of the last volution.

A single extravagant form which apparently belongs to *P. capillaria*, is illustrated on plate 30, fig. 22. The specimen is distorted by pressure, but otherwise presents the essential characters of that species, as shown upon the upper side; while the lower side presents numerous strong revolving carinæ which are crossed by the sharp elevated transverse striæ.

Formation and locality. In the soft calcareous shales of the Hamilton group, at and near York, Livingston county, N. Y.

PLEUROTOMARIA? APICIALIS.

PLATE XXI, FIG. 12.

Pleurotomaria apicialis, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 20, f. 27. 1876.

SHELL turbinate, higher than wide; spire erect. Volutions five or more, gradually increasing in size to the last one which is extremely ventricose: somewhat obliquely flattened on the upper side, and little expanded laterally, giving an obtuse angularity at the upper limit of the periphery.

SURFACE marked by strong rigid striæ, which turn slightly backward from the suture to the revolving band, which is situated at the upper margin of the periphery, crossing which they continue in a more nearly vertical direction on the last volution.

The characters of this species have only been obtained by gutta-percha impressions, from moulds of the exterior of the shell. It differs from the other species in the more erect spire and in the position of the peripheral band—the characters visible in the latter scarcely corresponding with that of ordinary Pleurotomariæ, on which account it is placed, with some hesitation, in this genus.

Formation and locality. In the decomposing semicalcareous beds of the Chemung group, at Nichols, Tioga county, N. Y.

MURCHISONIA, de Verneuil and d'Archiac.

Murchisonia desiderata.

PLATE XXI, FIGS. 1-3.

Murchisonia desiderata, Hall. Descriptions of New Species of Fossils, etc., p. 22. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 50, pl. 4, fig. 12. 1862.

Shell elongate, turretiform; spire somewhat rapidly ascending. Volutions ten or more obtusely angular, flattened on their upper sides, and a little more convex below the spiral band—the lower ones gradually enlarging; the greatest width of the last volution about equal to the height of the two above, and scarcely more ventricose than the preceding one, except towards the aperture. Aperture somewhat elongate; the columellar lip thickened, and bounded by a well marked callosity.

Surface marked by distinct concentric striæ, which are sometimes raised in fascicles above the general surface of the shell, and bending gently back from the suture reach the spiral band, crossing which they bend forward more abruptly, making a gentle curve to the suture below. The spiral band, at about three-fifths of the width of the volution below the suture, is simple, flattened or slightly concave, limited by narrow, moderately elevated revolving lines, and marked by the retrally curving striæ, which are less prominent upon it and the adjacent parts than near the suture. Suture close.

The height of five volutions from the mouth upward is nearly two and a quarter inches, and the diameter of the last volution is seven-eighths of an inch. The length of the aperture is about five-eighths of an inch, and the width half an inch, as far as can be determined from the imperfect specimen.

This species differs conspicuously from either of the two following forms in its proportionally greater length as well as the angularity of the volutions, and the distinct flattening upon their upper side. The suture-line is close, without indication of a groove, and the transverse striæ are much less conspicuous than in the other species.

The specimens of casts from the Upper Helderberg limestone of New York, which at one time I thought might prove identical with this species, are in such a condition as to give no satisfactory assurance of identity.

Formation and locality. In limestone of the Upper Helderberg group, at the Falls of the Ohio.

Murchisonia desiderata var.

PLATE XXI, FIG. 10.

Shell elongate, turretiform; spire rapidly ascending. Volutions ten or more, regularly enlarging from the apex, the last one scarcely more ventricose than those above; obtusely angular at the peripheral band, which is below the centre, flattened above it, scarcely convex below it—this portion of the volution a little more than half as wide as the upper.

Surface marked by fine close striæ which, so far as observed, have the same character and direction as in *M. desiderata;* spiral band narrow and flattened, giving prominence to the volution at that point.

The specimen is a mould of the exterior in chert, and the drawing is made from a gutta-percha cast; the striæ are imperfectly preserved. The volutions are somewhat less convex than in *M. desiderata*, and appear to be more rapidly attenuate above. The mould shows a part of another volution below the last one represented in the figure, so that the shell has had at least eleven volutions in a length of about three inches. In the absence of other material for comparison, and until we have the means of more satisfactory determination, I am disposed to regard this as a variety of the species already described.

Formation and locality. In limestone of the Upper Helderberg group, at the Falls of the Ohio.

Murchisonia Leda.

PLATE XXI, FIG. 4.

Murchisonia Leda, Hall. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 103, 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 162, pl. 4, fig. 10. 1862.

Shell elongate, terete or subfusiform. Volutions rounded (number unknown), somewhat rapidly expanding. Aperture subelliptical.

Surface marked by strong, elevated thread-like striæ, which are nearly vertical on the upper part of the volution, but turn gently backward towards the centre where they reach the revolving band, below which they are turned a little forward in a direct line to the suture. Peripheral band flat, limited above and below by a distinct carina, its upper margin being scarcely above the centre of the volution.

This species has the general aspect of a Loxonema, and in casts of the interior it is not possible to distinguish its generic relations; the striæ are of the same character as in the prevailing forms of that genus; it differs little in form from *L. pexata*, the volutions being a little more rounded, and the spire more rapidly attenuate. The volutions are also more rounded than in *M. Maia*. The simple suture and flattened peripheral band are distinguishing features.

Formation and locality. In limestone of the Upper Helderberg group, at Cambridge, Ohio.

Murchisonia Maia.

PLATE XXI, FIGS. 5-9.

Murchisonia Maia, Hall. Fourteenth Rep. N. Y. State Cab. Nat. Hist,, p. 103. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 162, pl. 4, fig. 11. 1862.

Shell elongate, turretiform; spire somewhat rapidly ascending. Volutions eight or more, gradually expanding from the apex, rounded above and below, very obtusely subangular on the periphery—the last volution a little more ventricose than the preceding. Aperture broadly oval, a little longer than wide, with the columellar lip extended below.

Surface marked by concentric, thread-like striæ which, for a narrow space, are directed a little forward from the suture to a revolving crenulated carina, and thence make a gentle curve backward to the peripheral band, below which they are again directed forward with a scarcely perceptible curve; peripheral band tricarinate. The striæ make a single retral curve across the space between the outer carinæ, without essential interruption by the central line.

The summit of the volutions is canaliculate just below the suture-line, and the striæ bending forward from the suture are turned backward as they pass the carina limiting the narrow groove. The striæ are distinct and thread-like in character, but not so coarse as in *M. Leda*, and the spire is less rapidly attenuate. The species is also distinguishable by the canaliculate suture and tricarinate band.

Formation and locality. In limestone of the age of the Upper Helderberg group, at Cambridge, Ohio.

Murchisonia intercedens, n. sp.

PLATE XXVIII, FIG. 29.

Shell turreted; spire somewhat rapidly attenuate above. Volutions about nine in the length of a little over half an inch, angular and rapidly enlarging, the last one ventricose; the apex imperfect in the specimen described; the volutions about equally depressed-convex on each side of the peripheral band. Aperture broadly oval, a little longer than wide; columellar lip extended below and pointed.

Surface marked by a narrow peripheral band in the middle and on the summit of the volutions, and the spaces above and below by rather strong transverse striæ, which apparently cross the upper volutions almost vertically.

This species has been seen only in the specimen figured, but its general form and the decided angularity of the volutions are sufficient to separate it from any other species of the formations under consideration. The specimen

is in such condition that the surface is not well preserved, and it is only in some of the higher volutions that comparatively strong striæ are visible. The shell has probably had at least three or four volutions beyond those preserved, making twelve or thirteen altogether.

Formation and locality. In the Upper Helderberg limestone, near Jamesville, Onondaga county, N. Y.

Murchisonia micula.

PLATE XXI, FIG. II.

*Murchisonia turricula,** Hall. Descriptions of New Species of Fossils, etc., p. 22. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 50, pl. 4, fig. 13. 1862.
" *micula,* " Miller. Amer. Palæozoic Fossils, p. 244. 1877.

Shell small, turretiform. Volutions about eight or nine, angular, flattened above and a little convex below the spiral band, rapidly enlarging from the apex—the last one scarcely more ventricose than the preceding. Spiral band strongly elevated, distinctly bounded by sharply carinated revolving lines, with its upper margin at about the centre of the volutions.

Surface marked by strong elevated concentric striæ above the band, and less conspicuous ones below it. Suture-line sharply marked by the deep contraction of the shell, and a narrow crenulated carina just outside of the constriction; on the last volution the suture-line is continued in a slender spiral line beyond the margin of the lip.

This minute species has a length of about a quarter of an inch. It possesses in some degree the character of *M. desiderata,* but the volutions are more angular and the suture-line more deeply impressed, with a narrow crenulate carina bordering the constriction; the concentric striæ and the spiral band are proportionally much stronger. More than a dozen specimens have been examined, all of which present the same form and surface characters.

Formation and locality. In the Hamilton group, at Delphi Falls, Onondaga county, N. Y.

* Name preoccupied by Billings in Report of Progress of the Geological Survey of Canada for 1857.

BELLEROPHON, MONTFORT.

SPECIES OF THE UPPER HELDERBERG GROUP.

BELLEROPHON CURVILINEATUS.

PLATE XXII, FIGS. 1-6.

Bellerophon curvilineatus, CONRAD. Jour. Acad. Nat. Sci. Phil., vol. 8, p. 269, pl. 16, f. 7. 1842.
" " " HALL: Descriptions of New Species of Fossils, etc., p. 27. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 55, pl. 6, figs. 8, 9. 1862.
" " " " Illustrations of Devonian Fossils: Gasteropoda, pl. 25, figs. 25-30. '76.

SHELL discoidal. Volutions four or five, compressed and sharply carinated on the back, each one embracing about half the width of the preceding one, the last scarcely more ventricose than the preceding, and bending almost rectangularly at the umbilical edge. Aperture triangular, acute at the anterior margin, which is deeply sinuate; the curvature of the peristome from the umbilical side receding about one quarter of a volution to the dorsal line. The inner margins of all the volutions are exposed in the cavity of the umbilicus.

SURFACE marked by fine striæ of growth, which follow the curvature of the peristome, making a retral curve of about one quarter of a volution; often slightly fasciculate, but sometimes the striæ are in regular fascicles of about six or seven finer ones, with a fine sharply elevated one separating them. The dorsum is sharply carinate.

The casts are angular on the back, showing a wide umbilicus, revealing the inner volutions. This species has somewhat the form and proportions of the *B. dubia* of D'ORBIGNY; but the umbilicus is proportionally larger, and the outer volution less rapidly widening towards the aperture. The following is the author's description of *B. curvilineatus:*

"Discoid; volutions exposed; back sharply carinate; surface with oblique arched striæ."

This species, cited by Mr. CONRAD as occurring in the Onondaga limestone, is more abundant in the Scholharie grit; though in this rock it rarely preserves the shell. In size, the specimens of this species vary from about one quarter of an

inch to more than an inch and a half in diameter. The casts of the younger individuals are less acutely angular on the back than of the older ones. The specimens present little variation in their general or special features—the younger specimens usually preserving the distinct fascicles of fine striæ, separated by a single slender sharp line, while in the older ones this regularity is not observed and the striæ become crowded in ridges, especially towards the aperture.

The species has a very limited geographical range, so far as observed no specimen having been found to the west of Schoharie county.

Formation and localities. In the Schoharie grit, and in the Upper Helderberg limestone at Schoharie, and the Helderberg mountains. A single imperfect specimen has been found in the Oriskany sandstone.

Bellerophon Pelops.

PLATE XXII, FIGS. 7-13.

Bellerophon (Bucania) Pelops, Hall. Descriptions of New Species of Fossils, etc., p. 28. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 56. 1862.
Bellerophon Pelops, " Illustrations of Devonian Fossils: Gasteropoda, pls. 22, 25. 1876.
Compare *B. propinquus*, Meek. Proc. Acad. Nat. Sci. Phil., p. 78. 1871.
" " " Geol. Surv. of Ohio. Palæontology, vol. 1, p. 226, pl. 20, fig. 4, a, b. 1873.

Shell subglobose. Body-volution ventricose and expanded at the aperture; umbilicus closed by a callus of the lip; outer lip with a moderate sinus in front and broadly rounded on each side, thickened and twisted at the umbilicus, with usually a thin callosity spreading over the columellar side of the aperture. Aperture transverse, broadly subreniform.

Surface marked by a slender dorsal band, which appears either as a simple elevation or with sharply carinate margins; the entire surface ornamented by fine subregular striæ, which, rising from the umbilical region, curve gently forward, and then more directly transverse over the body of the shell, bending slightly backward as they approach the dorsal carina, in crossing which they make a gentle retral curve; the striæ are usually stronger on the dorsal side, and fainter in the umbilical region.

The callosity of the lip at the lateral angles is a variable feature—being sometimes much thickened, and at other times expanded and moderately thickened, scarcely covering the umbilicus. In casts the inner volutions are more or less distinctly visible, according to the conditions and mode of preservation. Casts from the Schoharie grit in eastern New York, from the Upper Helderberg limestone at Clarence, in Erie county, where the shell has been replaced by crystalline matter, and from the same formation at Dublin, Ohio, show no characters for specific distinction. Specimens from the last named locality exhibit the shell in various degrees of preservation.

The specimens cited in my original description as from Brownville, Ohio, present no differences from those which have more recently come into my possession from the Dublin locality. This appears to be identical with the species described by Mr. MEEK as *B. propinquus* from the Upper Helderberg limestone of Ohio; and should farther study prove the western form to be distinct from that of New York, this name will be retained. For the purpose of comparison, a cast of the Ohio form is figured on plate 26. The specimen retains the shell on a part of the opposite side, and also the dorsal carina near the aperture, leaving no doubt of its specific relations with figures 7, 8 and 9, of plate 22.

Formation and localities. This species occurs in the form of casts of the interior, in the Schoharie grit at Schoharie, in the Upper Helderberg limestone at Clarence in Erie county, and in other places in Western New York; and in the same formation at Dublin, Ohio.

BELLEROPHON PELOPS var. EXPONENS.

PLATE XXII, FIG. 14.

Bellerophon Pelops, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 25, fig. 4 (referred with doubt to this species).

Form robust; exterior shell unknown.

In the cast three or more volutions are visible in the umbilicus, each one having about half its depth concealed in the concavity of the succeeding one.

Volutions somewhat flattened in the dorso-ventral direction; the outer volution expanded laterally, so that the width near the aperture is more than two and a half times as great as the height. The last half of the outer volution is obtusely angular on the dorsum (becoming rounded on the inner half), indicating a carina upon the exterior shell; and the aperture has apparently been deeply sinuate.

This form was originally included under *B. Pelops*, but a careful comparison shows the following differences: The outer volution near the aperture is more expanded laterally, the dorsal ridge is not continued backward as in the typical forms of *B. Pelops*, the inner volutions are more fully exposed, and the lateral margins of the outer volution are more angular. The only specimen of this form observed is much larger than the ordinary specimens of *B. Pelops*.

Formation and locality. In limestone of the Upper Helderberg group at Clarence Hollow, Erie county, N. Y.

Bellerophon Newberryi.

PLATE XXII, FIGS. 15, 16; AND PLATE XXVI, FIGS. 2, 3.

Bellerophon patulus, H. & W.	Twenty-fourth Rep. N. Y. State Mus. Nat. Hist., p. 200. 1872.
" " "	Hall: Illustrations of Devonian Fossils: Gasteropoda, pl. 22. 1876.
Not *Bellerophon patulus*, Hall.	Geol. of N. Y. Surv. Fourth Geolog. Dist. 1843.
	Descriptions of New Species of Fossils, etc.
	Fifteenth Rep. N. Y. State Cab. Nat. Hist.
Bellerophon Newberryi, Meek.	Proceedings Acad. Nat. Sci. Phila., p. 77. 1871.
" " "	Geological Survey of Ohio. Palæontology, vol. 1, p. 222. 1873.

Shell subglobose. Volutions covered, and the umbilicus closed or rarely perceptible; dorsum somewhat depressed-convex, with a faint depression along the median line. Aperture much expanded, reniform, more than twice as wide as the dorso-ventral diameter; the outer lip expanded (dimensions unknown), spreading laterally, and joining a strong callus of the columellar lip, recurves, inclosing and partially or entirely covering the umbilicus. Callus of the inner lip thick and strong, essentially flattened and spreading outward almost rectangularly to the direction of the

aperture; central part of the callosity more prominent, and projecting into the apertural cavity beyond the lateral portions.

SURFACE marked by regular transverse costæ or coarse elevated striæ, which are slightly bent backward on approaching the centre of the dorsum, along a gentle undefined depression.

The specimens examined are not sufficiently perfect to determine whether fine striæ exist in the spaces between the costæ, as in *B. patulus;* but the surface is probably of the same character as in that species.

Upon a cursory examination, this species, as presented in the specimens examined, may be readily confounded with *B. patulus;* but it is distinguished by the somewhat flattened dorsum (which in three specimens examined show a slight depression), by the slightly less arching costæ, the nearly or entirely closed umbilicus, and a strong, smooth, flattened callosity covering the columellar side of the aperture. The specimens at hand offer no means of determining the extent of the expansion of the outer lip, which has probably been much less than in *B. patulus* of the Hamilton group of New York.

Formation and locality. In the Upper Helderberg limestone, at Dublin, Ohio.

NOTE. The description above has been drawn from specimens collected at Dublin, Ohio (the one figured not being at present accessible to me). In the absence of all evidence of dorsal band, I would scarcely be warranted in referring it to *B. Newberryi*, though that species and *B. propinquus*, of MEEK, are the only ones mentioned in the Ohio Reports as occurring at that locality. The printing of this form has been delayed in the hope of obtaining characteristic specimens of *B. Newberryi* for comparison; and in the meantime Prof. ORTON, of Columbus, has sent to me an imperfect specimen, labelled by Mr. MEEK's hand *Bellerophon propinquus*, but which carries the transverse striæ as already described in the species under consideration, except that they are sharply elevated and cariniform, while there is a distinct, slightly elevated dorsal band, crossed by distant arching striæ, the whole scarcely rising so high as the adjacent parts of the volution. With the information before me I can only conclude that the

specimen figured on plate 22, as well as others examined, are so far eroded or exfoliated as to have lost the evidence of the dorsal band, and that they are in fact the *B. Newberryi*.

Bellerophon hyalina, n. sp.

PLATE XXVI, FIG. 4.

Shell subglobose, rounded upon the dorsum, and very abruptly depressed into the comparatively broad umbilicus. Body-whorl ventricose and rapidly expanding. Aperture very wide, broadly reniform — the full extent unknown; margin undetermined; the outer lip recurving at the sides, and partially inclosing the broad umbilical depression, and spreading in a thin callus over the columellar lip.

Surface marked by somewhat distant, sharp, transverse striæ which bend backward as they approach the centre of the dorsum; and these are cancellated by finer revolving striæ. No dorsal band has been observed.

The general aspect of the surface is like that of a young individual of *B. Leda*, but the broad umbilicus, with the subangularity of the sides of the outer volution are distinguishing features. The shell is silicified and crystalline, and the surface-markings pretty well preserved. Although no dorsal band has been observed, it is possible that such a feature may exist in better preserved specimens.

Formation and locality. In some decomposing cherty layers in the upper part of the Upper Helderberg group, near Jamesville, Onondaga county, associated with species of Loxonema, Pleurotomaria and of Coleoprion.

The above association of species is, in many respects, extremely similar to that of the cherty beds at Dublin, Ohio. The species of Coleoprion is apparently identical in the two localities; and of the other genera, several of the species are closely allied.

SPECIES OF THE HAMILTON GROUP.

BELLEROPHON PATULUS.

PLATE XXII, FIGS. 17-30; AND XXIV, FIGS. 3-6.

Bellerophon patulus, HALL. Geology of N. Y. Surv. Fourth Geol. Dist., p. 196, fig. 1. 1843.
" " " Descriptions of New Species of Fossils, etc., p. 29. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 57. 1862.
B. (Phragmostoma?) patulus, HALL. Illustrations of Devonian Fossils: Gasteropoda, plate 23. 1876.

SHELL subglobose, ventricose; umbilicus small, closed before reaching the centre. Volutions rounded, the last one abruptly and widely dilated, giving a broad subcircular aperture, the width greater than the dorso-ventral diameter. The lip is somewhat flattened and repand towards the exterior margin and broadly sinuate in front, contracted and more or less thickened at the postero-lateral margins, nearly inclosing and partially overlapping the volution on the posterior side, and extending more or less entirely over the columellar lip in a thickened callus, the exterior portion of which is pustulose. Inner margin of the columellar lip thickened and smooth, sometimes truncate, but usually projecting in a prominent boss in the centre.

SURFACE, on the expanded part of the outer volution, marked by fine, close, concentric striæ, which are sometimes crowded in fascicles, giving an undulating surface; the posterior prominent part of the volution is marked on the back, and partially on the sides, by strong, even, arching costæ, which are more abruptly and sometimes subangularly curved on the dorsal line. These costæ sometimes continue for half the length of the volution anteriorly, gradually becoming obsolete on the middle and sides, and are never seen upon the broad expansion of the shell. The spaces between these costæ are marked by fine, close, concentric striæ, and, in well-preserved specimens, extremely fine revolving striæ are sometimes visible. The costæ become finer or obsolete as they approach the umbilicus, and the surface is marked only by the fine striæ of growth.

This shell can usually be readily distinguished by its widely expanded outer volution, the broad, shallow sinuosity in the anterior margin of the lip, and the absence of all markings on this part of the shell except striæ of growth.

The prominent posterior part of the volution has more or less strongly defined costæ parallel to the striæ of growth. In some specimens this is scarcely a conspicuous feature; in others it is limited to so small a portion of the volution as hardly to be seen when looking directly upon the surface, as the fossil is usually imbedded in the rock with the mouth downward. There is also great variation in the size of these costæ, which in some specimens are twice as strong as in others, and the spaces between them two or three times as wide as the elevated portions; while in other examples they are reduced to regular equal striæ: and in all cases they gradually become obsolete by merging into the ordinary surface striæ. These phases are illustrated in figures 17–23. In most of the specimens examined, the expanded portion of the volution has been broken off, and there remains only the strongly marked portion of the surface. The removal of the shell leaves a smooth cast of the interior.

In all the specimens determined, the margin of the lip is found to be slightly recurved. The expanded margin of the aperture extends around the posterior part of the volution, nearly inclosing it, as shown in figures 17–19; and more especially on looking upon the interior, as shown in figures 27 and 28, where the margins are nearly conjoined on the posterior side. This expanded lip is usually recurved and thickened in the umbilical region, the heavy callus extending more or less completely over the posterior part of the volution. At the sides this callus is smooth, but in the central portions it is elevated and pustulose, following the convexity of the volution, and gradually extended outward from the aperture and forward on the volution. It sometimes nearly closes across the area, but usually leaves a free space or sinus where the transverse costæ remain visible, while the pustulose callus extends forward on each side, as shown in figures 22, 23, 27–29, and also in figures 5 and 6 of plate 24.

In many examples, the pustules upon the callus appear to have no regular

order, but as a rule they are arranged in lines corresponding to the arching costæ over which the callus lies. This is especially marked in figure 8, plate 24. Rare examples are seen where the callus scarcely extends beyond the thickened margin at the edge of the aperture, while the pustules are already implanted upon the arching costæ, and the spaces between them are gradually becoming undefined or obsolete. The pustules are often elongate, extending across two or more of the costæ, as seen in figure 7, plate 24. These phases in the extension of the callus are shown in figures 27–29 of plate 22, and in figures 6–8 of plate 24. In a single longitudinal section the thickened columellar lip is shown, as in figure 30 of plate 22, and more extremely on plate 26.

In its general expanded form this species resembles the *B. Leda* and *B. Lyra*, but differs in the external markings. It has also the same general form as *B. rudis* of the Hamilton group, and *B. trilirata* of the Chemung group, but in the former the strong distant costæ with distinct revolving striæ or ridges are marked characters; while the tricarinate aspect of the other, together with the revolving striæ are distinguishing features. In its arching costæ it closely resembles the *B. Newberryi;* but in that species the volution is more depressed on the back, with the callus of the columellar lip smooth, and extending almost directly across the volution.

Nearly all the specimens examined are more strongly striate on the back of the volution, near the expansion, than the one figured in the Geological Report of the Fourth District; but in other respects there is no important difference.

In the prevailing forms of this species the aperture measures, in the transverse diameter, from one inch and five-eighths to one inch and six-eighths, and in the longitudinal direction about one inch and a quarter. Larger specimens have a transverse diameter of aperture of two and a quarter to two and a half inches, with a dorso-ventral diameter of about two to two and a half inches.

Formations and localities. In the coarse shales of the Hamilton group in Schoharie county; in Otsego, Onondaga and Chenango counties; on the shores of Skaneateles, Cayuga, Seneca and Canandaigua lakes, and in the ravines entering those lakes; more rarely at York in Livingston county; and in the soft

calcareous shales on the shore of Lake Erie at Eighteen-mile creek. It is not rare in the form of casts near Cumberland, Md. It occurs in the limestone above the hydraulic beds at the Falls of the Ohio.*

Bellerophon rudis.

PLATE XXIV, FIGS. 13, 14, 15.

Bellerophon rudis, Hall. Descriptions of New Species of Fossils, etc., p. 29. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 57. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 23. 1876.

Shell extremely ventricose, the inner volutions rounded and subglobose; umbilicus small; the last half of the body-volution abruptly expanded, and the peristome spreading almost rectangularly to the axis of the shell. Anterior margin of the peristome slightly sinuous, and spreading on the posterior side over the preceding volution. The upper part of the last volution is marked by strong transverse arching costæ, which are closely arranged on the summit of the volutions, but towards the aperture, become irregular, stronger and more distant: the expanded portion of the volution has two, three or more strong folds or wrinkles parallel to the margin of the peristome, which are stronger in the middle, and become obsolete on each side: the upper part and sides of the volution are marked by longitudinal ridges which reach nearly to the margin in front, but in some parts are irregular and obscure; this feature is subject to great variation, being in some specimens scarcely perceptible.

This shell resembles in form the *B. patulus*, but is more robust, and the transverse costæ fewer and stronger; the concentric folds on the expanded portion, as well as the longitudinal ridges on the sides, are distinguishing characters. In one specimen the transverse diameter is about one inch and seven-eighths, and the longitudinal diameter nearly one inch and three-fourths. The general proportions are so nearly like *B. patulus* that it might perhaps be

* For information regarding the age of this limestone at the Falls of the Ohio, heretofore referred to the Upper Helderberg group, see note at the end of descriptions of the Gasteropoda.

regarded as an extravagant form of the same, marked by peculiar developments of the surface characters. In the best preserved specimen before me, the summit of the volution near the aperture is marked very nearly as in the more strongly costate forms of *B. patulus;* but receding from the summit the costæ become stronger and farther separated from each other, with strong revolving ridges, or coarse striæ coming between them. These last, though becoming obsolete, can be traced to the margin of the shell. The few specimens of this species observed show considerable variation in the external features, which are illustrated in figures 13, 14 and 15 of plate 24. In the broad anterior expansion and concentric rugæ this species resembles some forms of *B. triliratus* of the Chemung group; but the absence of carinæ and of the fine revolving striæ offer a characteristic distinction.

In the broad anterior expansion of the peristome the *B. patulus* and *B. rudis* resemble PHRAGMÓSTOMA, to which genus, in the absence of positive knowledge of the interior, I had at one time doubtfully referred them. They are, however, true BELLEROPHON.

Formation and locality. In the coarse shales of the Hamilton group, at Fultonham, Schoharie county, N. Y.

BELLEROPHON OTSEGO.

PLATE XXIV, FIG. 12.

Bellerophon Otsego, HALL. Descriptions of New Species of Fossils, etc., p. 32. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 60. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 22. 1876.

SHELL rotund, subglobose; body-volution ventricose, somewhat trilobate, the middle much wider than the lateral lobes, gradually spreading towards the aperture, which apparently is moderately expanded and sinuate in front. The lateral lobes are separated from the central part of the volution by a well marked sinus, and this character, with the comparatively wide dorsal band, limited by thin sharp striæ, are characteristic features.

Surface marked by fine, regular, transverse, arching striæ, having a retral curve upon the dorsum, which is traversed by a comparatively wide band, inclosed between two sharply elevated striæ, distant from each other about one line.

Formation and locality. In the coarse sandy shale of the Hamilton group, in Schoharie county, N. Y.

Bellerophon Thalia.

PLATE XXV, FIGS. 1, 2, 3.

Bellerophon Thalia, Hall. Descriptions of New Species of Fossils etc., p. 32. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 60. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 25. 1876.

Shell ovoid or subspheroidal. Volutions rotund, the last one gradually expanding for half its length, becoming ventricose and abruptly spreading toward the aperture, which is somewhat orbicular, with a deep sinus at the anterior margin; umbilicus exposed.

Surface marked by extremely fine, even, concentric striæ, bending abruptly backward on the dorsum, which is marked by a sulcate carina.

This species occurs as casts of the interior, or specimens from which the shell has been mostly removed by maceration and solution. Portions of the shell remaining show a surface-marking similar to *B. bilobatus* of the Lower Silurian rocks, and the shell has nearly the same form and proportions, with the exception of the banded dorsum, which is distinctly limited on each side by a sharply elevated line, and is always more or less well-preserved in the casts, when all the other surface-markings have disappeared. In general form this species bears much resemblance to *B. Pelops;* but the volution is more abruptly expanded near the aperture; the sides are obtusely subangular, and curving into a distinct umbilicus; the dorsal band is more conspicuous and distinctly sulcate or bicarinate; the sinus in the peristome is deeper and more abrupt; and the striæ are more sharply curved backward on the dorsum. All the

specimens observed are more or less distorted by pressure, and the surface-markings are but partially preserved.

Formation and localities. In shales of the Hamilton group, at York, Livingston county, and at Pratt's Falls in Madison county, N. Y.

Bellerophon acutilira.

PLATE XXV, FIGS. 4-8.*

Bellerophon acutilira, Hall. Descriptions of New Species of Fossils, etc., p. 28. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 56. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 25. 1876.

Shell ovoid or subglobose; the inner volutions discoid, and exposed in the rather large umbilicus; the body-volution becoming ventricose and much expanded towards the aperture; the ventro-lateral margin angular, and sometimes almost carinate from the rectangular bending into the umbilical depression; dorsum obtusely subangular, not carinate; aperture suborbicular, a little wider than high; peristome deeply sinuate in front, and the posterior margin slightly modified by the preceding volution.

Surface marked by regular, subequidistant, fine striæ, which bending forward from the ventral edge of the volution, make a broad curve on the side, and turn abruptly backward, making a sharp bend on the dorsal line. The dorsum is angular on the upper part of the last volution, but becomes regularly convex, with a less abrupt curvature of the striæ, upon the more expanded part toward the aperture.

In one specimen of this shell, I find characters corresponding to those given by Mr. Conrad to *B. brevilineatus*. The striæ proceeding from the umbilicus are well marked at first, become obsolete on the side of the volution, and are again well marked on the dorsum. This character obtains only on the last half of the outer volution; above this the striæ are uniform over the whole surface. The periphery is obtusely angular, and it does not appear, therefore, that this can be identical with the species of Mr. Conrad. At certain stages

* Figs. 6, 7 and 8 were erroneously referred in the *Illustrations of Devonian Fossils* (figs. 19, 20, 21) to *Cyrtolites nitella*.

of growth, the sinuosity in the anterior side of the peristome has been very deep and acute; but at a later period, this character has become gradually less extreme, and the striæ of growth make a distinct curve on that part of the shell.

This species bears much resemblance to the *Bellerophon Murchisoni* of D'ORBIGNY, but is more robust, with a greater width on the posterior side of the aperture and a wider umbilicus.

Formation and localities. In the shales of the Hamilton group, at Hamilton and Pratt's Falls, in Madison county; on the east shore of Cayuga lake, near Norton's Landing; and at York in Livingston county.

BELLEROPHON BREVILINEATUS.

PLATE XXVI, FIGS. 5, 6 7.

[?] *Bellerophon brevilineatus*, CONRAD. Jour. Acad. Nat. Sci. Phil., vol. 8, p. 269, pl. 16, fig. 6.

SHELL thin, ovoid, trumpet shaped, the outer volution rapidly enlarging, expanded at the aperture and sinuate in front; the dorsum elevated into a distinct carina, and limited on each side by a sinus, which separates it from the body of the volution. Umbilicus open and comparatively wide.

SURFACE marked by simple concentric striæ, which proceed pretty directly from the umbilicus, and gently arching over the sides of the volution, where they are often interrupted or obsolete, bend abruptly backward into the sinus, and thence sharply arch over the carinate dorsum.

In many specimens the striæ are interrupted, becoming obsolete beyond the middle of the sides of the volution, and do not continue into the sinus between the body of the shell and the carina, though reappearing upon the dorsum.

This feature corresponds essentially with the description and figure of *B. brevilineatus*, as given by Mr. CONRAD, which is as follows:

"Discoidal, tapering gradually to a very acute periphery; volutions exposed; from the margin of the umbilicus radiate short lines, less in length than half the width of the large volution."

In all the specimens observed the dorsum is carinate and striate, while the dorso-lateral part of the body-volution, as it descends into the sinus, is often smooth or obscurely striate. It is possible that in some conditions of preservation, the carinate dorsum may not be so distinct from the body of the volution as in those specimens examined; and this feature may be represented as "a very acute periphery." At the present time, I prefer to adopt the name given by Mr. CONRAD to the risk of increasing the synonymy.

In specimens where the striæ are continuous over the surface, this fossil bears much resemblance to the *B. Chasteli*, LEVEILLE, having a precisely similar dorsal elevation, but with much finer surface striæ. Where the transverse striæ are interrupted, or become obscure on the sides of the volution, it resembles the *B. Verneuili* of D'ORBIGNY, except in the presence of the dorsal elevation.

Formation and locality. In the shales of the Hamilton group, on the eastern shore of Cayuga lake, N. Y.

BELLEROPHON NATATOR.

PLATE XXIV, FIG. 1.

Bellerophon expansus. Geology of N. Y. Surv. Fourth Geolog. Dist., pp. 243–4, fig. 3. 1843.
Not *Bellerophon expansus*, SOWERBY.
Phragmostoma natator, HALL. Descriptions of New Species of Fossils, etc., p. 32. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 60. 1862.
" " " Illustrations of Devonian Fossils, pl. 23. 1876.
Not *Phragmostoma natator.* Explanations of plate 6, figs. 12–14. Fifteenth Rep. State Cab. Nat. Hist.*

SHELL with the inner volutions comparatively small, and apparently closely incurved; the outer volution abruptly expanded towards the aperture, which is broadly oval, with the transverse much greater than the longitudinal diameter; the peristome broadly and deeply sinuate in front. The sides of the shell are strongly undulated or wrinkled.

SURFACE marked by fine concentric striæ of growth, which bend abruptly backward on approaching the dorsum.

* These figures are illustrations of *Phragmostoma cymbula* of the age of the Hudson river group, and were referred by mistake to *P. natator.*

The dorsum is subangulated but not distinctly carinate in the specimen before me, and the striæ from the two sides meet at an acute angle in the centre, and make a broad curve upon the sides of the volution. The shell shows no evidence of revolving striæ, and the specimen from the Hamilton group presents characters similar to those seen in the figure cited from the Portage group.

I had originally referred this species, with doubt, to *Bellerophon expansus* of SOWERBY; but later observations prove it to be quite distinct. The feature which I had supposed to represent the septum of PHRAGMOSTOMA in the broken specimen from the Hamilton group, is probably only the projection of the thickened columellar lip into the cavity of the aperture, and not a true septum. The species is therefore retained under the genus BELLEROPHON.

The original of this species is a part of the outer volution of a specimen from the Portage shales on Cashaqua creek in Livingston county. Subsequently I identified with the same a specimen from the upper part of the Hamilton group in Chenango county. The latter is illustrated on plate 24, the Portage specimen not being at this time accessible to me. Both of the examples are very imperfect, and the entire characters of the fossil are still unknown.

Formations and localities. In the shales of the Portage group, at Cashaqua creek; and in the upper part of the Hamilton group, in Chenango county, N. Y.

BELLEROPHON EXPLANATUS, n. sp.

PLATE XXVI, FIG. 14.

SHELL large, subhemispheric; the inner volution unknown; the exterior portion of the outer volution abruptly expanding. Aperture extremely dilated, very broadly oval, being more than once and a half as wide as long. Peristome broadly sinuate in front and sharply notched in the middle (probably from accidental breaking away of the shell on the carina), repand at the sides, and somewhat abruptly recurved and auriculate at the postero-lateral margins, apparently leaving an open umbilicus.

Surface marked by fine, closely arranged concentric striæ of growth which are abruptly incurved towards the dorsum. The dorsum is elevated in a rounded, not carinate, band, which is distinctly limited at the margins, and upon which the striæ are rather gently arched.

This species is essentially different from any others here described except the *B. natator;* and from the typical form of this it is certainly distinct. It has the general aspect of *B. patulus*, but differs by the absence of the strong concentric ridges upon the summit of the outer volution, and especially by the presence of a dorsal band. It also resembles *B. triliratus* in form, but is not marked by the central and lateral ridges, nor has it any evidence of radiating or revolving striæ so characteristic of that species.

Formation and locality. The specimen has been placed in my hands as coming from the Chemung group, but from the character of the rock and certain associations I infer that it has been derived from the coarser shales of the Hamilton group in some one of the eastern counties of the State.

Bellerophon Leda.

PLATE XXIII, FIGS. 2-16.

Bellerophon Leda, Hall. Descriptions of New Species of Fossils, etc., p. 30. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 58. 1862.
" " " H. & W. Twenty-fourth Rep. N. Y. State Mus. Nat. Hist., p. 200. 1872.
" " " Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., pl. 13, fig. 1. 1875.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 24. 1876.

Shell subglobose, often a little flattened upon the dorsum; body-whorl ventricose, very rapidly expanding. Aperture very wide: peristome abruptly spreading, broadly sinuate in front and sometimes with a deeper notch in the middle, the margin gently recurved, joining the volution a little on the ventral side, where it is thickened, somewhat abruptly curving over and partially enclosing the small umbilicus, and extending in a callus over the columellar lip, which is sometimes distinctly striato-pustulose.

Surface marked by strong longitudinal or revolving striæ, which alternate in size, are sometimes fasciculate, and often finer and more numerous on each side of the dorsal band than on the lateral portions of the shell. The revolving striæ are cancellated by finer, subequal, thread-like transverse striæ. The dorsal band is narrow, rarely elevated or sometimes scarcely raised above the surface, and usually flat or slightly concave—the concentric striæ making an abrupt retral curve upon it in crossing. The band is likewise usually marked by two, three, or more revolving striæ, finer than those on the sides of the shell, and sometimes quite obscure.

In the exfoliation of the shell, and even in the best preserved specimens, the elevated transverse striæ sometimes become obscure towards the aperture, and the revolving striæ also becoming obsolete leave a border marked only by the finer striæ of growth.

The prevailing size of the shell, as seen in the calcareous shale, is about three-fourths of an inch in length—specimens rarely reaching an inch or an inch and a quarter in length, with a width of about seven-eighths to nearly an inch and a half. A large, well-preserved specimen, with expanded aperture, measures, as exposed in the stone, an inch from the back of the dorsum to the front of the aperture, with a transverse diameter of one inch and a half; while another specimen of the same width has a length of only seven-eighths of an inch—due probably to compression.

Nearly all the specimens are more or less distorted by pressure, and to this cause is mainly due the variation in proportional length and breadth. The broad concentric wrinkles which mark some of the specimens, are also in great measure the result of the same cause. As a general character, the exposed part of the outer volution increases somewhat rapidly but uniformly for about half its length, when it expands more abruptly; this feature is shown in figs. 6, 12 and 14—the revolving striæ either increasing in width or becoming fasciculate and spreading. The surface-markings present a considerable degree of variation, as illustrated in the figures on plate 23.

The mesial or dorsal band varies in character, sometimes preserving only the arched transverse striæ, or with faint indications of revolving striæ, while

there are all gradations from this condition to those where the transverse arching striæ are scarcely or not at all visible, and the band is marked only by the three, four or five sharp revolving striæ. The extremes of this feature are not fully shown in the figures. There is also a great variation in the character of the revolving striæ, which are sometimes almost equally alternate in strength, while in other examples there are fascicles of coarser and finer, or there is a single strong and prominent one separated by three or four which are finer and subdued, as illustrated in fig. 6.

The outer volution is comparatively small and prominent at its junction with the peristome, as shown in fig. 2, from a specimen which has not suffered from pressure. Fig. 3, showing the umbilicus, is also from a specimen not distorted by pressure. The pustulose character of the columellar lip is very similar to that of *B. patulus*, but less strongly marked, as the species is less robust, and this part of the fossil is rarely exposed. The species is well marked and readily distinguished from any other in the New York formations except *B. Lyra*, to which it bears much resemblance; but authentic specimens of that species are less ventricose and more evenly expanded at the sides, and the width does not so greatly exceed the length. At the same time, the study of a larger number of specimens has shown the possibility of a gradation of form from one to the other, as may be inferred from a comparison of figs. 9 and 10 with figs. 19 and 20 of plate 23.

This species occurs with *B. patulus* in several localities throughout the State, but is far less numerous than that form. It resembles in form and surface-markings the *B. decussatus* of Fleming, *B. elegans* and *B. clathratus* of d'Orbigny, and *B. cancellatus* of Hall.

Formation and localities. In the Hamilton group, at Fabius, Delphi and Pratt's Falls, in Onondaga county; at Sherburne creek; on the east side of Cayuga lake; on the shore of Canandaigua lake; at Darien; and at Hamburgh and Eighteen-mile creek, on the shore of Lake Erie.

Bellerophon Lyra.

PLATE XXIII, FIGS. 1, 17–20.

Bellerophon Lyra, Hall. Descriptions of New Species of Fossils, etc., p. 31. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 59. 1862.
" " " Illustrations of Devonian Fossils: Gasteropoda, pl. 24. 1876.

Shell subglobose; moderately and evenly convex on the dorsum, the outer half of the body-volution ventricose and abruptly spreading towards the aperture, which is extremely expanded, round-oval, a little wider than long; peristome distinctly sinuate in front.

Surface marked by regular, subequal, flattened, revolving striæ, which are sometimes bifurcated, increasing in width towards the margin. The spaces between the wider striæ are marked by extremely slender linear striæ, which do not increase in width as the adjacent ones, and are of the same strength at the margin as on the more prominent parts of the volution. The striæ are slightly undulating, and very distinct to near the aperture, where they become obsolete, or terminate in a smooth border which is not thickened exteriorly. There are no marked transverse striæ other than the obscure lines of growth, only to be seen under a lens. The dorsum is marked by an elevated, rounded carina, which is crossed by prominent arching and subimbricating lamelliform striæ or ridges, of which there are about two or three in the space of a line.

This species bears a close resemblance to *B. Leda* in some of its phases; but the shell is apparently less ventricose; the aperture is more equally, and less abruptly expanded than is usual in that species, and there are no conspicuous transverse striæ, while the revolving striæ are broader and more equal, and the dorsal band elevated into an obtuse carina with distant imbricating striæ. Length of aperture, in the largest specimen observed, about seven-eighths of an inch, with a transverse diameter of an inch.

All the specimens which can be strictly determined as of this species, are from the coarser shales of the Hamilton group in Schoharie county, while

there are none from the same region having the characters of *B. Leda*. A specimen, however, from the shore of Cayuga lake, referred to the latter species, has an unusually narrow form with flattened subequal striæ, and one and sometimes two slender linear striæ implanted between the larger ones—in these characters being essentially identical with *B. Lyra*. In this example the expanded part of the volution is marked by fine transverse lines of growth without elevated striæ, while the posterior part of the same is marked by prominent transverse striæ as in ordinary specimens of *B. Leda*. Possibly this condition may be due in part to exfoliation, but the finest surface-markings are preserved. When such varying conditions exist on the surface of the same specimen, it is easy to believe that individuals of the same species, living among the coarser sediments in the eastern part of the Hamilton area, may, from the influence of physical causes, have assumed different characters from those occurring in the western portion of the State. From the more eastern localities we do not know a single specimen of *B. Leda* associated with this species.

Formation and localities. In the coarser shales of the Hamilton group, at Fultonham, Schoharie county. One specimen only, shown in fig. 1, was found among the collections of Dr. KNAPP, from the rocks, of the age of the Hamilton group, at the Falls of the Ohio.

BELLEROPHON HELENA, n. sp.

PLATE XXIV, FIG. 11.

SHELL small, subovoid-hemispheric; outer volution rapidly enlarging, auriculate at the sides, ventricose; umbilicus exposed. Aperture widely expanded, broadly reniform, with the peristome spreading laterally, and sinuate in front.

SURFACE marked by sharply elevated, rather distant, concentric striæ, which curve very gently on the sides of the volution, and are somewhat abruptly bent backward as they approach the dorsal band; band comparatively wide, distinctly limited on each side, and marked by the retrally curving

distant striæ. Approaching the anterior and lateral margins, the stronger sharp striæ become obsolete, leaving the surface marked only by the simple striæ of growth.

This is a small species, attaining about half an inch in length. It is quite rare: no specimen seen has shown the interior of the aperture, or the columellar lip. It may be readily distinguished from any other described in the formations under consideration by its general form, the simple, sharp, transverse striæ, and the comparatively wide dorsal band, which is marked by striæ as on other parts of the surface.

In general form and surface-markings this species corresponds with *B. vasulites* of MONTFORT, as figured by FERUSSAC and D'ORBIGNY, but differs in the open umbilicus as well as in other details. It may also be compared with *B. hiulcus* of MARTIN. In form it is quite similar to the young of *B. Leda;* but in that one the revolving striæ are always present, and usually more conspicuous than the transverse striæ.

Formation and localities. A single specimen has been found in the shales of the Hamilton group in each of the following localities: Near Norton's Landing on the east side of Cayuga lake; below Monteith's Point on Canandaigua lake; and at York in Livingston county, N. Y.

BELLEROPHON ROTALINEA, n. sp.

PLATE XXVI, FIG. 8.

SHELL small, discoid. Volutions gradually expanding to near the aperture; umbilicus open; sides of the exposed volution depressed towards the back, and marked by a revolving sinus, leaving a prominent dorsal ridge.

SURFACE marked by distinct and sharply defined revolving striæ, which are distant from each other about twice their width. No concentric striæ are visible on the specimen examined.

This small species is quite distinct from any other known in these formations. The discoid form with open umbilicus, revolving striæ, and absence, so far as visible, of all other surface-markings, are characteristic features. It has

nearly the form of the European *B. trilobatus*, but with very different surface characters.

Formation and locality. From the shales of the Hamilton group at Norton's Landing, Cayuga lake, N. Y.

Bellerophon crenistria.

PLATE XXV, FIGS. 16-18.

Bellerophon crenistria, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 25. 1876.

Shell ovoid. Inner volutions small and gradually enlarging, partially exposed in the umbilicus; outer volution ventricose, somewhat rapidly and regularly expanding to near the aperture, where it is more abruptly spreading; rather broadly and abruptly sinuate in front; flattened or slightly concave on the dorsum, the flattened portion distinctly limited, and the margins often subcarinated by stronger longitudinal striæ. On each side of these limits the shell is usually more or less depressed, giving a subtrilobate aspect to the body-volution.

Surface marked by distinct revolving striæ which are regularly crenulated, producing a papillose aspect; the crenulations are arranged parallel to the lines of growth, curving forward from the umbilicus, and thence gently backward over the periphery; these lines are usually distinctly arched upon the flattened or concave dorsum.

This species is so conspicuously different from every other one in the formation under consideration that there are no features for comparison. The general aspect of the outer volution is subtrilobate, with the margins somewhat spreading and the front sinuate. The dorsal band is limited on each side by stronger single, or sometimes duplicate revolving striæ, presenting a slightly different aspect in the crenulations which are more oblique; two or three of the central striæ are sometimes apparently quite independent of the others in the arrangement of the crenulations. In different individuals the revolving striæ exhibit considerable variation; in some they are continuous with slightly nodulose elevations, and in others, distinctly pustulose—the prevailing character

being that of interrupted longitudinal striæ, with the intermediate spaces reaching the even surface of the shell.

Formation and localities. This species has thus far proved a rare form, though having rather a wide geographical distribution in the shales of the Hamilton group. It occurs near Summit, in Schoharie county; at Sherburne creek, in Chenango county; at Borodino, on Otisco lake; at Norton's Landing, on the east side of Cayuga lake; and at York, in Livingston county. With one exception, only a single specimen has been obtained at each of these localities.

SPECIES OF THE CHEMUNG GROUP.

BELLEROPHON TRILIRATUS.

PLATE XXIV, FIGS. 2, 16–19.

Bellerophon (Phragmostoma) tricarinata, HALL. Illustrations of Devonian Fossils: Gasteropoda, pl. 22. 1876.
Not *B. tricarinatus*, SHUMARD. 1858.

SHELL subhemispheric. Inner volutions comparatively small, the outer one extremely dilated, and in its normal condition very ventricose. Aperture greatly expanded, the peristome flattened and slightly repand, with a rather strong and moderately deep sinus in the anterior margin; auriculated posteriorly and nearly enclosing the volution in that direction.

SURFACE marked by distinct revolving striæ, which in the casts are indicated by sharp narrow grooves, with a flattened interspace of three or four times the width, the direction being often slightly undulating. Finer and less conspicuous striæ mark the entire surface and become more distinct towards the margin. The dorsal line is marked by a bicarinate band, which when well-preserved, shows a narrow depression of about one-sixteenth of an inch wide at the margin, and half that width at the columella, bounded on each side by a sharply defined line. On each side of this carina and equidistant from it, is an angular fold extending from the columella, from one-third to one-half the length of the expanded portion of the volution, and gradually becoming obsolete. The expansion is sometimes marked by three or four concentric wrinkles, having a regularity which might seem

to indicate specific value, but other well-marked specimens are destitute of this feature.

The interior characters are unknown, except as seen in a single specimen, which shows the inner volutions small, and the carina extending into the posterior part of the aperture.

The expanded outer volution has a width of one inch and three-fourths to two inches, with an antero-posterior diameter of one inch and a half to one and three-fourths. A single specimen has a width of two and a quarter inches.

In its revolving striæ this species bears some resemblance to *B. lyra*, which has stronger striæ and an elevated dorsal band, over which the concentric striæ are strongly arched. In general form it resembles *B. patulus* and *B. rudis*, but the volutions are less rotund and the outer one is marked by a bicarinate dorsal band and laterally by diverging angular ridges. These features, together with the fine, regular revolving striæ, sufficiently characterize the species among all the known forms of the rocks of New York.

Formation and locality. In the Chemung group, in the vicinity of Painted-Post, Steuben county, N. Y.

Bellerophon triliratus, juvenis ?

PLATE XXVI, FIGS. 15, 16.

Shell subtrilobate, gibbous, becoming ventricose towards the aperture; dorsum obtusely angular or with a rounded carina; dorso-lateral ridges distinctly angular and subcarinate. Umbilicus apparently not closed; peristome sinuate anteriorly.

The prominent subcarinate dorsum and strongly angular dorso-lateral margins, with concave intermediate spaces, are conspicuous features. The specimens are casts of the interior, and preserve no surface-markings.

All the typical forms of *B. triliratus* which I have seen are casts of the interior, or extremely macerated specimens, but still preserving some evidence of revolving or radiating striæ; while in these smaller shells there

is no evidence whatever of such striæ. I do not, however, at present find any sufficient reason for separating them from those figured on plate 24, in which the posterior part of the last volution is distinctly tricarinate.

Bellerophon Mæra.

PLATE XXV, FIGS. 9–14; AND PLATE XXVI, FIGS. 19–24.

Bellerophon Mœra, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 22. 1876.
" *Neleus*, H. & W. Illustrations of Devonian Fossils: Gasteropoda, pl. 22. 1876.
Not " " " Geol. Rep. U. S. Survey, 40th Parallel: Clarence King, Geologist (in MS.).

Shell subglobose, or broadly subovoid; length about equal to the greatest width at the aperture; in imperfect specimens the width is usually greater than the length. Inner volutions small and gradually enlarging to the third, which is more rapidly expanded, the exposed portion of the outer one being extremely ventricose. Aperture greatly expanded, the peristome broadly sinuate in front and auriculate at the sides; somewhat thickened and repand as it approaches the umbilicus, over which it extends, continuing in a thickened callosity across the columellar side.

The dorsum is marked by a distinct carina and the entire surface by strong pustulose striæ, or rows of pustules, which are arranged along lines parallel to the striæ of growth. The dorsal carina is also pustulose. These markings are somewhat less conspicuous on the anterior and lateral margins of the shell.

This fossil, when entire, presents a strong rotund form until near the aperture, where it becomes abruptly expanded. The shell is thick, and the surface completely studded with rows of pustules which, in one direction, are arranged in series parallel to the lines of growth in the shell, and, in the other direction, in diagonal lines crossing these, giving the aspect of a quincunx arrangement. On the removal of the shell the carina on the cast usually extends but a short distance from the margin of the aperture, and the dorsum beyond this is obtusely or obscurely angular. In a few examples, which present no marks of specific distinction, the carinate dorsum is continuous for the entire extent of the

exposed part of the volution. The casts are quite smooth and even, with the exception of the angular or subcarinate aspect of the dorsum upon a part of the outer volution.

The figures 9–14 of plate 25 are from gutta-percha impressions in molds of the exterior of the shell. A few individuals preserve a portion of the shell, sufficient to identify the surface-markings; but by far the larger number are casts of the interior, preserving some portion of the shell in a crystalline condition. The figures on plate 26 illustrate the species as it occurs in casts, and with the imperfectly preserved shell. A single example, of unusual size, has the exterior of the shell nearly removed by maceration and solution, but still preserving some of the surface-markings. The specimen, figure 19, plate 26, is one which has been subjected to maceration and a solution of the superficial portion of the shell, leaving a smooth surface, so far as the ordinary markings are concerned, but which has not quite the condition of a cast of the interior, though scarcely differing therefrom, except in the preservation of the dorsal carina. On the recurved portions of the volution some faint remains of pustules are visible, and another specimen in the same association is quite pustulose.

This species occurs in the central portion of the Chemung group somewhat rarely, but in the higher beds it is abundant at one or two localities. In its surface characters it is quite distinct from any other species in the formations under consideration, but resembles in a great degree the *B. tuberculatus* of Fer-ussac and d'Orbigny.*

Formation and localities. In the shaly beds of the Chemung group at Philipsburgh, Allegany county, N. Y., and in sandstone below the conglomerate near Mansfield and Tioga in Pennsylvania; at Howard in Steuben county, and abundantly at Nichols, Tioga county, N. Y.

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* *Bellerophon tuberculatus*, Ferussac & d'Orbigny. Monogr. Cephal., pl. 8, Figs. 7–10.
" " d'Archiac & de Verneuil. Rhenish Provinces, p. 353, pl. 28, Fig. 9.
" " Keyserling. Petchora-land, 262. Taf. 11, Fig. 5.
" " Geinitz. Grauwackenformation in Sachsen, Hft. ii, S. 44, Taf. 11, Fig. 12.
" " Sandberger. Schichtensystem in Nassau, S. 181, Taf. 22. Fig. 9, 9a, 9b.

Bellerophon nactus, n. sp.

PLATE XXVI, FIGS. 17, 18.

Shell below the medium size, ovoid, gibbous. Inner volutions small, the exterior portion of the last one regularly enlarging to near the aperture. Aperture moderately expanded; peristome auriculate at the postero-lateral margins, and partially curving around the open umbilicus. The dorsum with a sharp elevated carina.

Surface marked by fine concentric striæ, which in some parts are crowded in fascicles, curving gently over the sides of the shell and turned abruptly backward near the carina, in crossing which they make an acute retral angle. Obscure indications of revolving striæ appear upon some parts of the surface of the specimen, which is a partial cast.

This species is rare among the extensive collections made in this formation, and the few specimens observed are in a very unsatisfactory condition for illustration. The two examples figured, present much variation in form, the one having been compressed laterally, while the other, fig. 18, is of a larger size, obliquely compressed, and the surface striæ are less conspicuous.

Formation and locality. In the sandy shales of the Chemung group at Philipsburgh, N. Y., and on Keely creek, Tioga county, Pennsylvania.

Of the twenty-two species of Bellerophon, described in the preceding pages all are of the typical form of the genus; the only deviation worthy of notice being in *B. curvilineatus*, which is a remarkably compressed form. In the New York formations of Devonian age, there is not a single species of the type which I have termed Bucania; and the only one recorded as of this age is the *B. Devonica*, the relations of which may not have been satisfactorily determined. With this exception, so far as known to me, that genus is restricted to the Silurian and Cambrian formations of the country, a single species only being known in the Lower Helderberg group—the latest of these deposits. In the Niagara and Clinton groups six species are recorded, and another indicated

without specific name. From the Hudson river, Trenton and lower formations, nine species of BUCANIA have been described. At the same time about twenty species of BELLEROPHON proper have been described from all the formations below the Devonian.

The geographical distribution of the species herein described, appears, with few exceptions, to have been quite limited. *Bellerophon Pelops* occurs in Ohio as well as in New York. *B. patulus B. Leda* and *B. Lyra* have been found at the Falls of the Ohio in the same horizon which they occupy in the State of New York. *B. patulus* has also been found in the same horizon in Maryland and Virginia, in the arenaceous, calcareous and mud shales, and in the limestone of the formation, and probably occurs in the Hamilton group of Pennsylvania, having the widest distribution of any of the species, and being far more numerous in individuals than any other form.

Since the preceding pages were printed, I have received from Dr. JOHN S. NEWBERRY the originals of the species *Bellerophon propinquus* and *B. Newberryi*, for the purpose of comparison with the specimens in my possession. Among these are six individuals and several fragments of the latter species in various conditions of preservation. In the two larger individuals, one presents no evidence of dorsal band farther than in the one figured on plate 22, while in the other a faint indication of such character may be detected. Several of the smaller individuals show a distinct band on the posterior part of the outer volution, which, in some at least, becomes obsolete on the anterior expansion.

The transverse costæ become gradually obsolete on the sides of the shell, and merge into the ordinary striæ of growth before reaching the umbilicus. The same is also true of the anterior portion of the shell, which appears to be marked only by striæ of growth. In well-preserved specimens the transverse costæ are all cancellated by distinct, rounded, revolving striæ, which also become obsolete on the anterior portion of the last volution. When the last volution is fully preserved, the peristome is very abruptly expanded; the columellar lip is always more or less covered by a callus, either as represented in figure 16 of plate 22, or extending forward at the sides, as shown in *B.*

patulus, figure 22 of same plate, and in figure 6 of plate 24; but it is not pustulose in any specimen observed.

The shell is smaller than *B. patulus*, and, in the absence of the dorsal band, has much the same aspect as that species.

CYRTOLITES, Conrad.

Subgenus Cyrtonella.

Shells ovoid, trumpet-shaped. Volutions one or more in the same plane: apex minute, making about a single turn, and rapidly expanding beyond; peristome entire; dorsum angular or subcarinate. Surface sculptured.

The two following forms have the general character of the genus Cyrtolites, as described and illustrated by Mr. Conrad. They differ from all the described species, in the much more rapid expansion of the outer volution; but the direct or nearly direct transverse striæ in one species, the general surface ornamentation, and the essential absence of a sinus in the anterior margin of the peristome, are characteristics of the genus Cyrtolites. It is somewhat remarkable, however, that no species of the genus is known to occur in any of the formations between the Hudson River group and the Hamilton group, while the conditions of the Clinton, Niagara and Lower Helderberg groups would seem as favorable to their existence as the Hamilton. The recurrence of these forms, therefore, under such circumstances and after so long an interval, demands the most critical inquiry regarding their generic relations.

Cyrtolites (Cyrtonella) mitella.

PLATE XXV, FIGS. 23-28.

Cyrtolites? mitella, Hall.		Descriptions of New Species of Fossils, etc., p. 33. 1861.
" " "		Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 61. 1862.
" " "		Illustrations of Devonian Fossils: Gasteropoda, pl. 25, figs. 16–18 only. 1876.
" *pileolus*, "		Illustrations of Devonian Fossils: Gasteropoda, pl. 25, figs. 22–24. 1876.

Shell arcuate, subovoid, making altogether less than two volutions in the same plane; the first volution very minute; the body-whorl rapidly expanding to the aperture, which is nearly circular; the peristome scarcely spreading;

the shell carinate, and the casts obtusely but distinctly angular on the dorsum; apparently not sinuate or but slightly undulated on the anterior margin.

Surface marked by regular, sharply elevated, subparallel, transverse striæ, which are comparatively distant (at least twice or thrice their width) near the apex and on the upper part of the outer volution, but become more crowded towards the front of the shell. On the upper part and sides of the shell the intermediate spaces are regularly cancellated by short revolving striæ which hardly rise so high as the transverse ones, giving the entire surface a pitted or finely reticulate character, similar to that represented in fig. 28. Approaching the margin, the spaces between these striæ diminish, as the result of the rate of growth in the shell, and they often become so crowded as to present the character of simple undulating granulose lines of growth. These striæ are not sensibly curved in passing over the rounded carina. When the shell is partially exfoliated they give a lamellose-striate character to the surface.

The fossil is usually found in the condition of casts of the interior, which preserve some marks of the transverse striæ, but the exterior shell is rarely seen. The dorsum is decidedly carinate in one specimen where the shell is preserved, and the casts are always distinctly angular, and sometimes subcarinate, along the dorsal band. The transverse striæ are extremely irregular in their distance from each other, becoming crowded as the rate of growth is impeded. This condition gives to the reticulate character considerable variation in the size and proportion of the depressed spaces between the two sets of striæ. At the time of writing the original description I had not seen the entire shell-surface, and it was supposed to be without revolving striæ.

In comparison with specimens recognized as *C. pileolus*, the dorsum is more distinctly angular, and when entire is carinate, while in a single specimen of that species which retains the shell, or at least where the surface-markings are fairly preserved, the dorsum is angular but not absolutely carinate (see fig. 29 of plate 25). The specimen fig. 22 of the same plate is a cast of the interior, somewhat less laterally expanded than usual—erroneously represented as

regularly rounded upon the back, while it is obscurely angular along the dorsal line.

Notwithstanding the wide difference presented in the surface-markings of the two forms, as illustrated in figs. 28 and 29 of plate 25, I conceive it to be possible that the variations observed in the form, and the much greater variation in the surface sculpture, may be due to conditions of growth and to other causes operating upon the shell to develop one set of striæ in excess of the other, and to such a degree that one may become obsolete while the other predominates.

Formation and localities. In the calcareous layers of the Hamilton group at Pratt's Falls; in the coarser shales at Cazenovia in Madison county, and at Fultonham in Schoharie county, N. Y.

Cyrtolites (Cyrtonella) pileolus.

PLATE XXV, FIGS. 20-22, 29; AND PLATE XXVI, FIG. 25.

Cyrtolites pileolus,	Hall.		Descriptions of New Species of Fossils, etc., p. 33. 1861.
"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 61, pl. 6, figs. 10, 11. 1862.
"	*mitella*,	"	Illustrations of Devonian Fossils: Gasteropoda, pl. 25, figs. 13-15 (not 16-21). 1876.
Not "	*pileolus*,	"	Illustrations of Devonian Fossils: Gasteropoda, pl. 25, figs. 22-24.

Shell obliquely or arcuately subconical. Apex of the spire making a single slender volution, and rapidly spreading below; more or less distinctly carinate or angular on the back. Aperture nearly round, a little angular in front; peristome expanded, without apparent sinus, or with a slight depression in the anterior margin.

Surface marked by distinct, undulated revolving striæ, which become less conspicuous towards the aperture; obscure striæ of growth mark the surface transversely, and these become more distinct in the casts of the fossil and towards the margin.

In this species the sides of the volution are usually less abruptly expanded, and the dorsum is sometimes less distinctly angular (or subcarinate) than in the preceding species. The equal, undulating, revolving striæ constitute

a conspicuous difference between the two. In the casts, faint impressions of the revolving striæ are usually preserved.

The specimen figs. 20–22 is a cast of the interior, of remarkably rounded form, and showing a slight sinus on the left beneath the apex. The dorsum in fig. 22 is improperly represented as evenly convex, while there is a slight angularity visible in the specimen.

Formation and localities. In the coarse shales of the Hamilton group at Hamilton, and at Pratt's Falls in Madison county, N. Y.

PORCELLIA, Leveille.

Porcellia Hertzeri.

PLATE XVI, FIG. 24.

Porcellia Hertzeri, Hall. Illustrations of Devonian Fossils: Gasteropoda, pl. 16. 1876.

Shell discoid. Volutions about four, very gradually enlarging, the last one rounded on the back, becoming ventricose towards the somewhat obovate aperture; dorso-lateral margin subangular, nodose, and sloping thence to the ventral margin; umbilical depression broad and shallow; the dorsal margin preserving evidence of a deep sinus.

The finer surface-markings are unknown. The dorso-lateral margin is marked by distinct elongate nodes, and the sloping ventral sides preserve some remains of similar markings.

The only specimen of the species known to me has a length of about one inch and a quarter, with a width of one inch. It resembles in form the European *P. puzo*, but the elongate nodes of the dorso-lateral margin present a very characteristic distinction.

Formation and locality. In limestone of the Upper Helderberg group in Delaware, Ohio. The species has been communicated by Rev. Mr. Hertzer, of Louisville, Ky., formerly of Columbus, Ohio.

Porcellia Nais.

PLATE XVI. FIGS. 27, 28; AND PLATE XXVI, FIGS. 26-28.

Gyroceras Nais,	Hall.	Descriptions of New Species of Fossils, etc., p. 40.	1861.
"	"	" Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 68.	1862.
Porcellia	"	" Ib., Explanations pl. 6, figs. 5 and 6.	
Porcellia	"	" Illustrations of Devonian Fossils: Gasteropoda, pl. 16.	1876.

Shell consisting of about four volutions, which are somewhat rapidly expanded from the apex towards the aperture; volutions subangular and nodose on the sides, and rounded on the back; the dorsum a little elevated on each side of the mesial band; the ventral side sloping abruptly into the umbilical depression. The aperture has probably been somewhat broadly subreniform.

Surface of the umbilical slopes of the volution marked by strong, rounded, transverse striæ, which are sometimes bifurcated toward the side of the shell, and are crossed by revolving lines, giving it an undulated or subnodose aspect. The back of the shell, in a partial cast, is conspicuously marked by flattened revolving bands, which are crossed by less strong transverse striæ. The dorsum is marked by a narrow depressed band, on which the striæ make an abrupt retral bend, indicating the sinuosity in the margin of the aperture. About half-way from the dorsal line to the angular side of the volution, commence low elevations which become strong oblique ridges or elongate nodes, limited by the angular margin, and not passing to the ventral region nor marking the umbilical slope of the volutions.

The larger specimen, which is figured on plate 16, preserves about one volution and a half; it is imperfect towards the aperture, and the inner volutions are broken away. It has a diameter of about two inches.

A fragment, consisting of nearly three of the inner volutions, while preserving the general features already noticed, shows the dorsal side and umbilical slopes of the volutions to be cancellated by distinct elevated equal striæ, which are conspicuously nodulose at their crossing; it also shows that the entire shell consists of at least four volutions.

This is a strongly marked species, and readily distinguished from any other at present known in these formations. It is extremely rare, since, up to the present time, but two individuals are known.

Formation and localities. In the shales of the lower part of the Chemung group in Chemung county; and near Ithaca, N. Y.

The two species of BELLEROPHON, *B. obsoletus* and *B. repertus*, having been omitted from the preceding descriptions, are inserted in this place.

BELLEROPHON REPERTUS, n. sp.

PLATE XXVI, FIG. 9.

SHELL subglobose, rounded upon the dorsum, and regularly depressed into the umbilicus. Transverse section of one volution subcircular. Body-whorl ventricose and gradually expanding. Aperture apparently not expanding beyond the regular enlargement of the body-whorl.

SURFACE cancellated by fine, regular, revolving and transverse striæ. The transverse striæ curve slightly backward over the dorsum into the mesial band. Dorsal band narrow, depressed, well-defined, and crossed by the concentric striæ which form a distinct sinus. The species is distinguished by its regular striate surface, and the narrow depressed mesial band.

Formation and locality. Hamilton group, shore of Cayuga lake.

BELLEROPHON OBSOLETUS, n. sp.

PLATE XXV, FIG. 15.

SHELL short, broadly subovate or globose, ventricose. Body-whorl regularly expanding.

SURFACE marked by obscure, lamellose, concentric striæ, which make a broad retral curve over the dorsum. The only specimen observed is imperfect, and preserved as a natural mould in the rock. Its form and surface striæ differ conspicuously from the other forms of the genus here indicated.

Formation and locality. From the calcareous sandstone of the Chemung group at Nichols, N. Y.

ADDENDA TO THE GASTEROPODA.

DESCRIPTIONS OF SOME NEW FORMS, AND NOTICES OF OTHERS PREVIOUSLY KNOWN.

Since the commencement of this volume, additional information has been obtained regarding some of the species described, and a few new forms have been added to the Collection. The illustrations have been made as complete as the material available at the time would permit; but each new accession indicates the occurrence of forms not yet known or described. Much of this material is too imperfect for satisfactory determination, and farther collections are required for their study and proper arrangement. The great variation in form and other characters among the Platyceridæ will always render their determination a matter of great difficulty, and many specimens must be left in uncertainty. A comparison of larger collections may result in showing that some of the forms which I have distinguished can be merged, for the lines of specific separation are not strongly marked, and these often become less striking and of less importance when compared among extensive collections of individuals.

The great variability of form and character among those designated as species has its maximum expression in the genus PLATYCERAS, and continues as a marked feature in PLATYOSTOMA, which, in some species, is scarcely separable from the former genus by any persistent characters. This variable or erratic character is still manifested in the species of STROPHOSTYLUS, where it is reduced to its minimum expression.

In the higher groups the means of specific determination are better marked, but among these, so large a proportion of specimens is in the condition of casts of the interior that the determination often becomes very difficult and unsatisfactory. This is essentially true of nearly all the species in the Schoharie grit, and to a considerable extent among those of the limestones above. In this condition, many specimens are left undetermined and unillustrated, such only among them having been selected as seemed important in

giving expresssion to this class of fossils as they occur in these rocks. Since, however, this is the ordinary if not universal condition of some of the species, we have no other means of illustrating the fauna, nor the student of designating the species than from the casts; and by those alone are the formations sometimes to be distinguished.*

The following species of LOXONEMA, illustrated upon plate 28, appear to be quite distinct from those described in the preceding pages.

LOXONEMA RECTISTRIATUM, n. sp.

PLATE XXVIII, FIG. 9.

SHELL elongate terete. Volutions probably twelve or more in number, moderately convex, very gradually increasing in size, the last one being scarcely more ventricose than the preceding; each volution is distinctly contracted a little below the close suture, and then expanding gives the greatest convexity near the lower third. Suture-line close. Aperture ovate, with the columella extending below.

SURFACE marked by slender, gently curving longitudinal striæ, which bend backward from the suture to the bottom of the constriction, and then continue to the base of the volution—those of the last one curving gently forward to the columellar lip. The spaces between the striæ are from once and a half to twice the width of the ridges.

This species may be distinguished from any other described in this volume by the finer longitudinal striæ, which are scarcely curved on the body of the volution, and also by the constriction of each volution just below the suture-line. The striæ are stronger on the upper volutions, gradually becoming finer and less prominent on the lower ones, though continuing distinct throughout. The specimen figured, which preserves about eight of the lower volutions, measures a little more than one inch in length.

* Where the specimens occur in the condition of casts only, the difficulties of determining the genera LOXONEMA and MURCHISONIA are often insurmountable; and among PLATYCERAS, CYCLONEMA, PLEUROTOMARIA and CALLONEMA, the forms are so nearly alike that the casts offer few characters for generic determination.

Formation and locality. In limestone above the hydraulic beds, of the age of the Hamilton group, at the Falls of the Ohio.

This and the *L. lævіusculum* have been communicated by Dr. JAMES KNAPP, of Louisville, Ky.

LOXONEMA LÆVIUSCULUM, n. sp.

PLATE XXVIII, FIGS. 10, 11.

SHELL elongate, subulate. Volutions about twelve in the entire shell, rounded and somewhat rapidly expanding to the last one, which is moderately ventricose. Suture close and simple. Aperture ovate, the columellar lip much extended below.

SURFACE nearly smooth or marked by faint obsolescent striæ, which are moderately curved over the convexity of the volution, and become fasciculate on the lower side of the last one as they approach the columellar lip.

This species has the general aspect of *L. Hamiltoniæ*, but it is less rapidly tapering towards the apex, the volutions somewhat less convex, and the last one not so ventricose as in well-preserved specimens of that species. Usually the specimens have the appearance of being worn and macerated, and the general absence of striæ upon the surface may be due in part to this cause; but they are associated upon the same surface with *L. hydraulicum*, which, in similar conditions, has retained its surface-striæ in good preservation. This species is readily distinguished from *L. hydraulicum* by the less rounded volutions and slighter constriction at the suture. It is more rapidly tapering than *L. rectistriatum*, with which it is associated, and has no constriction of the upper part of the volution as in that species.

A specimen preserving nine volutions, including the last one, measures about one inch and a quarter.

Formation and locality. In limestone above the hydraulic beds, of the age of the Hamilton group, at the Falls of the Ohio.

Loxonema breviculum, n. sp.

PLATE XXVIII, FIG. 12.

Shell somewhat abruptly turretiform. Volutions about five or six, moderately convex, somewhat rapidly expanding near the apex, and more gradually below—the last volution scarcely more ventricose than the preceding. Aperture broadly subelliptical.

Surface unknown.

The specimen figured presents a longitudinal section of the volutions, the opposite side having the shell crystalline and exfoliated, but preserving some obscure indications of strong longitudinal curving striæ. From these characters, and its general form and association, it is referred to the genus Loxonema.

Formation and locality. In calcareous concretions in the shales of the Hamilton group at Hamburgh, on the shore of Lake Erie.

Loxonema postremum, n. sp.

PLATE XXVIII, FIG. 13.

Shell short subfusiform. Volutions about six, moderately convex, the upper ones closely arranged and gradually increasing in size, the last one slightly ventricose and extremely elongated, its length being greater than the entire spire above. Aperture elongate subelliptical, narrowed above.

Surface marked by strong, scarcely curving longitudinal striæ, which are faintly visible on the last volution in casts of the interior.

This species is conspicuously distinct from every other in the formations under consideration in the short compact spire, and in the extreme length of the last volution. The shell is crystalline and inseparable from the matrix, so that we are able to obtain only casts of the interior. It is associated with *Loxonema laxum* and *Bellerophon Mæra.*

Formation and locality. In some compact semicalcareous beds in the upper part of the Chemung group, at Nichols, Tioga county, N. Y.

TROCHUS, Linnæus.

Palæotrochus, n. subgen.

Shell conical, trochiform. Spire elevated. Volutions moderately convex. Aperture transverse: columella?

Palæotrochus Kearneyi.

PLATE XXX, FIG. 14.

Pleurotomaria Kearneyi, Hall. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 105. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 163, f. 14. 1862.

Shell large, trochiform. Spire obtusely conical, comparatively short, consisting of four or more volutions, which rapidly increase in size from the apex, the last one much expanded. Suture apparently canaliculate from a carinate expansion of the preceding volution. The last volution is flattened or slightly concave on the upper third, and prominent above the middle along a line of obscure or undeveloped nodes; flattened on the lower half, which is separated from the base by a strong, simple, angular carina; basal side of the volution prominent in the middle, depressed towards the umbilical region. Aperture transverse, somewhat semi-elliptical, nearly once and a half as wide as high.

Surface marked by strong unequal striæ of growth, which bend backward from the suture to the more prominent part of the volution, in crossing which they curve a little forward but do not become vertical, and again bend more abruptly backward in approaching the carina, over which they pass without sensible change in direction, curving forward on the middle of the lower side, and thence backward to the umbilicus.

This shell attains the dimensions of more than three inches in height; the one figured is a little more than three inches in diameter on the base: some individuals attain a greater size. So far as known, the surface is marked only

by striæ of growth which are crowded into fascicles, and often become strong ridges near the suture-line and on the lower part of the outer volution. The prominent portion of the volution, about one-third below the suture, is irregularly and obscurely marked by a series of undefined oblique nodes. The carina above the suture-line is a conspicuous feature in well-preserved specimens (the one figured has been exfoliated in the upper part), and is continued on the outer volution as represented in the figure.

This fossil, originally described as a PLEUROTOMARIA, has the general form of *Pleurotomaria subconica*, HALL, of the Lower Silurian rocks; but a critical examination shows that it does not possess the peripheral band which is characteristic of that genus. The apparent band is simply a projecting ridge, over which the striæ are curved in the same manner as over other inequalities of the surface on the upper part of the last volution. The surface striæ, moreover, are of different character, being striæ of growth crowded into fascicles, and producing an unevenly ridged surface. Having no cancellating revolving striæ, it wants, in this respect, a common element in the surface of PLEUROTOMARIA. The aperture is transversely suboval, and there is no columella extending below, nor an open umbilicus. The aperture, form and general aspect of the shell indicate its relations with the Trochidæ; and I see no good reasons why it may not be embraced in the Linnean genus TROCHUS. I have therefore proposed for it the above subgeneric name.

Formation and locality. In limestone of the age of the Upper Helderberg group, near Sandusky, Ohio.

The casts of this species bear considerable resemblance to *Pleurotomaria Griffithii*, of McCOY, which is described as "acutely conical; whorls flat; a single, very prominent square keel in the middle of the body-whorl, but continued along the base of the spiral whorls close to the suture." The surface-markings are not described or represented in the figure, which is from a cast of the interior. The general form of the fossil, the strong peripheral keel and other features, render it very probable that it is generically identical with the *P. Kearneyi*, while some of its characters seem incompatible with PLEUROTOMARIA.

TURBO, Linnæus.

Turbo Shumardii.

PLATE XXIX, FIGS. 1-4.

Turbo Shumardii, de Verneuil. Bulletin de la Soc. Geol. de France.

Shell gibbous, subglobose. Spire moderately elevated, apex minute; volutions about five or six, gradually enlarging in the earlier stages of growth, and the last one becoming extremely ventricose, with a broadly expanded aperture: the earlier volutions are smooth and regularly rounded upon the exposed surfaces, gradually becoming nodose and flattened or somewhat concave upon the upper side, the nodes increasing in size and strength with the increase of the volutions. Suture close in the earlier volutions, and becoming somewhat canaliculate in the later ones. Lower side of the outer volution very convex, even in the umbilical region, and much extended in the direction of the columella. Aperture broadly rounded or somewhat obscurely pentahedral: columellar lip obtuse, thickened, having a distinct broad opercular groove; callus covering the umbilicus and spreading outwardly; external margin of the aperture thin.

Surface marked by fine, comparatively even striæ of growth, which are often crowded in fascicles, and in old shells are somewhat imbricated at irregular intervals. Periphery of the outer volution with a strongly elevated obtusely angular carina, which is continued from the suture-line at the inner posterior angle of the aperture. The outer one or two of the volutions (depending on the size of the shell), marked by strong curving nodes, which, commencing just below the suture, are nearly vertical for a short distance, and then curving forward are finally directed towards the aperture, and gradually become merged in the general surface.*

* This feature is not constant. In some specimens the nodes, after turning forward, are continued vertically in a low elevation till they invade the peripheral carina, giving it a subnodose character, as seen in the lateral view of the larger specimen on plate 29. In the older shells the carina becomes subdued and rounded in outline.

The striæ, originating at the suture, are first directed backward, and thence, gently curving over the nodes, become nearly vertical and thus continue to near the peripheral carina, where they are turned a little backward, and, passing this elevation, they are directed with a slight curve towards the columella.

This fossil possesses all the characteristic features of the Linnæan genus TURBO, to which it was originally referred by M. DE VERNEUIL, who described and named it in honor of the late Prof. B. F. SHUMARD of St. Louis. It differs so essentially from any other fossil of the Upper Helderberg formation, that there are no other forms for comparison. In many of its features it reminds one of the recent *Turbo heteroclita*, but it is more rotund and the columellar lip is solid and more extended. In its external characters it presents some interesting resemblances to *Palæotrochus Kearneyi*. The surface striæ are in all respects similar to those of that fossil, and their curvature is made in precisely the same manner. The peripheral carina is almost identical in character, except where it may be invaded by the nodes from above. The range of nodes in the TURBO is represented by the obscure elevations in similar position on the TROCHUS. In the general form of the shell, aperture and columella, there are no points for comparison.

This beautiful fossil, having never been redescribed in America, has been nearly lost sight of, and I believe the name is scarcely or not at all known in our catalogues of fossils. The shell is usually silicified, and is rarely well preserved, though a few good specimens are known. It is nevertheless not rare, as is shown by numerous casts of the interior occurring in some of the western localities. The individuals illustrated are from the cabinet of Dr. JAMES KNAPP, of Louisville, and are the best specimens known to me. An imperfect specimen of large size exists in the collections of New York State Museum.

It is worthy of notice that, among all the American fossils, there has not been found in the older rocks so complete representation of the genera TURBO and TROCHUS as in these examples, both of which occur in the same formation.

Formation and localities. In limestone of the age of the Upper Helderberg group at the Falls of the Ohio, and at other places in Indiana and Kentucky. Some of the larger casts of Gasteropoda, occurring in the same formation in New York and Ohio, are probably of this species.

NOTE ON EUOMPHALUS DECEWI.

On page 56 reference has been made to a specimen of this species, communicated by Dr. ROMINGER, which is illustrated on plate 27, figures 1, 2 and 3. The specimen has been covered on the lower side by an overgrowth of STROMATOPORA, and the mouth is filled by the same parasitic growth which had overlapped the upper and inner side of the volution near the aperture. Besides this enveloping body, the upper and lateral portions of a part of the outer volution have been covered by a Bryozoan which has left its markings, and partially its substance, as shown in the figures. The removal of the STROMATOPORA from the lower side has destroyed the markings of the shell, except upon a small portion of the surface, as seen in figure 2. The shell has been somewhat compressed in a vertical direction; otherwise, it preserves its proper proportions. In consequence of this vertical compression, the baso-lateral angle has been expanded into a kind of projecting carina, as shown in figures 2 and 3.

This shell presents characters not before suspected from an examination of the casts, which is the only condition in which the fossil was for a long time known. Recently the surface markings of the upper side have been illustrated in figures given in the reports of the *Geological Survey of Ohio: Palæontology*, vol. 1, plates 19 and 20. While possessing the form and general features of EUOMPHALUS, this fossil presents an aperture of peculiar character, being broadly expanded, and somewhat quadrangular on the lower side, and triangular as seen directly in front. The upper margin is sharply sinuate, making a deep retral angle which meets a strong peripheral band, as in PLEUROTOMARIA; but instead of being on the side of the volution, as in that genus, it is upon the summit: in all other respects the characters of the band are the same. This feature is not altogether properly represented in the figure. The appearance

of the fossil is that of a flattened PLEUROTOMARIA,—the upper side of the volutions being depressed towards the spire.

These characters of mouth and peripheral band are scarcely compatible with those of the genus EUOMPHALUS, as understood from descriptions, or as usually represented in the figures of the typical form of the genus. The *Euomphalus Wahlenbergii* of GOLDFUSS possesses the peripheral band and all the essential characters of our species, and is clearly congeneric with it.

CHENU, in his description of the genus, recognizes a more or less deep sinuosity in the external lip, and the presence of a peripheral band; and Prof. MCCOY suggests the necessity of subdividing the genus, and separating those "with rounded whorls and a circular, entire mouth," from those with angular volutions and "a slit in the outer lip, as in SCHIZOSTOMA."

If the features described and illustrated in the species under consideration are characteristic of the typical form of the genus EUOMPHALUS, then it seems proper that it should be referred to the family Pleurotomariidæ; otherwise, this fossil should be designated as a new generic form, for which I would propose the name PLEURONOTUS, with the following diagnosis:

PLEURONOTUS, N. GEN.

SHELL discoid. Volutions slightly oblique to the plane of the shell, gradually enlarging from a minute apex; concave above and below. Umbilical side broad, and the depression shallow; spire concave; external lip with a distinct sinus. Surface, on the summit, and partially on the external side of the volution, marked by a distinct band, to the margins of which the surface-striæ converge on the two sides, and upon which they make a regular retral curve.

The relations of this fossil (*E. Decewi*) with PLEUROTOMARIA are quite obvious; but unfortunately I have not at this time the means of comparing authentic Carboniferous forms of EUOMPHALUS with the specimen under consideration; and therefore I must leave undecided for the present, its positive relations to that group of fossils.

THE LOUISVILLE LIMESTONES.

NOTE ON THE HYDRAULIC BEDS AND ASSOCIATED LIMESTONES AT THE FALLS OF THE OHIO.

At the Falls of the Ohio and adjacent localities, the lowest beds of the limestone formation are marked by the presence of *Halysites catenulatus*, and for a long time have been locally known as the "Catenipora beds." This Silurian limestone is succeeded by the great coral-bearing Devonian limestone, which is everywhere, in that part of the country, a well defined geological horizon; and though the higher beds of the formation are distinguished by the presence of other fossils than corals, there is no marked physical change from the base to the upper stratum which is characterized by *Spirifera acuminata*. The whole is more generally recognized by its numerous corals, and the genera FAVOSITES, MICHELINIA, ZAPHRENTIS, HELIOPHYLLUM and CYSTIPHYLLUM are prevailing forms.* This limestone is succeeded by beds of an argillaceous magnesian limestone, known as the "Hydraulic limestone," which gradually merges above into thin, slaty beds, some of which are highly siliceous, and these are followed by what is known as the "Encrinal limestone;" the whole terminated above by the black slate. This entire limestone formation above the "Catenipora beds" has been generally, if not universally, recognized as of the age and the western extension of the Upper Helderberg group of New York (representing all that was originally included by EATON under the designation of Corniferous limestone and Schoharie grit). I have accepted and advocated this view of the age of these formations, which seemed to be sustained by large numbers of identical fossils from the two distant regions; and I believe that their relative age has not, up to the present time, been called in question.

As might naturally be expected, the subdivisions recognized in the east and in the west do not always coincide, but it is usually quite possible to correlate these different members by a comparison of their fossil contents. The main

* It was from the presence, in this locality, of numerous species of Corals, identical with those of the New York formations, that, in 1841, I recognized these limestones as of the same age.

limestone (the great coral reef, comprising the Onondaga and Corniferous limestones of the New York system) seems to have been originally unbroken, at least from the valley of the Hudson nearly and perhaps quite to the line of the present valley of the Mississippi. It is traceable in unbroken continuance from the Hudson to the Niagara rivers, and through Canada west to Lake Huron, and thence into Michigan; while in a southwesterly direction are the outcrops on the two sides of the Cincinnati axis, extending through Ohio and Indiana, and thence into Kentucky, where it gradually thins out. During the formation of this remarkably extensive coral reef, there could have been no great change in the conditions of the ocean; for not only do these corals indicate an undisturbed and luxuriant growth, but the same genera and the same species prevail over a large part of the above area. It is only in the superjacent beds that we may look for changed conditions, which have given origin to the different terms used to designate the subdivisions of the formation in different parts of the country.

In New York we have the following members of the series, between the Marcellus shale and Oriskany sandstone:

	1. Marcellus shale.	
Upper Helderberg group.	2. Limestone with Ichthyic remains (bone bed).	The Corniferous limestone of Eaton.*
	3. Cherty beds, with species of Loxonema, Pleurotomaria, Bellerophon, etc. .	
	4. Corniferous limestone	
	5. Onondaga limestone (the great coral-bearing limestone)	
	6. Schoharie grit.	
	7. Oriskany sandstone.	

* In the arrangement of Prof. Eaton, all the limestone formation between the Schoharie grit and Marcellus shale was termed "Corniferous limestone"—no subdivisions being recognized. In the reports on the Geological Survey of New York, the subdivision into Onondaga and Corniferous limestones was made for the convenience of reference, and on account of the character of the prevailing fossils in the two members. Farther investigation has shown the existence of a peculiar Cherty bed containing characteristic fossils, and also a Calcareous bed with remains of fishes; both of which are distinct from the Onondaga and Corniferous

In the State of Ohio, Dr. NEWBERRY recognizes the following:

Hamilton shale.
Hamilton limestone.
Corniferous group. { Sandusky limestone.
Delhi bed.
Columbus limestone.

In 1847, Messrs. YANDELL and SHUMARD published the following table of formations at the Falls of the Ohio, as determined by Dr. CLAPP of New Albany:

Upper limestone. { Subcrystalline limestone, ... 8 feet.
Water limestone, ... 12 feet, =20 feet.

Shell limestone. { Subcrystalline limestone, with many characteristic shells and trilobites, and a few corals, ... 16 feet.

Coralline limestone. { Upper Coralline, to Catenipora [beds], composed mostly of corals, and destitute of shells . . . 20 feet.
Lower Coralline—corals mostly different from those above, and very few shells; the upper part alone visible on the Falls, 20 feet, = 40 feet.

They also describe these several beds, giving certain fossils in each as determined by them. They recognize the lower beds as equivalent to the Niagara group of New York, and cite several species of fossils as identical with the New York forms. The beds above, with their fossil contents, are treated in some detail, and the waterlime is described as resting on the Pentremital stratum, bearing *Pentremites* (= *Olivanites* = *Nucleocrinus*) *Verneuili*. The waterlime is represented as covered by a siliceous bed containing CHONETES, LOXONEMA, "a small Orthoceratite," etc., and immediately above this comes a

beds below, but neither of them, apparently, co-extensive with these lower members of the series. The characteristic fossils of the Corniferous or Onondaga limestones do not occur in either of these higher members. It is true, that the extent and value of these beds have not been determined; but they represent the deposits and the fauna of a changed condition of the ocean bed supervening the coral-growing period, and are entitled to recognition in any critical subdivision of the series.

granular limestone which contains numerous species of ENCRINITES and a few corals and shells. [From these, and from other observations of earlier and later date, the limestones of the Falls of the Ohio have been considered the equivalent of the Corniferous limestone (= Onondaga and Corniferous limestones), and generally of the limestones of the Upper Helderberg group of New York.]

These authors recognize the black slate, above the limestone of the Falls, as having a thickness of 104 feet.

At a later period Major SIDNEY S. LYON published a table of the "*Stratigraphical Arrangement of the Rocks of Kentucky*," in which he gives the following table of the beds at the Falls of the Ohio and vicinity:

q Black slate [= Genesee slate].	*u* Nucleocrinus bed.
r Encrinital limestone.*	*v* Turbo bed.
s Hydraulic limestone.	*w* Coral beds.
t Spirifer bed.	*x* Catenipora beds [= Niagara formation].

The beds from *r* to *w* inclusive have been regarded, I believe, by all geologists as the equivalent of the Upper Helderberg limestones of New York; and without critical examination of rocks in place, or a careful comparison of the fossils contained in the several beds, I have heretofore accepted this determination, and aided in the dissemination of this opinion.

This view seems in fact to have been unavoidable, since the fossils from the limestones at the Falls of the Ohio have been collected and widely distributed throughout the country without reference to the successive beds of the formation from which they had been obtained. More recently my attention has been called to the vertical distribution of the species in these rocks, and during the printing of the earlier pages of this volume, I became doubtful of the real identity of the higher beds with the New York limestones; and in considering the numerous species of characteristic Hamilton fossils which

* In this table, the thin-bedded or slaty siliceous limestone, with CHONETES and many other fossils, is not distinctly recognized, although it is really an important member.

they contain, I became satisfied that there was room for farther inquiry and comparison.

In the month of August of the present year (1877), during a low stage of the water in the river, I had an opportunity of examining the waterlime and superincumbent beds, as well as the coral-bearing beds beneath.

A considerable portion of the waterlime beds consists of an argillaceo-magnesian limestone, destitute of organic remains. The upper part contains many specimens of *Spirifera euruteines*, and the thinly-bedded, slaty and siliceous strata above it are charged with numerous fossil species, the most abundant of which is the *Chonetes Yandellana;* but many other known forms occur, and the entire facies, when critically viewed, presents the general aspect of the fauna of the Hamilton group. The encrinital bed above these thin layers contains numerous Crinoidea, all of which are congeneric with Hamilton forms, and many of the species are identical with those known in that horizon in the State of New York.

The following tabulated list of species from the Devonian limestones at the Falls of the Ohio, though incomplete, will serve for a comparison with the Upper Helderberg and Hamilton groups of New York. The species indicated in the first column are known species of the Upper Helderberg limestones of New York,* and occur at the Falls of the Ohio in beds *t*, *u*, *v* and *w* of Major Lyon's series (p. 142). All the species which pass upward into the succeeding hydraulic and encrinital limestones are likewise known to pass from the limestones below into the Hamilton group in the State of New York. A considerable number of species occur in the Louisville upper limestones which are not known in the Hamilton group of New York; but these are largely among the Crinoidea, where there has been no opportunity for a critical comparison of specimens. The corals, with a single exception, are omitted from the list, since they are almost in all respects identical with those of the Upper Helderberg limestone of New York, and their mention is quite unnecessary for the present purpose.

* *Pleurotomaria imitator*, *Turbo Shumardii* and *Dalmanites Calypso* have not yet been observed in this formation in the State of New York.

LIST OF DEVONIAN FOSSILS OCCURRING AT THE FALLS OF THE OHIO.

SPECIES.	Upper Helderberg Gr'p.	Hydraulic & Encrinal Limestones.	Hamilton Group, N.Y.	Chemung Group, N.Y.
CORALS.				
Michelinia stylopora	.	*	*	.
CRINOIDEA.				
Actinocrinus eucharis	.	*	*	.
A. Kentuckensis	.	*	.	.
A. multicornis	*	.	.	.
A. pentaspina	*	.	.	.
A. Cassedayi	.	*	.	.
Megistocrinus abnormis	.	*	.	.
M. depressus	.	*	*	.
M. Knappi	*	.	.	.
M. Ontario	.	*	*	.
M. rugosus	.	*	.	.
M. spinosulus	*	.	.	.
M. plenissimus	.	*	.	.
Dolatocrinus glyptus	.	*	*	.
D. lacus	.	*	.	.
D. sculptilis	.	*	*	.
D. Marshi	*	.	.	.
Cyathocrinus lævieulus	.	*	.	.
C. sculptus	.	*	.	.
C. Wortheni	.	*	.	.
C. valens	.	*	.	.
Rhodocrinus Halli	.	*	.	.
Potereocrinus cylindricus	*	.	.	.
P. simplex	*	.	.	.
Platycrinus Leai	.	*	.	.
Codaster alternatus, representing C. pyramidatus	*	.	.	.
Nucleocrinus angularis, representing N. Lucina	.	*	.	.
N. Verneuili	*	.	.	.
N. elegans	.	?	*	.
Elentherocrinus Cassedayi, representing E. Whitfieldi	.	*	*	.
Ancyrocrinus spinosus	*	.	.	.
A. bulbosus	.	*	*	.
BRACHIOPODA.				
Discina grandis	.	*	*	.
Orthis Vanuxemi, or its equivalent	.	*	*	.
O. Livia	*	.	.	.
Strophodonta inequistriata	*	*	*	.
S. demissa	*	*	*	*
S. hemispherica	*	.	.	.
S. perplana	*	*	*	*
Strophomena rhomboidalis	*	.	.	.
Chonetes Yandellana, representing C. scitula	.	*	?	.
C. acutiradiata	*	.	.	.
Productella subaculeata, var. cataracta.	.	*	.	.
Spirifera euruteines	.	*	.	.
S. fimbriata	*	*	*	.
S. medialis	.	*	*	.
S. Oweni, representing S. granulifera	.	*	.	.
S. varicosa	.	*	*	.
S. segmenta	.	*	*	.
S. acuminata	*	.	.	.
S. arctisegmenta	*	.	.	.
S. duodenaria	*	.	.	.
S. gregaria	*	.	.	.
S. raricosta	*	.	.	.

LIST OF DEVONIAN FOSSILS, Etc. (Continued).

SPECIES.	Upper Helderberg Gr'p.	Hydraulic & Encrinal Limestones.	Hamilton Group, N.Y.	Chemung Group, N.Y.
BRACHIOPODA (Continued).				
Amboccelia umbonata	.	*	*	.
Cyrtina Hamiltonensis	*	*	*	*
C. crassa	*	.	.	.
Trematospira hirsuta	.	*	*	.
Nucleospira concinna	*	*	*	.
Athyris spiriferoides	*	*	*	.
A. vittata, representing A. Cora	.	*	.	.
Meristella nasuta	*	.	.	.
M. (Pentagonia) unisulcata	*	.	.	.
Atrypa reticularis, and varieties	*	*	*	*
A. aspera	.	*	*	.
Rhynchonella Tethys	*	.	.	.
R. Sappho	.	*	*	.
Pentamerella arata	*	.	.	.
P. papilionensis	.	*	*	.
Terebratula harmonia	.	*	*	.
Cryptonella rectirostra	.	*	*	.
C. lens	.	*	*	.
Tropidoleptus carinatus	.	*	*	.
LAMELLIBRANCHIATA.				
Pterinea flabellum	.	*	*	*
Limoptera cancellata, v. occidens	.	*	*	.
Aviculopecten pecteniformis	*	*	*	.
A. princeps	.	*	*	.
A. parilis	.	*	*	.
A. crassicostata, representing a Hamilton form	.	*	.	.
Nuculites triqueter	.	*	*	.
Nucula Neda = N. bellastriata var	.	*	.	.
N. Niotica	.	*	.	.
Modiomorpha concentrica	.	*	*	.
Cypricardinia inflata	.	*	*	.
C.? cylindrica	.	*	.	.
Yoldia? valvulus	.	*	.	.
Tellinomya subnasuta	.	*	.	.
Ptychodesma Knappianum	.	*	.	.
Grammysia secunda, v. gibbosa	.	*	*	.
Lucina (Paracyclas) elliptica	*	.	.	.
L. P. lirata	.	*	*	.
Cardiopsis crassicosta, representing P. robusta	*	*	.	.
Conocardium trigonale	.	.	.	.
GASTEROPODA.				
Platyceras conicum	*	*	*	.
P. cristatum, n. sp. near P. carinatum	.	*	.	.
P. bucculentum	.	*	*	.
P. rictum	*	*	*	.
P. dumosum	*	.	.	.
P. dumosum, v. rarispinum	*	.	.	.
p. fornicatum	*	*	*	.
P. symmetricum	*	*	*	.
Platyostoma lineatum	*	*	*	*
Trochonema emaceratum	.	*	.	.
T. Yandellanum	.	*	.	.
T. rectilatera	.	*	.	.
Pleurotomaria sulcomarginata	.	*	*	.
P. Estella, representing P. Itys	.	*	.	.
P. Lucina	*	*	*	.

LIST OF DEVONIAN FOSSILS, Etc. (Continued).

SPECIES.	Upper Helderberg Gr'p.	Hydraulic & Encrinal Limestones.	Hamilton Group, N.Y.	Chemung Group, N.Y.
GASTEROPODA (Continued).				
Pleurotomaria imitator	*	.	.	.
Loxonema hydraulicum	.	*	.	.
L. rectistriatum	.	*	.	.
L. lævisculum	.	*	.	.
Naticopsis lævis	*	.	.	.
Turbo Shumardii	*	.	.	.
Bellerophon Lyra	.	*	*	.
B. Leda	.	*	*	.
B. patulus	.	*	*	.
PTEROPODA.				
Coleoprion tenuicinctum[1]	.	*	*	.
CEPHALOPODA.				
Gomphoceras turbiniforme	.	*	.	.
Goniatites discoideus, v. Ohiensis	.	*	*	.
CRUSTACEA.				
Phacops bufo, v. rana	.	*	*	.
Dalmanites myrmecophorus	*	.	.	.
D. anchiops	*	.	.	.
D. Ægeria	*	.	.	.
D. Helena	*	.	.	.
D. selenurus	*	.	.	.
D. Calypso	*	.	.	.
D. Pleione, representing D. Boothi	.	*	.	.
Proetus crassimarginatus	*	.	.	.
P. canaliculatus	*	.	.	.

The above list of fossils is far from being complete; but at the present time we have not the means of perfecting it. When once the facts are recognized, and the position of these beds acknowledged, they will be studied as a distinct formation, and the fossils separated from those of the beds below, with which they have hitherto been confounded.

It should be remembered that the facts above stated, and the fossils enumerated, have been derived from a single locality—the Falls of the Ohio river. Elsewhere, in Kentucky and Indiana, the same conditions exist and the same species of fossils are known. In the State of Ohio similar conditions may be

[1] This fossil, which is apparently identical with the New York species, is quite common in the same bed with *Chonetes Yandellana*, at the Falls of the Ohio. Messrs. YANDELL and SHUMARD, in speaking of the "siliceous crust," above the waterlime, say: "In this crust we find a small Orthoceratite, two and sometimes three inches in length, with very thin septa. We have not been able to detect the position of the syphon. It is always siliceous." This "small Orthoceratite" is unquestionably the Coleoprion, cited above; and the slender cinctæ were very naturally regarded as the septa.

inferred, from the fact that certain species of known Hamilton fossils are published in the Ohio Geological Reports as from the Corniferous group.

In the State of Wisconsin, the magnesian limestones of the Humboldt river, near Milwaukee, are charged with characteristic Hamilton fossils, and doubtless represent the hydraulic limestone and superincumbent beds at the Falls of the Ohio. I shall, at some future time, give a list of species which I have recognized in that locality during a former geological survey of the State. In the States of Illinois and Iowa, the Hamilton group is everywhere partially or entirely represented by a limestone, and the term "Hamilton limestone" has been used in the geological reports of the former State. In those portions of the country where the Upper Helderberg limestone is not known as a member of the series, there seems less difficulty in recognizing the age and character of the Hamilton limestones. It is in those localities where the Upper Helderberg limestone is well developed, and where the superincumbent beds are conformable, that they are likely to be regarded as a component part of the formation, and their fossils grouped together in accordance with this view.

The number of species of the hydraulic and encrinital limestones which are common to these beds and the Hamilton group of New York, as shown in the list above presented, certainly offers very strong evidence in support of the view which I am compelled to take, that they are the equivalent of the Hamilton group of New York; and not only the equivalent, but the actual extension of the group in a southwestern direction, in the form of calcareous beds, beyond the limits of the littoral and off-shore sediments, which characterize the formation for three hundred miles of its outcrop within the State of New York.

The erroneous determination of the age of these beds having permeated all the literature of the science for years past,* it will be necessary to make the correction wherever in this and the preceding volumes of the New York Palæontology, and other reports and papers upon geology and palæontology, the fossils contained in these Hamilton beds have been referred to the Upper Helderberg group.

* A single exception has come under my observation. Messrs. LYON and CASSEDAY, in a paper describing new species of CRINOIDEA (*American Journal of Science*, vol. 28, p. 244), under "*Geological position and locality*," of *Megistocrinus rugosus*, use the following language: "It is found in the Devonian rocks of the

NOTE ON THE BLACK SLATE SUCCEEDING THE HAMILTON LIMESTONES AT THE FALLS OF THE OHIO.

The Black slate, known under that name alone, in the vicinity of New Albany, Jeffersonville, and many other places in the southern part of Indiana, has been recognized in all the published sections of the strata at the Falls of the Ohio. It has usually been regarded as of Devonian age, but has sometimes been claimed as belonging to the Carboniferous series. Evidences of its true geological age and its equivalency with known sedimentary formations in the east must be sought in its fossil contents and its geological relations, since its direct continuity cannot be traced.

In order to come to this point with some preliminary appreciation of the subject, it may be remarked that the results of all our geological investigation have shown a gradual (occasionally an abrupt) thinning, in a westerly and southwesterly direction, of all the sedimentary formations which lie between the Upper Helderberg limestone and the base of the coal formation. In New York and Pennsylvania, these are represented by coarse and fine shales and sandstones, the coarser materials predominating. At intervals there occur beds, greater or less in extent, of fine sandstone, slate or shale; and these become more marked and conspicuous in a westerly direction; while gradually the arenaceous deposits give way, and the whole mass becomes finer in character and greatly diminished in its aggregate thickness. In the course of several hundred miles, not only do the arenaceous, littoral portions of the deposit give place to finer sedimentary materials, but calcareous matter supervenes, either as a general admixture with the shale, or as continuous belts of distinct concretions, or of concretionary or other forms of limestone bands, forming an important feature in the geology.

Although a full discussion of the different conditions in which these deposits present themselves in their westward extension would occupy much more space

age of the Hamilton group, associated with *Orthis suborbicularis*, *Atrypa reticularis*, *A. aspera*, *Euomphalus cyclostomus?* etc. This is about the same horizon in which HALL found his *Megistocrinus latus*."

This is the only reference of any of these fossils to the Hamilton group which I have been able to find among the writings of LYON and CASSEDAY, or of Major LYON.

than we have at our present disposal, it is nevertheless with this question in all its aspects that we have to deal, in considering the equivalency of the western formations with those of the east.

In the first place, we may glance at the mode of occurrence of the Hamilton group and associated strata in eastern New York. At its base the formation consists of soft laminated shales with calcareous intercalations. These, in ascending, gradually become brittle, arenaceous and crumbling shales, alternating with more sandy beds, until the formation near its upper portion assumes a prevailing arenaceous character, or consists of flagstones with intermediate shaly beds. This order of succession can be traced through about three thousand feet of thickness, with little evidence of distinct groups or formations, though, locally, each mass may possess a specific character.

In following these beds westward for fifty or one hundred miles, great changes in the nature of the sediments are noticeable, and the limits of the formation are better defined. We everywhere find the Hamilton group followed above by a finely laminated black slate, and its arenaceous character is greatly modified, until finally the shaly portion of the group becomes highly calcareous. At the end of more than three hundred miles of continuous outcrop, the entire mass, which was more than twelve hundred feet thick in the eastern part of the State, has thinned to a few hundred feet of calcareous shale, with some bands of limestone. At a point more than one hundred and fifty miles to the west and north, in Canada, we find the shales of the same calcareous character, with the bands of limestone increased in importance, and the whole mass greatly diminished in thickness.

It is therefore a fair and logical inference, that the continuation of this group of strata much farther to the west, would preserve the calcareous beds alone—the sedimentary character having been gradually diminishing with the distance from the source of the deposit, and with the diminished transporting power of the ocean current.

The same evidence is presented by the Hamilton group in Michigan, and also in Wisconsin, where it is still more calcareous, and corresponds in its outcrops to the older formations, as shown upon the geological map. We are able,

therefore, to trace the extension of this group westward, along a line north of any important influence arising from the Cincinnati axis, and to show its gradually increasing calcareous character with constantly diminishing thickness. The same law has undoubtedly prevailed over the entire bed of the Hamilton ocean; and there is no reason to suppose that the same law and conditions which operated upon the sediments which we trace with slight interruptions from the Hudson valley to Wisconsin, should not have prevailed also in a southwesterly direction, giving at one time an expansion of these calcareous and semi-calcareous beds, of which the continuity in that direction has been broken by the Cincinnati axis.

Moreover, in considering this condition, it should not be forgotten that the eastern outcrop of these sedimentary formations, extending from the Helderberg mountains in New York, southwesterly through Pennsylvania, Maryland and Virginia, in an unbroken line of more than six hundred miles of the coarser sediments, have, in their western extension, followed the same law which prevails in the three hundred miles of continuous outcrop within the State of New York. The operation of the same law has given us the Hamilton group at the Falls of the Ohio, represented by about thirty feet of impure and magnesian limestones.

We now come to the consideration of the age and relations of the Black slate which lies upon the Hamilton limestones in the neighborhood of the Falls of the Ohio and at numerous localities in Indiana. To do this appreciatively, we must consider the relations of the Hamilton group to the succeeding rocks in the State of New York and other eastern localities. These relations have been heretofore fully described, and we need only a cursory review of the facts.

In central and western New York, the fossiliferous, semi-arenaceous and semi-calcareous shales of the Hamilton group are succeeded by a black, fissile slate, known as the Genesee slate; and this Black slate is succeeded by a green or olive slate or shale, followed by successive alternations of black and

greenish shales, and alternating shales and flagstones, and finally heavy bedded sandstones with intermediate, arenaceous, shaly partings.

The Genesee slate has been regarded as constituting beds of passage to the next formation, known as the Portage group; and this, as well as the succeeding shale, carries a few fossils, which are likewise known in the Hamilton group below. This entire formation, consisting of shales and sandstones, and having a thickness of a thousand feet or more in central New York, diminishes like all the other strata in a westerly direction. On the shores of Lake Erie it has become a succession of green and black shales and flagstones, with here and there a lenticular mass of heavy-bedded sandstone, with abundant concretions, and not unfrequently with lenticular masses of calcareous matter. Not only this, but the lower beds of the Chemung group have become shaly and non-fossiliferous; and the lines of demarkation between the formations can nowhere be easily drawn. In this condition, these formations are exposed along the Lake Erie shore, in New York, Pennsylvania and Ohio.

The Portage group has been traced in the peninsula of Canada West, and is finely exposed at Kettle Point on Lake Huron, where it carries all the characteristics pertaining to its lower members in the Genesee valley or in western New York, and holds, also, the same relative position to the Hamilton group outcropping in close proximity.

We have now to consider whether the Black slate in the vicinity of the Falls of the Ohio is represented by the Genesee slate, or by any of the black slates of the series of which it is the lowest member in New York. In this question it should be remembered that some at least of the fossils of the Genesee slate are known to pass upward into the green or olive Cashaqua shale; and that so far as regards a grouping of the strata, the Genesee slate would more properly form a member of the Portage group. Its relations to that formation have always been recognized, having only been separated as a distinct member to indicate the upward limitation of the Hamilton group.

The strata below this Black slate, which have already been described, hold the position and contain many of the characteristic fossils of the Hamilton group, as already shown. The small Lingula of the Black slate differs little

if at all from the *Lingula spatulata* of the Genesee slate of New York; and the *Discina truncata*, a characteristic fossil of the Genesee slate, is associated with this Lingula in several localities near the Falls of the Ohio. In some specimens of the Black slate from near Lexington in Scott county, Indiana, I have found well marked specimens of *Chonetes lepida*, and a species of LEIORHYNCHUS which does not differ in any distinctive characters from *L. quadricostatum*. Both these fossils are well known forms of the Genesee slate in the State of New York.

In the same association in Indiana, I find the slaty laminæ covered by innumerable individuals of a species of STYLIOLA, which is indistinguishable from one known in the Genesee slate and in some calcareous bands above, as well as in the succeeding green shales of the Portage group. In central and western New York this minute fossil constitutes, of itself, layers several inches in thickness, which are consequently calcareous; and it is also, in some places, disseminated through the slaty layers to such a degree as to render them very calcareous and extremely fragile.

From the above considerations I am led to the conclusion that the Black slate of the west is the equivalent, and even the absolute continuation, of the black shales succeeding the Hamilton group of New York (the Genesee slate), carrying as it does identical species of fossils, and holding the same geological position.

It is not necessary, at the present time, to enter into the discussion of the age of the succeeding deposits in the west,—the digression here made from the purpose of this work being simply intended to aid in the determination of the geological horizon, to which many of the fossils of this volume are to be referred, and to set at rest, if possible, some difficulties in the way of a proper understanding of the range of certain species of fossils in these portions of the geological series.

The preceding remarks upon the Black slate, in connection with the Hamilton limestones of the Falls of the Ohio, are the results of my personal observations, and inferences therefrom. Similar conclusions had some time since been arrived at by Prof. Cox, State Geologist of Indiana, regarding the Black slate or shale of New Albany and other localities in Indiana, and were published in his Reports of 1874 and 1875. In previous Reports this formation is referred to as Devonian Black slate, Black bituminous shales of Devonian age, and New Albany black shale; but in 1874 he refers the New Albany black shale to the age of the Genesee slate of New York. This conclusion is based upon the discovery, at Lexington, by Prof. W. W. BORDEN, of certain fossils which are characteristic of the Genesee slate in New York, viz.: *Leiorhynchus quadricostata*, *Chonetes lepida*, *Tentaculites fissurella* [=Styliola], and fragments of a large species of Cardiola [=Cardiopsis], not unlike *C. radians*. The fossils previously known in this rock were a species of LINGULA and a DISCINA, which had not been considered by him sufficient evidence for determining the geological age of the formation.

Prof. Cox, in his Report for 1875, describes the New Albany black shale of Floyd, Clarke, Scott and Jennings counties as the "equivalent of the Genesee shale of New York;" and cites "*Tropidoleptus carinatus* and *Chonetes coronata*, COX. (Hamilton group of New York)," as occurring in the dark gray limestone below the New Albany black shale.

In his Reports of 1874 and 1875 Prof. Cox has given numerous instructive sections, which show the varying conditions of the formations associated with the Black slate. In some instances this formation is represented as resting directly upon the Corniferous limestone, or separated only by some beds of inconsiderable thickness and importance. In one locality, half a mile north of Lexington, the section gives as follows:

Black slate	4 to 7 feet.
Oxide of iron	6 inches.
Light gray, shaly limestone with abundance of fossils, *Spirifer gregaria*, *Sp. acuminatus*, corals, etc.	4 feet.
Limestone, darker, with fossils	8 feet.
Corniferous limestone, very white, with an abundance of characteristic fossils.	6 feet.*

* Report of 1874, pp. 128 and 129. See, also, p. 150, same Report, where the Black slate is represented as resting on limestone containing *Conocardium*, *Zaphrentis*, *Spirifer acuminatus*, and other fossils.

Since the *Spirifera gregaria* and *Sp. acuminata* are characteristic fossils of the Corniferous limestone in all the western localities, it is clear that the hydraulic, siliceous and crinoidal beds of the sections in the vicinity of Louisville have thinned out, and are represented only by the few inches of oxide of iron which has accumulated at this place during the deposition of the limestones in other localities. In other sections, however, the oxide of iron is represented as lying between the Hydraulic limestone and the Black slate, showing a lapse of time and the absence of some member of the series; but in nearly all the sections, the Hydraulic limestone, with its associated or equivalent beds, is represented in greater or less force, the thickness varying from a trace, to six or eight or even twelve feet in the counties of Scott and Jefferson; while in some localities in Clark and Floyd counties, it reaches a thickness of twenty feet or more.

In a general section of the geological formations of Clarke and Floyd counties, given in the Report of 1873, Prof. Cox doubtfully refers the Crinoidal and Hydraulic limestones to the Hamilton group:*

Knob limestone—Keokuk group		80 feet.
Knob sandstone, Knob shale,	Kinderhook group	344 feet.
New Albany Black slate, Crinoidal limestone, Hydraulic limestone,	(?) Hamilton group	140 feet.
Corniferous limestone—Upper Helderberg group		22 feet.
Utica limestone—Niagara group		52 feet.
Magnesian limestone—Clinton group		30 feet.
Madison limestone—Cincinnati group		207 feet.

In the Report of 1874, p. 123, Prof. Cox gives the relations of the New Albany black shale with the superincumbent rocks, indicating it as the equivalent of the Genesee shale of New York.

* Report of 1873, p. 172. Since this reference does not appear in succeeding reports, the view then entertained may have subsequently been modified. This section had escaped my attention in looking for authorities regarding the age of the upper limestones of the Falls of the Ohio, and should have been cited in its proper place in the preceding pages.

PTEROPODA.

TENTACULITES, Schlotheim.

The first publication, having reference to the fossils now included under this genus, was made by Walch in 1775. At a later period, 1784, they were referred by Schrœter to the genus Dentalium. In 1820 they were described by Schlotheim under the name *Tentaculites*, and considered by him as the appendages of Encrinites. Among the illustrations given by this author are forms which are clearly such appendages, and others of doubtful character.

The term Tentaculites was for a long time applied to this form of organisms without strict generic significance, and in later times species of the genus Cornulites have been included under the same designation. In 1831 these fossils were described by Von Buch as the spines of *Leptæna lata*. Goldfuss, in 1832, still regarded them as the appendages of Encrinites, and illustrates the *T. annulatus* and *T. scalaris* of Schlotheim as the extreme ramifications of the arms of *Cyathocrinus pinnatus*.*

In 1832 Prof. Eaton noticed for the first time in this country a species of Tentaculites, which he described and figured as *Echinus gyracanthus*, under the belief that these fossils were the spines of some Echinoderm (*Geolog. Text Book*, p. 128, pl. 1, fig. 15). This species occurs abundantly at the base of the Lower Helderberg (Tentaculite) limestone.

* *Brachia auxiliaria variæ formæ.* Under the same designation are also included what appear to be a species of Cornulites; but the two species, *T. annulatus* and *T. scalaris*, are true Tentaculites in the restricted and accepted signification of the term at the present time.

In 1842 Mr. VANUXEM indicated the occurrence of *Tentaculites ornatus* of SOWERBY, in the water-lime group of New York (Hydraulic lime rock of EATON), giving a figure of the species which occurs in the Tentaculite limestone.

In 1843 Mr. MATHER adopted and published the same figure, as characteristic of the Tentaculite limestone, which was at that time recognized as the upper member of the water-lime group (*Geology of N. Y. Surv. First and Third Geolog. Dist.*).

In 1843 M. CASTELNAU described and figured *Tentaculites regularis* and *T. irregularis*, from the Trenton limestone (*Le système Silurien de l'Amerique Septentrionale*).*

In 1843 JAMES HALL indicated *Tentaculites scalaris*, of SCHLOTHEIM, as occurring in the Corniferous limestone at Le Roy, in western New York. He also described and illustrated a new species, *T. fissurella*, from the Marcellus shale and Genesee slate (*Geology of N. Y. Surv. Fourth Geolog. Dist.*).

In 1847 the same author described and figured *Tentaculites? flexuosa*, from the Trenton limestone (*Palæontology of New York*, vol. 1, pp. 92, 284, plates 29 and 78).†

In 1852 the same author described three species from the Clinton and Niagara groups of New York, viz., *T. minutus*, *T. distans*‡ (*Palæontology of New York*, vol. 2, pp. 183, 184, pl. A 41, figs. 8 *a-e*, and 9 *a*, *b*); and *T. Niagarensis* (p. 352, pl. 85, figs. 11 and 12).

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* The occurrence of these two forms at Trenton Falls has not been verified by subsequent collections at that locality; nor have these or any other species of true TENTACULITES been found in the Trenton limestone either at that locality or elsewhere in New York. The name *T. irregularis*, of CASTELNAU, is suggestive of the characters of *T. gyracanthus*, which species may have been obtained from collectors living at Trenton Falls. The dark limestone in which it occurs is so similar to that of Trenton Falls that the character of the rock may also have influenced the conclusion that the specimens were from the Trenton limestone.

† This species was referred to TENTACULITES with doubt. The apparently septate character is due to exfoliation of the exterior test, revealing the character of CORNULITES; and in the reference to the species on page 284, it was compared with *Cornulites serpularius* of SCHLOTHEIM, as figured by MURCHISON (*Sil. System*). I expressed doubts of its identity with TENTACULITES on account of its "adhering to other bodies," as well as "from its internal structure, which has not heretofore been shown in true TENTACULITES." "All the other species known in our strata are straight [or slightly bent from accidental causes during growth], ridged, and gradually tapering to a point, always separate, and never known as adhering to other bodies." Subsequent examination has shown this fossil to be the base of a CORNULITES, growing in small groups, and attached to other bodies.

‡ The relations of this species require to be verified.

In 1855 Dr. B. F. Shumard described and published *Tent. incurvus*, from the Cape Girardeau limestone, referred by him to the age of the Lower Helderberg group (*Geolog. Survey of Missouri, Second Annual Report*, p. 195, pl. B, figs. 6 *a*, *b*).*

In 1859 James Hall described *Tentaculites elongatus*, from the shaly limestone of the Lower Helderberg group, and, recognizing that the species occurring in the Tentaculite limestone was not the *T. ornatus* of Sowerby, proposed the name *T. irregularis*,† correcting the same in the explanations of plates, and adopting the name *T. gyracanthus*, given by Eaton in 1832 (*Palæontology of New York*, vol. 3, pp. 136, 137, pl. 6, figs. 16–21, 22 and 23).

In 1863 Prof. J. D. Dana (*Manual of Geology*), following Messrs. Mather and Vanuxem, cites the *T. ornatus* as occurring in the Tentaculite limestone at the base of the Lower Helderberg group. He also cites the *T. scalaris*, from the Corniferous limestone of New York, following the erroneous determination in the Geological Report of the Fourth District.

In 1865 Messrs. F. B. Meek and H. A. Worthen described three species of Tentaculites, viz., *T. tenuistriatus*, *T. Oswegoensis* and *T. Sterlingensis*, from rocks of the age of the Hudson River (Cincinnati) group of New York (*Proceed. Acad. Nat. Sci. Phila.*, pp. 254, 255).

In 1866 Prof. A. Winchell described *T. subtilis*, from the Hamilton group in the State of Michigan (*Report on the Lower Peninsula of Michigan*).

In 1868 Messrs. Meek and Worthen published descriptions with figures of *T. tenuistriatus*, *T. Oswegoensis*, *T. Sterlingensis* (*Geolog. Survey of Illinois: Geology and Palæontology*, vol. 3, pp. 341–343, pl. 4, figs. 6, 7 *a*, *b*, and 8).

In 1874 Mr. S. A. Miller, of Cincinnati, described *T. Richmondensis*, from Lower Silurian strata, of the age of the Hudson River (Cincinnati) group (*Quarterly Journal of Science, Cincinnati*).

In 1876 Mr. C. A. White described *T. Hoyti*, from strata of Devonian age (*Proceed. Acad. Nat. Sci. Phila.*, p. 34, 1876).

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* This species has the characteristic features of Cornulites in its young state; but its mode of occurrence, as described, differs from the ordinary condition of the young forms of that genus. The formation, at the locality where the Tentaculites occurs, has more recently been referred to the upper part of the Hudson River group, and by S. A. Miller to the Trenton group (*Catalogue American Palæozoic Fossils*, p. 142).

† At that time the author was not acquainted with the work of M. Castelnau.

In 1876 JAMES HALL indicated and figured six new species of TENTACULITES, viz., *T. arenosus*, *T. attenuatus*, *T. bellulus*, *T. scalariformis*, *T. sicula** and *T. spiculus*; and also illustrated another form under the name *T. fissurella* (see page 173 of this volume), a species previously described in 1843 (*Illustrations of Devonian Fossils*, pl. 26, figs. 1–25).

In the above historical notice, American authors only, or those treating of American species of the genus since 1832, have been cited. During this period our knowledge of this group of fossils has been greatly increased, chiefly by the investigations and writings of European authors, the principal of whom are the following:

HISINGER in 1837;† Sir R. I. MURCHISON in 1839; M. DE VERNEUIL in 1840 and in 1850; MM. D'ARCHIAC and DE VERNEUIL in 1842; Count CASTELNAU in 1843 (already cited); Dr. F. A. RŒMER in 1843 and 1850; Mr. AUSTIN in 1845; M. DE VERNEUIL and Count KEYSERLING in 1846; Prof. GEINITZ in 1846 and 1856; M. ALCIDE D'ORBIGNY in 1850; Prof. ABICH in 1850; Prof. MCCOY, Prof. QUENSTEDT and Prof. GEINITZ in 1851; M. BARRANDE in 1852–1865 and 1867; Drs. G. and FR. SANDBERGER in 1850–56; Dr. FR. SANDBERGER in 1852; Prof. GEINITZ in 1853; Dr. STEININGER in 1853; Dr. EDWARD GUÉRANGER in 1853; Prof. MORRIS in 1854; Dr. R. RICHTER in 1854, 1856, 1865, 1866 and 1867; M. ED. DE VERNEUIL in 1855; Dr. BOLL, in 1856, 1859 and 1867; Dr. FERD. RŒMER in 1857, 1862 and 1865; Chevalier EICHWALD in 1857 and 1860; Prof. GIEBEL in 1858; Dr. FR. SCHMIDT in 1858 and 1859; Messrs. SALTER and MORRIS in 1859; Prof. RUDOLF LUDWIG in 1864; Prof. KJERULF in 1865.‡

In 1867, M. BARRANDE, in his "*Système Silurien du Centre de la Bohème*, Tome III," has given a most complete resumé of all that has been written in Europe and America concerning this group of fossils; including also the genus STYLIOLA of LESUEUR. He has likewise presented, in a most complete and satisfactory manner, the geological and geographical distribution of these genera in the

* See pages 159 and 165 of this volume.

† This author cites EATON, as referring the TENTACULITES to spines of ECHINUS, "Aculii Echini gyracantæ," and the species cited by him from near Schoharie, N. Y., is evidently the *T. gyracanthus*.

‡ The works of some of these authors are not accessible to the writer, and they are cited upon the testimony of M. BARRANDE.

different countries of Europe and America. I shall have occasion farther to refer to this work.

The position of these bodies in the animal kingdom remained for a long time undetermined, and they were arranged by most authors under the convenient head of *incertæ sedes*. While it was easy to separate them from the Crinoidea (which they resemble in their annulated exterior), by their form and general characters, as well as by their intimate structure, it was more difficult to make any satisfactory reference to established groups. In 1845 they were referred by Mr. AUSTIN to the PTEROPODA.* This reference has generally been followed by later authors up to the present time, and is accepted by the writer as his conviction of their true relations. These bodies, however, in their comparatively thick, calcareous test, and the annulating marks which affect the interior, and are visible upon the cast, are quite unlike the thin hyaline shells of most of the existing forms of PTEROPODA. The interior casts of some of the TENTACULITES present so many features in common with those of CORNULITES that there is a very natural inference of a family relation between the two forms. At the same time, the free growth of the one and the attached mode of growth of the other (its usual condition in its young state at least), together with the difference in the structure of the test,† are sufficient grounds for a wide separation in a systematic arrangement of these genera.‡

It may be necessary to state in this place that the reference of American species of TENTACULITES to known European forms has not been sustained by critical examination. The *Tentaculites ornatus* of SOWERBY seems to me to have its nearest representative in *T. Niagarensis* of the Niagara group. The *T. tenuis* is represented in the species of the Hamilton group; though a comparison of specimens may reveal a greater analogy with those of the Upper Helderberg formation.

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* *Annals and Magazine of Natural History.*

† See illustrations of the structure of the test of CORNULITES in *Murchison's Silurian System*, pl. 26. Also *Twenty-eighth Report on the N. Y. State Museum of Natural History*, 1875, plate 31.

‡ Prof McCOY has thus indicated the distinguishing features of TENTACULITES: "Their being unattached, small size, and straight, regular form, separate them from the allied genus CORNULITES" (*Synopsis of British Pal. Foss.*, p. 63. 1855).

The *Geographical distribution* of the species of TENTACULITES has received little attention, and we are not prepared to give any complete information upon the subject. In the State of New York no species have been described from strata below the Clinton group. Of the two species of this formation, one is known in the green shales of Rochester and central New York, and has not been recognized beyond the limits of the State. The other species described from the same horizon is known only in Canada West, near the head of Lake Ontario.

The *Tentaculites Niagarensis* occurs in the upper beds of the Clinton group, and in calcareous bands in the shale of the lower part of the Niagara group, but has not been traced beyond the limits of central and western New York. Among all the Niagara fossils from Iowa and Wisconsin, I have not recognized a single species of the genus; and several thousands of all classes of fossils of this age from Waldron, Ind., have passed under review without revealing a single specimen of TENTACULITES. In strata of the age of the Niagara group at Cumberland, Md., and in the same layers, associated with well known Niagara fossils, a species occurs very similar to, but more slender than *T. gyracanthus*, but which is unknown to us beyond that immediate neighborhood.

The *T. gyracanthus* is abundant in eastern New York at the base of the Helderberg mountains and in Schoharie; it is not known beyond a distance of fifty or sixty miles westward, although having an extension to the southwestward, along the trend of the formation, of more than three hundred miles. It is of common occurrence, in the same beds, in the southern part of the State and the adjacent portions of New Jersey; and at Warrior's Ridge, in Huntington county, Pa., it is as abundant as at the base of the Helderberg mountains, or in Schoharie.

The *T. elongatus* of the shaly limestone of the Lower Helderberg is known to the author in many localities in the vicinity of Schoharie and the Helderberg mountains, and has been recognized in the extension of that formation as far south as New Jersey.

The *T. incurvus* of SHUMARD, referred by its author to the same geological age as above, seems to be unknown beyond the locality originally cited.

The *T. arenosus* has only been found in a single locality in the Helderberg range in the town of Knox, Albany county, N. Y.

The *T. scalariformis* is rare at Scholharie, and has been found in two localities in central and western New York. It seems to be the nearest representative of the *T. scalaris* of Europe which we have in this country, judging from all the figures of that species accessible to me, and it may be only a geographical variety. The form indicated as *T. sicula* is identical with *T. scalariformis*, so far as can be determined from the condition of the New York specimens, and, while rare in this State, is extremely abundant in the neighborhood of Sandusky and Delaware, Ohio. It also occurs in Charlestown and Pendleton, Indiana.

The *T. attenuatus* is very abundant in some decomposing arenaceous shales in Otsego county, N. Y., and *T. bellulus* occurs in several localities in the central part of the State; but neither of them are known to me as occurring in the western counties, or in any localities of the Hamilton group beyond the limits of New York in a westerly direction. On the other hand, the *T. attenuatus* is extremely abundant in some arenaceous beds of the Hamilton group at Saddleback Ridge, in Huntington county, Pa.; a point at least three hundred miles southward from the localities in the State of New York.

The *T. spiculus* of the Chemung group is very numerous in certain decomposing layers to the south of Ithaca, and in Cortland county, N. Y.; but no specimens have occurred in all the extensive collections made in the country west of the Genesee river, nor in all the southern range of counties of the State.

The Devonian species, *T. Hoyti* of White, and *T. subtilis*, described by Winchell, we know only from the localities cited by their authors.

Of the species from the rocks of Lower Silurian age, we have no other knowledge of their geographical distribution than as given by their authors, who cite the occurrence of the species in three localities in the State of Illinois and one in Indiana.

From our present knowledge, therefore, we might conclude that the distribution of the species is very unequal; but it is more probable that our collections are too incomplete to admit of any satisfactory generalization at

the present time. Two of the most abundant, and, so far as known, widely distributed species, the *T. gyracanthus* and *T. attenuatus*, occur in very dissimilar deposits—one of them being in a limestone, while the other occurs in an arenaceous or semi-argillaceous formation. These, in their respective horizons, can be traced for the distance of more than three hundred miles in a northeast and southwest direction, while they have a very limited extension to the westward. Since, as a rule, these fossils occur in limestone or in semi-calcareous deposits, it seems a little remarkable that neither *T. attenuatus* or *T. spiculus* should be found in the western extension of their respective formations, in which direction the sediments become more calcareous. In the single example of *T. scalariformis*, we find a greatly increased number of individuals in a westerly direction, as far as Ohio, but this is strictly along the trend of the limestone formation.

The following tabular arrangement of species described under the generic name of TENTACULITES will show their distribution in the American Palæozoic rocks:

SPECIES.	LOWER SILURIAN.	UPPER SILURIAN.			DEVONIAN.		
	Trenton and Hudson River.	Niagara and Clinton.	Lower Helderberg.	Oriskany Sandstone.	Upper Helderberg.	Hamilton.	Chemung.
T. arenosus	..	..	..	*	..	..	..
T. attenuatus	..	..	..	..	..	*	..
T. bellulus	..	..	..	..	..	*	..
T. distans	..	*	..	..	..	..	..
T. elongatus	..	..	*	?	..	..	..
T. fissurella	..	..	..	..	..	*	..
T. Hoyti	..	..	..	..	..	*	..
T. gyracanthus	..	..	*	..	..	..	..
T. incurvus	..	..	*	..	..	..	..
T. minutus	..	*	..	..	..	..	..
T. Niagarensis	..	*	..	..	..	..	..
T. Oswegoensis	*	..	..	..	..	..	..
T. Richmondensis	*	..	..	..	..	..	..
T. scalariformis	..	..	..	..	*	..	..
T. sicula	..	..	..	..	*	..	..
T. spiculus	..	..	..	..	..	..	*
T. Sterlingensis	*	..	..	..	..	..	..
T. subtilis	..	..	..	..	..	*	..
T. tenuistriatus	*	..	..	..	..	..	..

A critical examination of all the forms at present referred to the genus TENTACULITES suggests an inquiry as to the reliable characteristics of the genus. The inquiry is the more pertinent in its special reference to the recognition, as veritable TENTACULITES, of the Lower Silurian species of the preceding table.

An examination of the figures and descriptions which have been given of these four species of TENTACULITES shows that they are all of curved forms, and that they possess characteristic and peculiar features in their annulations which are quite distinct from any of the Upper Silurian or Devonian species of this country, with the exception of *T. distans* of the Niagara group, which is probably a CORNULITES. They are moreover, where well preserved, always longitudinally striated, a feature unknown in authentic species of the Upper Silurian and Devonian formations, except in a single form.

It seems scarcely possible that such external differences can be simply those marking the geological age of the species; and I infer that these characters have a deeper significance. Since the preceding pages were in type I have had an opportunity of examining specimens of the Lower Silurian forms, *T. Richmondensis* and *T. Sterlingensis*,* and also the *T. incurvus* of SHUMARD. The two first named preserve all the characters above described, while the last (as seen in a block containing four individuals of the curved forms) is too much worn for satisfactory generic determination. At the same time there is a single, almost straight individual on the same stone, which is marked by the characteristic annulations and distinct longitudinal striæ, and it is fair to presume that the other specimens have been similarly marked. The *T. Richmondensis* is smaller than the figures of *T. Oswegoensis*† of MEEK and WORTHEN, but otherwise very similar in character, and the proportionate number of annulations agreeing very nearly with the description of the latter species. The specimens of *T. Sterlingensis*, communicated as above, are of smaller size, corresponding with the figures of that species, as cited. They

* Through the favor of Mr. S. A. MILLER of Cincinnati.

† This species has been compared with curved individuals of *T. elongatus*, to which it has only a very remote resemblance; and *T. elongatus* is never curved except through accident, so far as known to the writer.

are distinctly and strongly striated longitudinally, and the annulations are abrupt and well defined, varying considerably in their distance in different specimens. The collection before me consists of six separate individuals lying upon the surface of the stone, differing in the degree of curvature and in the strength of the annulations. There are five other specimens, which are in groups of two, three or four individuals adhering together at their bases, or attached to some other body. Another single individual among these, shows the annulations nearly obsolete, and a thickening and irregular growth of the test.

These characters are such as belong to the genus CORNULITES, and have not been found in any true TENTACULITES, so far as my observation has extended. If these Lower Silurian forms are to be recognized as TENTACULITES, the definition of the genus must be extended in order to include them, and it would then embrace very incongruous material.

In the comparison of individual specimens, it may not always be practicable to distinguish TENTACULITES from CORNULITES; but under an ordinary magnifier the surface of the latter presents, in most examples, a somewhat different texture, and the annulations are usually less abruptly elevated, and often sloping equally in both directions. In nearly all the American species of TENTACULITES the striæ are transverse, and in perfect specimens usually marking, in a greater or less degree, not only the interspaces but the annulations. This feature, however, may be obscure from age or wearing, or may in some species not exist at all. On the contrary, the species of CORNULITES are always longitudinally striated, and in their young state the annulations show little variation in their character and general aspect. The external basal portions of both CORNULITES and TENTACULITES are often free from annulations. In the latter, the annulations become stronger on receding from the base of the fossil, while in older individuals of the former they often become less marked, and finally obsolescent; they are likewise frequently irregular in their development, projecting more on one side than upon the other, and otherwise subject to variations which are not observed in TENTACULITES. At the same time some

forms of the genus appear to be quite free in their mode of growth (at least in their advanced stage), and in this respect resemble TENTACULITES.

In geological distribution, we find the species of CORNULITES restricted to strata of Silurian age, beginning in the Trenton limestone, and represented by species in the Hudson River, Clinton and Niagara groups. Thus far, none have been described from strata of Devonian age, and none are known to me as occurring at a later period than the Niagara. On the other hand, species of the genus TENTACULITES have been described from all the formations from the Trenton limestone to the Upper Devonian, inclusive.

As the result of studies made on the characters of typical forms of the genus, I propose to recognize as TENTACULITES only those organisms which consist of straight, elongate, attenuately conical tubes. These tubular bodies are, for the most part, annulated by abruptly elevated rings, closely arranged near the apex or point of origin, and becoming more distant and stronger with the increasing size of the shell and their distance from the apex. The surface between the annulations, and often the annulations themselves, are marked by fine transverse striæ, rarely by longitudinal striæ. More rarely, also, there are forms which are not marked by annulations, but have otherwise the characters described.

The annulations are sometimes irregularly disposed, as in *T. gyracanthus*, where this character extends to all parts of the individual; while in others this feature is confined to certain portions, as near the aperture. The section of the tube is always circular when not accidentally compressed. The cavity forms a single chamber without septa, but the annulations of the exterior are marked upon the interior by constrictions of the tube. The cavity does not extend to the apex—that part being partially filled with a calcareous deposit formed by the tissues during the growth of the animal. This deposit is variable in its extent in individuals of the same species, and extremely different in degree in different species of the genus, sometimes filling a considerable portion of the entire length. The open extremity or mouth of the tube is directly transverse, without indication of anterior or posterior sides. The notch or apparent slit which often occurs in flattened specimens is due to compression or exfoliation.

In this view of the subject, and from an examination of all the species accessible to me, I consider it extremely doubtful if any true TENTACULITES exist, either in the Trenton limestone or in the Hudson River group.

The above views of the generic relations of these forms is based entirely upon the study of their external form and characters. These are often so similar in well determined species of the two genera that there may be some hesitation in adopting conclusions in the absence of a knowledge of the internal structure, and to this we must resort for a farther elucidation of the subject.

TENTACULITES ARENOSUS.

PLATE XXXI, FIGS. 1, 2.

Tentaculites arenosus. HALL. Illustrations of Devonian Fossils: Pteropoda, pl. 26, figs. 1, 2. 1876.
Compare *T. elongatus,* " Pal. N. Y., vol. 3, p. 136, pl. 6, figs. 16–21.

FORM elongate-conical, straight, slender, tapering very gradually from the apex to the aperture. Annulations not fully known, equally distant, measuring in the cast of the interior a little less than three in the space of the diameter of the tube; and, from the larger extremity, nine in the length of half an inch, and eleven in the same space as measured from the smaller extremity.

The specimen is essentially a cast of the interior with some portions of the shell imperfectly preserved, and showing obscure marks of transverse striæ. The fossil, in its present condition, presents the appearance of a series of cone-frustrums, reversed in direction as compared with the entire cone of the fossil. The proportions of the specimen are so similar to *T. elongatus* that I have some doubt as to the propriety of specific separation from that species. The individual figured, and the base of another in the same piece of rock, are all that have been observed.

Formation and locality. The fossil occurs in a semi-calcareous layer of the Oriskany sandstone, near Clarksville, in the Helderberg range of mountains, Albany county, N. Y.

Tentaculites scalariformis.

PLATE XXXI, FIGS. 3-11.

Tentaculites scalaris, Hall. Geology of N. Y. Surv. Fourth Geolog. Dist., pp. 172, 173, fig. 2. 1843.
Not *T. scalaris*, Schlotheim. Silurian Researches, p. 643, pl. 19, fig. 16.
T. scalariformis and *T. sicula*, Hall. Illustrations of Devonian Fossils: Pteropoda. pl. 26, figs. 3–11. 1876.

Form elongate-conical, straight, somewhat more cylindrical in approaching the aperture; with the apex, in well-preserved specimens, extremely attenuate, and quite solid for one-fourth to one-third of the entire length of the shell. Annulations prominent, subangular, sometimes rounded on the larger part of the cone; closely arranged and sharply angular near the apex, gradually increasing their distance, becoming less angular with the increase of the size of the shell, and obtuse and rounded towards the aperture; usually but little variation in character on the outer half of the length, where the spaces between are greater than the annulations. Interspaces and annulations, when well preserved, marked by fine, even, transverse striæ, of which nine or ten may be counted in the furrows, and half as many on the summit and sides of the annulations.

In a few specimens there is much irregularity in the distance and development of the annulations towards the aperture. The extreme point of the apex is rarely or never preserved in our specimens; but measuring the annulations at the smaller extremity we find that the distance between them increases according to the following figures: taking the measure of the first nine annulations in four specimens, we have the following ratio: (1) 9, 5, 3, 3, 3; (2) 9, 5, 4, 4, 3; (3) 9, 5, 4, 3, 4½; (4) 9, 5, 4, 3, 2½, 2, 2. The fossils are imbedded in compact limestone, or spread over the laminated surfaces of the semi-argillaceous layers, and the specimens, with rare exceptions, are compressed and often extremely flattened, except the apical portion, which is solid and preserves its form. The degree of compression influences the form of the cone, as may be seen in the figures. In a few well-preserved specimens, the cylindrical character of the tube towards the aperture is scarcely noticeable, and the whole appears as an elongated cone.

The specimens attain the length of one inch, rarely more, and usually somewhat less. The longest one observed has a length of nearly one inch and a quarter.

This form is stronger and more robust than any of the species of the Hamilton and Chemung groups. It differs from the *T. bellulus* in having the annulations of the distal portion more obtuse, while, in the Hamilton species, the apical portion with fine annulations is proportionally longer and more attenuate, and the entire length in the longest individual is greater. In *T. bellulus* the annulations on the large part of the tube are more acute, the intermediate depressions are proportionally wider, and the transverse striæ somewhat stronger. *T. scalariformis* differs in the same manner from *T. elongatus* of the Lower Helderberg group, which has thin, sharp annulations, and a more gradually attenuate form.

In the usually macerated condition of most of the specimens, the transverse striæ are chiefly obliterated, and it is only in rare individuals that these markings are well preserved. The same influence has subdued the sharpness of the annulations, and in many examples this cause, together with the effects of subsequent pressure, has given them a subnodose character.

In the compact limestones of New York and of Sandusky, Ohio, the exterior surface is rarely well preserved, and it is only on some slabs of a thinly laminated and often argillaceous limestone that the full form and external characters have been retained.

Formation and localities. This species occurs in the Upper Helderberg limestone at Schoharie in eastern New York, and at Le Roy and other points in the central part of the State. It is abundant in the same limestone near Sandusky and at Delaware, Ohio, and at Charlestown, Ind. It likewise occurs as casts of the interior, or sometimes partially preserving the shell, in a sandstone at the base of the Corniferous limestone at Pendleton, Indiana. The known geographical extension of the species is therefore at least seven hundred miles, and it seems quite probable that it will prove coextensive with the limestone formation of the Upper Helderberg group.

Tentaculites bellulus.

PLATE XXXI, FIGS. 15-18, AND PLATE XXXI A, FIGS. 48-51.

Tentaculites bellulus, Hall. Illustrations of Devonian Fossils: Pteropoda, pl. 26, figs. 15-18. 1876.

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

In one specimen, where the extremity is well preserved, a portion measuring three and a half millimetres preserves about sixty annulations, while a short space at the apex is apparently smooth. At the larger extremity of the same specimen the space between the annulations is nearly twice as great as the annulations themselves. The extreme apex of this fossil is rarely preserved. Two specimens in the ordinary condition, measured, show, in one individual thirty-seven annulations in five millimetres, and in the other thirty-eight in the same space; and in seven millimetres, measured from the apex of the same, there are forty-six annulations. Three other like measurements continued towards the aperture, give respectively fourteen, ten and eight annulations in each seven mm. The specimen, fig. 16, gives essentially the same proportions. As the annulations increase in distance, fine transverse lamellose striæ become developed in the interspaces; at first a single one, then two, three, etc., till towards the aperture there are eight or ten striæ in the depression and upon the sides of the annulations. The latter are abruptly elevated and acute, sloping a little more on the apertural side, very abrupt, and nearly rectangular on the apical side, with the periphery quite smooth and free from striæ.

In well preserved specimens the striæ are extended in thin lamellæ, and in a single example there is a doubtful appearance of crenulations upon their margins, but this appearance does not extend to the annulations. When preserved in shale the substance of the shell is apparently scarcely changed,

except the annulations which are subcrystalline; but when occurring in calcareous beds, the entire test is quite crystalline throughout.

This fossil has usually a length of from fifteen to twenty or twenty-two mm., while a single specimen, with the apex imperfect, measures thirty-one mm.: the largest individuals have a diameter at the mouth of nearly three mm. (the figures are enlarged to three diameters). Under ordinary observation the specimens present the appearance of a more abrupt increbescence of the annulations at about one-third the distance from the apex. Interruptions in the growth have sometimes increased or diminished the space between the annulations, as shown in figure 16 at a little above the middle of its length, and sometimes one or two of the annulations near the aperture are smaller than those preceding or following.

This species differs from the *T. scalariformis* in its more slender character and extremely attenuate apex with finer annulations: also upon the body of the shell the annulations are more prominent and acute, while the intermediate striæ are fewer. In its general character it resembles the *T. elongatus* of the Lower Helderberg group; but the annulations are proportionally stronger, a little more closely arranged, and not covered by the striæ as in that species.

Formation and localities. In the calcareous shales of the upper part of the Hamilton group, at Pompey Hill in Onondaga county, at Cayuga and Canandaigua lakes, at Bellona in Yates county, and at Geneseo, N. Y.

Tentaculites attenuatus.

PLATE XXXI, FIGS. 19, 20.

Tentaculites attenuatus, Hall. Illustrations of Devonian Fossils: Pteropoda, pl. 26, figs. 19 and 20. 1876.

Form elongate-conical, regularly expanding from the apex, and with no evidence of becoming cylindrical towards the aperture. The apical portion of the shell is very finely marked by acute annulations for a distance of about two and a half millimetres, without visible intermediate striæ. Beyond this, towards the aperture, the annulations increase in distance, and the intermediate furrows are marked with one, two, three

or more fine, regular, transverse striæ—the usual number on the larger part of the tube being four or five, but sometimes increased, in exceptionally wide spaces, on some individuals, to eight.

As a rule, the annulations in this species increase in distance towards the aperture, but they are for the most part placed at irregular intervals, the one figured being the most regular and uniform of any observed.

Measurements of several individuals, where the impressions are sharply preserved in the stone; show about eight or nine annulations in the space of five mm. from the larger extremity; and in an equal distance beyond, there are twelve or fourteen or more. In these specimens the annulations are sharply defined, narrow and abruptly elevated from the body of the shell, and without evidence of striæ.

The entire length of this fossil is from ten to twelve mm., and rarely a little more. It occurs as casts and as impressions of the exterior shell in argillaceous sandstone, and is not at this time known in any other condition.

In general character and in details of surface-marking, this species is very similar to *T. bellulus;* it differs in being of smaller size, and in the irregularity in distance of the annulations. This fossil occurs in myriads, occupying thin layers in the argillaceous sandstone, and is never of greater size and length than represented in figure 19 of plate 31. (Fig. 20 is enlarged to five diameters.) The *T. bellulus* occurs but rarely in the calcareous shales in the central part of the State; and if we suppose the *T. attenuatus* to be only a smaller variety of that form, we have evidence that the conditions required for individual development have not existed at the period of the argillaceous sandstone, since a piece of the rock of one cubic inch, holding the *T. attenuatus*, contains a greater number of specimens than have ever been seen of *T. bellulus* in all the collections.

Formation and localities. In thin bands of shaly sandstone near Cooperstown, at East Worcester, and other places in Otsego county, N. Y. The same form occurs in some thin-bedded, impure sandstones and coarser beds, associated with *Pterinea flabellum* and *Homalonotus Dekayi*, at Saddleback Ridge in Huntingdon county, Pennsylvania. It likewise occurs in the shales of the Hamilton group at Arkona (C. W.) Ontario, on the authority of Dr. Rominger.

Tentaculites spiculus.

PLATE XXXI, FIGS. 21-25.

Tentaculites spiculus, Hall. Illustrations of Devonian Fossils: Pteropoda, pl. 26, figs. 21-25. 1876.

Form a slender-elongate, annulated cone; very gently expanding from the apex, and sometimes showing a tendency to cylindricity towards the aperture: annulations abruptly elevated, sometimes rounded and oblique to the axis of the cone; about equal to the spaces between them, and gradually increasing in distance towards the aperture: ten to fourteen annulations in the space of five mm. in specimens of the same size; apical portion very finely annulated or transversely striate, about twenty in the length of one mm., while an equal distance measured near the aperture gives eleven annulations. Interannular spaces on the body of the shell marked by fine transverse striæ, to be seen only under favorable conditions of the fossil. Length of longest specimens from eight to ten millimetres: ordinary length, four to six mm.

This species is known almost entirely as imprints in argillaceous sandstone, and its characters are obtained from these and from gutta-percha casts of the same. The extreme apical portion, in the condition in which the fossil usually occurs, seldom preserves evidence of annulations.

This species resembles the *T. attenuatus* in many of its characters, but the annulations are thicker and more obtuse on the periphery, and the intermediate striæ are fewer and stronger, as shown in a single specimen preserving the shell towards the outer extremity, and as apparent in the impressions of the exterior. This character, together with the common appearance of an obliquity of the annulations, are all the features that can be indicated as distinguishing the species from *T. attenuatus*, when in the ordinary condition in which the two forms occur.

Formation and localities. In some semi-arenaceous layers of the Chemung group, a few miles south of Ithaca, N. Y., and in similar beds to the south of Cortland village in Cortland county, N. Y.

Tentaculites gracilistriatus, n. sp.

PLATE XXXI, FIGS. 12, 13, 14, AND PLATE XXXI, A, FIGS. 37–47.

Tentaculites fissurella, Hall. Illustrations of Devonian Fossils: Pteropoda, pl. 26, figs. 12–14. 1876.
Not *Tentaculites fissurella*, Hall. Geology of N. Y. Survey Fourth Geolog. Dist., pp. 180, 222. 1843.

Form minute, slender, elongate-conical, extremely attenuate towards the apex, and, in well preserved individuals, apparently becoming slightly more cylindrical towards the aperture. Apical portion solid, and the surface smooth, or free from annulations; this feature gradually becoming stronger towards the aperture. Annulations subequidistant on some parts of the shell, but varying in individuals of the same size in the proportion of five to six in the same space; those towards the apex more distant, and becoming gradually subdued; approximating and quite closely arranged as they approach the mouth; in the apical portion often appearing as simple undulations of the surface. The entire surface is covered by fine crowded longitudinal striæ, which mark both the annulations and the interspaces, but which are not visible to the naked eye. Length from three to six mm.; usually under four mm.

This minute and peculiar species presents considerable variety of aspect, and, when the apical portion of the shell only is preserved, to the length of two or three millimetres, it might be mistaken for a distinct species; and sometimes, from wearing or other causes, it is so nearly smooth as to require careful examination under a magnifier to detect the annulations, which, in such cases, occupy much less space than the interjacent depressions. Where the specimens are preserved in limestone, the annulations are abruptly elevated and acute, but, where preserved in shale, they are obtuse and rounded, often becoming obscure, and sometimes nearly obsolete. They are also variable in distance, depending mainly upon the part of the tube on which they are measured. In one specimen three mm. in length, one-half a mm. is smooth, and on the larger end there are six annulations in one mm. In a specimen of three and a half mm. in length, there are seven

in one mm. near the aperture; and in another of four mm. in length there are but three annulations in the length of a millimetre. In a specimen of six mm. in length there are sixteen annulations in the space of three mm. towards the larger end, and twelve in two mm. near the aperture. Several imperfect individuals in limestone, measuring from two to three mm. each, have from three and a half to four annulations in each millimetre.

Leaving out of consideration the *T. distans* of the Niagara group, this is the only species in the rocks of New York which, so far as our knowledge extends, is ornamented by longitudinal striæ. These striæ are often obscure or indistinguishable by the naked eye; and this is usually true of the specimens occurring in the softer shales. This ornamentation, however, is often very distinctly preserved on partial casts of the interior, more especially in specimens imbedded in compact limestone, where the outer shell is exfoliated.

There are evidently two distinct forms or varieties of this species, one of which is more slender and elongate than the other. As the shorter one acquires the same aspect as the longer, the condition, apparently, is not due to age. In the shorter form that portion near the aperture, with closely arranged annulations, is quite similar to the longer form, and the shortening has taken place between this portion and the smooth apical end, or in the space occupied by the more distant annulations. The apex is not always acute, but the initial point is often a minute ovoid bulb, which appears to be of organic origin, and not due to subsequent influences.*

This species differs sufficiently from all others in rocks of the same age, to be readily identified, and especially where the surface-striæ are fully preserved. In general form only, it resembles the young of *T. scalariformis*, but it is otherwise easily distinguished, as well as from all others, in the absence of transverse striæ.

Formation and localities. This species occurs in the Marcellus shale, and in limestone associated therewith, at numerous localities, from Schoharie county on the east to near the shore of Lake Erie. It occurs at Cherry Valley in

* This minute bulb is so precisely like the initial point of the shell in BALANTIUM, and as represented in the recent forms of STYLIOLA, that I cannot doubt that it is of precisely similar character and significance.

Otsego county, both in the shale and in limestone nodules, and is abundant in the upper part of the shale near Alden, in Erie county. It also occurs in the soft shales of the Hamilton group on Canandaigua lake.

STYLIOLA, Lesueur (1826).

CRESEIS, Rang (1829).

Styliola. Lesueur, Ludwig, Richter, Hall.

In 1864, Prof. Rudolph Ludwig (*Palæontographica* XI) proposed to restrict the generic term Tentaculites to the annulated forms, in accordance with the original definition of the genus; and placed under the genus Styliola, of Lesueur, all the smooth forms, or those which are either longitudinally or transversely striated, but without annulations.

In 1865, 1866 and 1867, Dr. R. Richter (*Zeitschrift der Deutsch. Geol. Gesellschaft*) adopted the same distinction among these fossil forms heretofore referred to the genus Tentaculites.

In 1867, M. J. Barrande has maintained the same view, and described *Styliola clavulus*, from the Bohemian strata of Devonian age, in his *Système Silurien du Centre de la Bohème.*

* * * * * * * * * * * *

The following definition of the genus, as given by Prof. Ludwig, is translated from the work of M. Barrande:

Generic characters: "Shell small; transverse section circular; closed below, and thicker than in the upper part; conical. Surface without annulations, smooth, but with fine striæ of growth, and sometimes with fine longitudinal striæ; without longitudinal slit, but sometimes with one or two longitudinal grooves, which do not penetrate the shell; without operculum, and without interior partitions, but having a persistent point, sometimes curved backward. The greatest width is at the opening, which is oblique or normal to the axis of the shell."

This definition of the genus, applied to the American forms known to us, renders the distinction between Tentaculites and Styliola sufficiently clear. M. Barrande has remarked, with much reason, that from the nature of these

slender forms, without surface ornament, great difficulty will arise in indicating specific distinctions among the STYLIOLA. We may add that in *Tentaculites* (*Styliola*) *fissurella* many of the specimens are expanded or bulbiform at the apex, corresponding in this respect with the existing forms of STYLIOLA. This feature, however, is not observed in another form here described.

Since this genus has not heretofore been noticed in America, I cite from M. BARRANDE (*Système Silurien*, pp. 135, 136) the condensed information given, as below.

"VERTICAL AND HORIZONTAL DISTRIBUTION.

"We have already shown in our table (p. 123) the vertical and horizontal distribution of Styliola with that of Tentaculites, in palæozoic countries. The principal facts established for the first of these two genera are as follows:

"1. *Styliola* is thus far known only in certain countries of the old continent, which appertain, some to the great southern zone, and others to the great central zone. None have been found in the palæozoic regions of America, nor in those of the north of Europe.

"2. No species of Styliola has hitherto been observed in the primordial Silurian fauna, nor in the second fauna. As the second fauna presents about seven distinct species of Tentaculites, spread through many countries, it follows that the form which appears the most simple, among these two types, is precisely that which has appeared the later during the palæozoic times, at least according to the actual state of our knowledge.

"3. The total number of forms of Styliola, designated by names, is nine. The most ancient of these forms made their appearance during the existence of the third Silurian fauna, and they have been designated by three specific names. They are included in the geographical space occupied by Bohemia, Thuringia and the Harz.

"4. The remaining six described forms belong to the Devonian period, and to the countries on the borders of the Rhine, the Harz, Thuringia and Saxony.

"We may remark the inequality of their vertical extent. A single form (*Styl. lævigata*, RŒMER) is found in the schists of Wissenbach, that is to say, in the inferior subdivision of the Devonian system, according to the classification of Sir ROD. MURCHISON (*Siluria*, p. 419. 1859). Its presence is also indicated by Prof. F. A. RŒMER in the Stringocephales limestone of the Harz, that is to say, in the middle subdivision. The five other species all belong to the superior subdivision of the same system, for they have been found only in the Cypridinia schists, and in the formation called Kramenzelstein which makes part of the same subdivision.

"The following table indicates the vertical range:

"Styl. striata, . .	Richter, . .	Cypridinia schists,	*Devonian fauna.*
St. lubrica, . .	Ludwig, . .	Kramenzelstein, .	III.
St. intermissa, .	" . .		
St. crenato-striata,	" . .		
St. bicanaliculata,	" . .	Eifel, ...	II.
St. lævigata, . .	F. A. Rœmer,	Harz, ...	
St. lævigata, .	"	"	I.

"The majority of the known forms of this type being found in the formations which crown the Devonian system, we may be surprised at their sudden and total disappearance before the end of these deposits. No form of the genus Styliola has hitherto been observed in the Carboniferous system, which also contains no trace of Tentaculites. These two genera seem then to disappear at the same time, which renders their reciprocal relations more marked."

One species at present known to us in America has a comparatively extended geological range. The *S. fissurella* begins its existence in the Marcellus shale, occurs also in the shales of the Hamilton group above, and in the Genesee slate, disappearing in the Olive shales above the base of the Portage group. In the Marcellus shale, and lower part of the Hamilton group, this species is associated with *Tentaculites gracilistriatus*, but the latter form is at present unknown in the centre of the Hamilton group or in any higher position; the Styliola alone, so far as known, being present in the superior strata.

In its geographical distribution, the *S. fissurella* has a remarkable range, being known throughout the entire extent of the State of New York from east to west — a distance of more than three hundred miles. It also occurs in the western extension of the Genesee slate and associated rocks, in the State of Indiana, where the New Albany black shale, at Lexington, presents large surfaces quite covered with Styliola. It has, therefore, a geographical extension of more than seven hundred miles in a direct line from its most easterly known locality. There is little doubt but it will be found also in Ohio and in Canada West (Ontario).

In some of its phases it does not seem possible to separate this species from *Styliola clavulus*, of Barrande, by any external or internal characters thus far described or illustrated. The fossils are minute, smooth or striated acicular tubes, presenting in all respects similar features, and having similar associa-

tions; and they are of the same geological age in the two countries. In very numerous examples these fossils are striated transversely or longitudinally, and not unfrequently the two sets of striæ are visible on the same specimen. These are apparently only varieties of form and condition of the *Styliola fissurella*.

STYLIOLA FISSURELLA.

PLATE XXXI A, FIGS. 1-30.

Tentaculites fissurella, HALL. Geol. of N. Y. Surv. Fourth Geolog. Dist., p. 180, figs. 9 and 10, and p. 222, fig. 4. 1843.

Not *Tentaculites fissurella*, HALL. Illustrations of Devonian Fossils: Pteropoda, pl. 25, figs. 12–14.* 1876.

FORM an extremely slender, elongate cone, like the point of a small needle. Apical portion of the tube solid. Apex extremely minute, often bulbiform, and very gradually enlarging to the mouth.

SURFACE often smooth and without any visible ornamentation, so far as can be determined; or with fine striæ of growth, which are unequally developed on different parts of the shell; and also with fine longitudinal striæ, which may be present with or without transverse striæ. Usual length from one to two, sometimes two and a half, and rarely five millimetres.

This species occurs in the Marcellus shale and lower part of the Hamilton group, associated with *Tentaculites gracilistriatus*, and it is quite possible that some of the larger specimens, noticed in the mass of individuals, may be casts of the interior of that fossil, which do not show the marks of annulations, and in such conditions the smaller forms may not always be readily distinguishable from the smooth apices of the TENTACULITES. These two species together often compose almost entire layers of the rock.

In the soft calcareous shales, the STYLIOLA retains nearly its full form; while in the finely laminated slates it is always compressed, except the solid apex, showing a sharply depressed line of fracture for nearly its entire length; and

* The specimens figured in the "ILLUSTRATIONS OF DEVONIAN FOSSILS" were from slabs containing both he *Styliola* and *Tentaculites gracilistriatus*, and the erroneous reference escaped the author's notice.

where this line meets the aperture it often produces a slight notch in the margin, giving the characters suggestive of the original name. When occurring in calcareous bands this feature is not characteristic.

This little fossil presents such a variety of aspect that I had already designated the various prevailing forms as distinct species, before having had the opportunity of examining the larger collection from which many of the illustrations on plate XXXI A are drawn. A final comparison among a very large number of specimens seems to indicate that these phases are due to the presence or absence of certain external features originally characterizing the individual, which have been modified to a considerable degree by the nature of the sediments and the conditions of preservation.

Formations, localities, etc. The most easterly appearance of this species is in the black Marcellus shale at the base of the Hamilton group, in Schoharie county; at Cherry Valley and other localities in Otsego county. It is found near Alden, Erie county, where it is extremely abundant, the shale being completely filled with this fossil and *Tentaculites gracilistriatus*, and its occurrence is likewise known quite to the western limits of the State. In the shales of the Hamilton group, it is associated with a stouter form. In the Genesee slate it is extremely abundant, covering large surfaces, and forming alone, or with the TENTACULITES, calcareous bands several inches in thickness, the whole having a subcrystalline aspect. This feature has been especially noticed in the upper part of the slate in Bristol, Ontario county, and also in Erie county. It occurs at Ithaca, and in the Cashaqua shales, near Mount Morris in the Genesee valley, and elsewhere in central New York. In the green shales of the Portage group it is common, but less abundant than in the Genesee slate. In the latter, throughout central and western New York, this species is associated with *Chonetes lepida*, and in the black slate at Lexington, Indiana, we find the same association of species.

At an exposure of the Genesee slate, on the Cayuga creek, two and a half miles southwest of Alden, in Erie county, there is a calcareous layer of six inches thick, composed entirely of the shells of *Styliola fissurella*, with a small number of *Tentaculites gracilistriata*.

Styliola fissurella, var. strigata.

PLATE XXXI A, FIGS. 2, 31 and 32.

Form a minute elongate, attenuate cone, regularly enlarging from the apex to the aperture. Apex solid.

Surface longitudinally striated, with comparatively coarse striæ; sometimes with obscure transverse striæ or undulations. Length of specimens from two to three millimetres.

The angle subtended by the apex is greater than in the ordinary smooth *S. fissurella;* the shell is strong, and, while tapering regularly for some distance from the apex, appears to be more abruptly expanded towards the aperture, and therefore does not present a uniform attenuation.

The surface striæ are comparatively strong and apparently crenulate, while in certain aspects there is an obscure appearance of undefined transverse undulations. The more marked forms of this variety have been found associated with *Tentaculites gracilistriatus* and *Goniatites plebeiformis* in the shaly laminæ of the Goniatite limestone.

Formation and localities. In the Marcellus shale and in limestone concretions in the shale, associated as above, at Cherry Valley; and in laminated shale at West Winfield, Herkimer county, N. Y.

Styliola fissurella, var. obsolescens.

PLATE XXXI A, FIG. 33.

Shell an extremely elongated cone, with the apex obtuse or slightly bulbiform; gradually enlarging for about one-third or more of its length, thence becoming more nearly cylindrical towards the aperture.

Surface obscurely striated longitudinally, and under ordinary conditions appearing smooth; transverse striæ not observed. Length about four mm.

This variety, in its general form, resembles the *Tentaculites intermedius* of Barrande, but it is without the transverse striæ which are seen in that species. It occurs in the shales with the smaller forms of *S. fissurella* and *Tentaculites*

gracilistriatus, having the general aspect of a large individual of the former, and distinguished by the extremely fine longitudinal striæ, which are visible under a magnifier. A few specimens only of this variety have been observed, occurring upon the surface of a slab of shale, which shows several hundreds of the smaller forms.

Formation and locality. In a grey shale at the base of the Hamilton group.

Styliola fissurella, var. intermittens.

PLATE XXXI A, FIGS. 11–17.

Shell a minute, extremely elongate-conical tube, having a length of from one and a half to five mm. Surface marked by fine transverse striæ, which appear to be crowded, or the shell thickened at regular or irregular intervals, giving an undulated or obscurely annulated appearance. This feature is often more conspicuous in specimens where the shell is partly exfoliated. In this respect it may be compared with *Tentaculites intermedius* of Barrande, in which the annulated character is more obscure.

This form, which cannot be separated from *S. fissurella* by any constant and reliable characters, presents much variety of aspect in its different conditions, and the same individual sometimes combines all the features observed in the species. The transversely striate character is rarely regular or uniform, but usually somewhat fasciculate, and prevailing over all other surface marking, while not unfrequently there are obscure indications of longitudinal striæ, which in many individuals assume an equal strength with the transverse markings, and present a minutely cancellate structure. It not unfrequently happens that these markings are not uniform over the entire surface of the same individual, and the variation is so great as to preclude the possibility of recognizing as distinct species any of the forms here noticed.

The illustrations of *S. fissurella* on plate XXXI A, represent the principal phases of this very variable fossil as presented in the Marcellus shale, the Hamilton group, and the Genesee slate. In the Cashaqua shale and the succeeding shaly rocks of the Portage group these fossils are usually in such a

condition that no satisfactory illustration can be given. The *Tentaculites gracilistriatus* occurs in constant association with the *S. fissurella*, and is abundant in the Marcellus shale and lower beds of the Hamilton group, while in the abundant development of the latter fossil in the Genesee slate, the former is comparatively rare.

Formation and locality. In some compact layers of the Genesee slate to the south of Alden, in Erie county, N. Y.

Styliola obtusa, n. sp.

PLATE XXXI A, FIGS. 34-36.

Form a minute elongate cone, comparatively robust in its proportions. Apex solid, often obtuse or rounded, and appearing as if worn.

Surface smooth. Length of ordinary specimens one and a half to two millimetres, often two and a half, and rarely three millimetres.

The angle subtended by the sides is greater than in *Tentaculites gracilistriatus*, and much greater than that of *Styliola fissurella* in similar conditions. The surface appears to be entirely smooth, but perhaps it may have been very finely striated in its living condition. The form is round though often appearing, as the result of compression, obtusely subangular towards the aperture.

It is distinguished from *Tentaculites gracilistriatus* by its more obtuse form, especially at the apex, and the absence of annulations. From *Styliola fissurella* it differs in its stouter and more obtuse form. The apical portion of *T. gracilistriatus*, occurring in the same rock, is distinguished by its more slender form and the obscure annulations in receding from the apex.

The prevailing form occurring in the shales of the Hamilton group, preserves no visible striæ, and the apex is quite obtuse, often appearing as if worn. In some calcareous bands there occur a few specimens of a very similar fossil, which show minute striæ, but their identity has not been determined.

Formation and localities. In shales of the Hamilton group at Darien Centre, Genesee county, and on the shores of Canandaigua lake in Ontario county, N. Y.

COLEOPRION, Sandberger (1847).

In 1847 Dr. G. Sandberger established the genus Coleoprion, upon a fossil form found in the "Spirifer sandstones," near the base of the Devonian system in the Rhenish provinces, giving the following generic description:

"Shell tubuliform, appearing as an elongate cone, encircled by oblique annulations, which are interrupted along a longitudinal line, and attenuate at their extremities; internal walls of the shell smooth."

The typical form described by the author is *C. gracilis* (Leonhard and Bronn, *Jahrbuch* I, p. 25, pl. 1, fig. 15).

In 1852 the author reproduced his description of the genus and typical species, comparing this new type, from the Spirifer sandstones, with the genus Creseis, which he regards as its nearest analogue among the existing fauna (*Verstein. des Rheinischen Schichtensystems in Nassau*, p. 246, pl. 21, fig. 8).

In 1857 Dr. Ferd. Rœmer quoted the observations of Dr. Sandberger on the genus Coleoprion and the typical species *C. gracilis*, remarking upon the resemblance between Coleoprion and the recent genus Creseis (*Lethea Geogn.* II, Lief. p. 439).

In 1864 Prof. Ludwig defined the genus Coleoprion, describing a new species, *C. brevis*, from the upper part of the Devonian system in the Rhenish provinces (*Palæontographica*, p. 322, pl. 50, fig. 23).

In 1865 M. J. Barrande indicated the presence of Coleoprion in the Silurian basin of Bohemia (*Defense des Colonies*, III, p. 41).

In 1867 M. Barrande gave a resumé of our knowledge of the genus, and described two species, *C. Sandbergeri* and *C. Bohemicum*, from the Silurian basin of Bohemia.

In 1876 the writer referred to this genus a new species (*C. tenuicinctum*), from the Hamilton group (middle Devonian), of the State of New York (*Illustrations of Devonian Fossils*, pl. 27. A subsequent examination of this fossil with a larger collection of specimens before me, has proved that it does not possess the characteristic features of the genus Coleoprion, as will be shown in these pages.

The following form I refer with doubt to the genus Coleoprion.

COLEOPRION? TENUIS, n. sp.

PLATE XXXII, A, FIGS. 1, 2.

FOSSIL a slender elongate, subcylindrical tube; section apparently subelliptical. Length of specimen two centimetres, with a width, as presented in the stone, of scarcely one millimetre.

SURFACE marked by oblique, interrupted, undulating striæ, which converge to a distinct longitudinal groove extending the entire length of the shell.

The specimen is an extremely slender subcylindrical tube, which on one side presents a distinct groove. The transverse striæ, on approaching this groove, are turned abruptly forward or apparently toward the larger extremity of the shell. The characters presented are not precisely in accordance with the generic description of COLEOPRION, and I therefore refer the species with doubt to that genus.

Formation and locality. In shales of the Hamilton group, associated with *Tentaculites bellulus* at Arkona, Ontario. C. W.

COLEOLUS, N. GEN.

COLEOPRION, HALL (1876). Not *COLEOPRION*, SANDBERGER (1847).
ORTHOCERAS, YANDELL and SHUMARD. Geology of Kentucky, p. 15. 1847.

SHELL tubuliform, extremely elongate-conical, straight or slightly curved, comparatively thick; inner walls smooth.

SURFACE marked by annulating striæ or rings which are more or less oblique, or sometimes rectangular to the axis: sometimes longitudinally striated.

A critical study of other specimens of the species described by me as *Coleoprion tenuicinctum* has shown the impropriety of its reference to that genus. The oblique elevated striæ or annulations, characteristic of the genus, and which were apparently interrupted by a longitudinal groove, are found to be continuous, the apparent groove being due to fracture from compression of the tube, as may be seen in figures 6–8, plate XXXII A, which present the

ventral side of the specimen, and show on one part the continuous arching striæ free from interruption by the fracture. This freedom from a longitudinal groove or interruption of the striæ is still more completely shown in the specimens from the Falls of the Ohio, which are larger and usually better preserved than those of the Hamilton group in New York.

Dr. SANDBERGER has included similar, but somewhat larger, forms under the genus DENTALIUM (*D. annulatum* and *D. tæniolatum*), but the rigidly straight form and annulated surface of *C. tenuicinctum* are scarcely compatible with the typical forms of that genus, and it seems necessary therefore to adopt some other designation.

COLEOLUS TENUICINCTUM.

PLATE XXXII, FIGS. 5-9; AND PLATE XXXII A, FIGS. 6-10.

Coleoprion tenuicinctum, HALL. Illustrations of Devonian Fossils: Pteropoda, pl. 27, figs. 1–4. 1876.
Orthoceras, YANDELL and SHUMARD. Geology of Kentucky, page 15. 1847.

SHELL an extremely elongate, gradually and regularly tapering cone, having in the largest individuals, a diameter of six millimetres at the larger extremity, with a length of seventy-five millimetres.

SURFACE marked by fine closely arranged striæ, or frequently with more distant oblique annulations, receding from the aperture, or sinuate on the ventral side—the degree of obliquity depending upon the position of the fossil, or the relation of the parts exposed to view. Interrupted longitudinal striæ are visible in well preserved specimens.

The individuals of this species are quite common in some localities of the Hamilton shales in the State of New York, but they are almost always in a crushed condition, and showing a line of fracture which may be mistaken for a longitudinal groove. The specimen originally figured is but slightly compressed, and the annulations are more distant than on any other one observed.

The diameter and length of specimens vary to a considerable degree, and no individual in the Hamilton shales has yet been found entire—the extreme apex being unknown. The specimens are usually rigidly straight, though sometimes curved towards the smaller end, as represented, probably occurring

from accident. The surface-marking is subject to considerable degree of variation in the strength of the annulations, which are sometimes sharp elevated rings, and are variable in their distance from each other, while in other parts of the same specimen they are reduced to fine striæ. In two specimens only, are we able to observe what appears to be the position of the ventral line; but there is no evidence of a groove or interruption of the striæ, except where the specimen has been compressed, and this groove is apparently the result of a fracture of the shell. In another part of one of the specimens thus marked, the annulating striæ converge towards the apical extremity, but are continuous across the body of the shell, as shown in figure 8 of plate XXXII A.

At the present time I see no reason for separating the form found at the Falls of the Ohio from those of the Hamilton shales in New York. The latter is usually stronger and always rigidly straight; the annulations, where well preserved, are sharply elevated and present the characters of the best preserved specimens in New York. Among a considerable number of specimens from the western locality, none of them preserve any evidence of a longitudinal groove or sinus; the annulating rings are continuous and distinctly oblique, except when the dorsal or ventral side of the specimen is presented to view.

This species has a wide geographical distribution in the Hamilton group; and if we recognize the rigid, compressed tubular forms in the Genesee slate and Portage group, and also in the Marcellus shale, as the same, or only a variety of the same form, with the surface-markings obliterated by maceration, we have also a great vertical range for the species.

From the occurrence of these forms with TENTACULITES and STYLIOLA, it may be inferred that they have had the same mode of life, and that they more properly belong to the Pteropoda than to the Gasteropoda.

Formation and localities. In the shales of the Hamilton group near Fultonham, Schoharie county; at Sherburne creek, Chenango county; at Delphi, Onondaga county; on the shore of Cayuga lake in several localities; and at Hamburgh, on the shore of Lake Erie; having a geographical range of more than 300 miles within the State of New York. It also occurs in limestones of the age of the Hamilton group at the Falls of the Ohio.

Coleolus aciculum.

PLATE XXXII A, FIGS. 11–15 (16?).

Orthoceras aciculum, Hall. Geol. of N. Y. Surv. Fourth Geolog. Dist., p. 243, fig. 4. 1843.

Fossil extremely elongate, cylindro-conical, having in the larger specimens a diameter at the base (in its flattened condition) of about seven millimetres, with a length of more than three inches, becoming extremely slender and attenuate towards the apex.

These fossils usually appear to have been subjected to maceration in the muddy sediment, and seldom preserve any indication of surface-markings. There are rare examples, which present some evidence of obscure annulations or striæ.

The specimens are usually much compressed and entirely inseparable from the surrounding shale, and so destitute of external characters that they could not, by themselves alone, be referred to any known organic forms. From their general similarity of form and proportions, I had compared them with *Coleolus tenuicinctum*, while one or two specimens of recent acquisition, from the shales of the Portage group, which are apparently referable to the same form, preserve some obscure surface-markings.

These fossils occur in the Genesee slate, and in the olive shales of the Portage group; in the latter formation appearing usually as the slender attenuate bodies represented in figure 14 of plate XXXII A. Similar slender forms also occur with the more elongate ones in the Genesee slate, as shown in figure 13. These slender bodies in the Portage group are doubtless identical with the one described by me as *Orthoceras aciculum* ut cit. The original of this species is not now accessible to me; but an examination of all the similar forms in the same formation shows them to be destitute of septa, and therefore not referable to Orthoceras.

It is with much hesitation that I separate these forms from *C. tenuicinctum*; but in the absence of evidence of absolute identity, I leave them under the original specific designation. The following forms, figured on plate XXXII

A, figs. 11–14, are here recognized under this specific term, while figures 15 and 16 may perhaps be only varieties of the same species: the first of these preserving obscure transverse markings, while the latter in one part is indistinctly cancellated.

Formations and localities. In the upper part of the Genesee slate near Bristol Centre, Ontario county, and in other localities in central and western New York; in the Cashaqua shales of the lower part of the Portage group on the banks of the Genesee river, and in the same geological position near Ithaca, N. Y.

Coleolus crenatocinctum, n. sp.

PLATE XXXII, FIGS. 1, 2, 3, AND PLATE XXXII A, FIGS. 3, 4.

Shell an extremely elongated cylindro-conical tube, which tapers very gradually from the larger extremity towards the acute apex. Section circular. Shell substance comparatively thick and strong.

Surface annulated by narrow crenulated rings, which appear to be directly transverse.

The largest diameter of the imperfect specimen, figure 1, plate XXXII, is five millimetres, and at the smaller end approximating three and one-half millimetres, with a length between these points of about four centimetres. Another fragment in the same rock measures fully seven millimetres in diameter. The longest specimen observed, and which, in the absence of surface-markings, I have referred with doubt to this species, is about three and a half inches in length.

This species occurs in the higher beds of the Upper Helderberg group, and in some localities it is quite abundant. The specimens, figures 1 and 2, plate XXXII, are in a decomposing chert, and the shell is silicified; a single fragment only preserving the surface-markings, as represented in fig. 2. The directly transverse aspect of the annulations may be due to the position of the specimen, though we have no evidence of their oblique direction.

In the specimen, figure 1, plate XXXII, the shell is shown to have been replaced by layers of siliceous matter. The comparative diameter of the

interior and the exterior, with the thickness of the shell, is shown in the small circular figure. The specimen, figure 3, is an extremely elongated tubular body in compact limestone; but its surface characters are entirely obliterated by weathering. In a single small block of shaly limestone there are three similar forms—one of which shows obscure transverse markings (plate XXXII A, figure 3).

At a locality of the higher beds of the limestone in Erie county, some tubular bodies which I refer to this species are very abundant. The shell is thick and converted into spathic calcite (figure 4, plate XXXII A).

Formation and localities. The typical specimens occur in the higher cherty beds of the Upper Helderberg limestone at Jamesville in Ontario county. The species also occurs to the south of Columbia in Herkimer county, and at Eastman's quarry in the south part of Oneida county; and is abundant in the limestone at Clarence Hollow in Erie county, N. Y.

Coleolus? Mohri, n. sp.

PLATE XXXII A, FIG. 5.

Form cylindro-conical, elongated, curved and very gradually attenuate from the larger extremity.

Surface transversely striated.

The length of the fragment under examination, which is curved and imperfect at both extremities, is about three and a half inches. Diameter at the larger extremity about half an inch, and at the smaller extremity one-quarter of an inch. The shell has been comparatively thick, and is converted into crystalline, calcareous matter.

The surface has been marked by somewhat regular transverse striæ, which, as preserved in the impression of the exterior, have been sometimes crowded into fascicles of unequal strength. In the impression of one side of the shell, there is no evidence of an interruption of the striæ, or of any longitudinal striæ.

This tubular fossil is referred to the genus Coleolus with much hesitation,

both on account of its great size and length, and also of its curved form. The latter feature, however, may have come from accidental causes.

Formation and locality. The specimen figured is from the cabinet of Mr. PAUL MOHR, of Cincinnati, and was found in the Upper Helderberg limestone in the eastern part of Indiana.

COLEOLUS (DENTALIUM?) ACICULATUM.

PLATE XXXII A, FIGS. 17, 18.

Dentalium aciculatum, HALL. Thirteenth Report N. Y. State Cab. Nat. Hist., p. 107. 1860.

FORM slender, elongate, cylindrical, tubular, very gradually attenuating from the base.

SURFACE striated?

The specimens under examination are several fragments of longer tubes, but there are no entire examples. Some of these are very slightly curved while others are entirely straight, and it is possible that the curvature may be due to accident. From the specimens examined no satisfactory determination of the surface-markings can be made.

Formation and locality. In the Goniatite limestone of the Marcellus shale at Manlius, N. Y.

COLEOLUS? GRACILIS, n. sp.

PLATE XXXII A, FIG. 19.

FORM extremely attenuate, slightly curving, elongate, cylindro-conical, tubular. Shell comparatively thick.

SURFACE unknown, but apparently transversely striate.

All the fossils of this species which have come under my observation are imbedded in a compact, calcareo-arenaceous rock, the shell adhering firmly to the matrix, while the cast of the interior is all that can usually be seen. The specimens observed are all slightly curved.

Formation and locality. In some compact layers of the upper part of the Chemung group, associated with *Bellerophon Mæra* and *Loxonema postremum*, near Nichols, Tioga county, N. Y.

HYOLITHES, Eichwald.

The genus Hyolithes was founded by Prof. Eichwald in 1840, who gave the following definition:

"The bodies which I name Hyolithes are very peculiar; they appear to be the internal moulds of tubes, but I do not know from what animals they are derived; it is possible that they belong to genera like Orthoceratites.

"These bodies are linguiform, terminated in a somewhat flattened point, but still somewhat convex on each of the plain sides, so that they have a thickness of four and a half lines, and a width of six and a half lines. There are others less completely preserved, which are wider and longer" (*Sil. Schicht. Syst. in Ehstl., p.* 97).

Following this definition, the author describes *Hyolithes acutus*, in which he observes that the shell is striated in two directions; and farther notices that the interior of the shell is divided into a series of parallel and oblique divisions or chambers. He places the Hyolithes provisionally among the Cephalopads.

In the same year (1840), bodies of identical form were described and figured, by Count Munster, under the name of *Orthoceras anceps* (*Beitrage*, vol. 3, p. 104, pl. 9, fig. 6).

In 1843 Capt. Portlock described a species of this genus from the Lower Silurian rocks of Ireland, under the name of *Orthoceras triangulare* (*Rept.*, p. 375, pl. 28 A, figs. 3 a, b, c), placing the same under the head of doubtful Orthoceratites.

In 1845 M. E. de Verneuil and Count Keyserling expressed an opinion that the bodies described by Prof. Eichwald were the internal moulds of the siphon of *Orthoceratites* (*Russia and the Oural Mts.*, vol. 2, p. 350).

In 1845 Sowerby founded the genus Theca upon a similar fossil from New South Wales, and this generic term was adopted by Morris, Sharpe, Hall, Salter, Marie Rouault, McCoy, de Verneuil, Barrande, Hawse, F. Rœmer, Schmidt, Prof. Quenstedt, E. Boll, E. Billings, R. Ludwig, Prof. Angelin,

KJERULF, F. A. RŒMER and others, in ignorance of the preëxisting name of HYOLITHES.

In 1847 M. BARRANDE proposed the name PUGIUNCULUS, and was followed by SANDBERGER and others.

In 1848 Mr. SALTER described *Theca anceps*, from the Upper Silurian of the Malvern Hills (*Memoirs of the Geol. Survey*, vol. 2, pp. 255–355, pl. 14, fig. 17).

In 1850 Prof. D'ORBIGNY proposed the generic name of VAGINELLA, which includes fossils of the genus THECA=HYOLITHES as well as other forms.

In 1857 the Chevalier EICHWALD reproduced the generic description of his genus HYOLITHES, making reclamation of priority for the name (*Beitr., in Bull. Soc. Imp. des Nat. de Moscou*, p. 146).

In 1864 Prof. LUDWIG included these forms under CLEODORA, and SALTER, in 1866, under the genera CLIDOTHECA and CENTROTHECA in part.

The American species of this genus have been described in the following order:

In 1847 the writer described *Theca triangularis* (*Pal. N. Y.*, vol. 1), which was subsequently re-described by BILLINGS (1871) as *Hyolithes Americanus;* the name *triangularis* having been preoccupied by PORTLOCK in 1843.

In 1851 I indicated the occurrence of similar bodies at the base of the Calciferous sandstone on the Escanaba river (*Foster and Whitney's Report on the Lake Superior Land District*). These fossils are probably identical with those subsequently described as *Theca primordialis.*

In 1860 I described *Pugiunculus? (Theca) aculeata*, from the Goniatite beds of Rockford, Indiana; in 1861 *Theca primordialis*, from the Potsdam sandstone of the Mississippi Valley, and in 1862 *Theca parviusculus*, from the Hudson River group, and *Theca ligea*, from the Upper Helderberg group.

In 1861 MEEK and HAYDEN described *Theca gregaria*, from the Potsdam sandstone of the Big Horn mountain (*Proceedings Phila. Acad. Nat. Sci.*).

In 1871 E. BILLINGS described *Hyolithes Americanus* (= *Theca triangularis*, HALL, 1847), and in 1874 *H. communis, H. princeps and H. excellens;* all from the Potsdam group.

In 1872 Mr. FORD described *Hyolithes impar*, and in 1873 *H. Emmonsi*, from the Potsdam group.

In 1873 HALL and WHITFIELD described *Hyolithes gibbosus* (probably a variety of *H. primordialis*), from the Potsdam sandstone.

In 1876 the writer designated and illustrated *Hyolithes principalis*, from the Upper Helderberg group, *H. aclis* and *H. striatus*, from the Hamilton group.

In 1877 Dr. T. T. BARRETT described *H. centennialis*, from the Lower Helderberg group.

Two other species, *H. triliratus* and *H. singulus* are added to the list in the present volume.

The American species of the genus HYOLITHES, according to their respective authors, are distributed as follows:

Hyolithes (Theca) aculeatus,	HALL	Lower Carboniferous.
H. aclis,	"	Hamilton group.
H. triliratus,	"	
H. singulus,	"	
H. striatus,	"	
H. ligea,	"	Upper Helderberg group.
H. principalis,	"	
H. centennialis,	BARRETT	Lower Helderberg group.
H. parviusculus,	HALL	Hudson River group.
H. Americanus,	BILLINGS	Potsdam sandstone.
(= triangularis,	HALL)	
H. communis,	BILLINGS	
H. Emmonsi,	FORD	
H. excellens,	BILLINGS	
H. gibbosus,	H. and W.	
H. gregarius,	MEEK and HAYDEN,	
H. impar,	FORD	
H. primordialis,	HALL	
H. princeps,	BILLINGS	

In this enumeration of eighteen species some allowance may, probably, be necessary for repetition, owing to the studies having been made from incomplete or insufficient material, and from the want of a comparison of collections from the several localities. As these are now recorded, we have nine species from the primordial zone, one species from the second horizon, one from the third; six species occur in the Upper Helderberg and Hamilton groups which, from the occurrence of many identical species of fossils, are regarded as

corresponding in age to the formations of the Rhenish provinces of Europe, and, with our present knowledge, are parallelized with the Devonian. One species may be referred to the lower formation of the carboniferous system of America as at present recognized.

It is certainly surprising that no species of HYOLITHES has been noticed in the extensive collections made in the Niagara group of New York, Canada, Wisconsin, Indiana, Illinois, Kentucky and Tennessee. Very abundant collections have also been made in the Lower Helderberg group in New York, Canada, Maryland and Tennessee, in which no species of HYOLITHES has occurred, except the one described by Dr. BARRETT.

In 1867 M. BARRANDE (*Système Silurien du centre de la Bohème*) enumerates thirty-three distinct species as occurring in the Silurian formations of Bohemia; and in the palæozoic formations of all countries, including Bohemia, he enumerates eighty-four species. Of this number, ten species occur in the first, forty-two in the second, and twenty in the third fauna of the Silurian system, as recognized by M. BARRANDE. Ten species occur in the Devonian and one in the Permian.

The contrast in the number of species found in the different horizons in all other palæozoic countries, when compared with those of the United States, is very marked. While in the second fauna of European countries we have more than twice as many species as in any other horizon, we have in America, in the corresponding formations, but a single known species. In the third fauna, which corresponds in part to our Niagara and Lower Helderberg groups, we have, in all other countries, twenty species, while in America we know but a single one. Regarding the Upper Helderberg, Hamilton and Chemung groups, as representing the Devonian of Europe, we have four species, while there are nine species in the European formations of the same age.

The American species, so far as known, are much restricted in their geographical range. Those of the Upper Helderberg are limited to two known localities; while those of the Hamilton group are confined to the central part of the State of New York; those of the second and third Silurian faunæ are known only in the localities from which they have been described. Our

knowledge of the species of the primordial zone is too limited to speak with confidence of their geographical distribution.

In the primordial zone, the fossils of this genus are associated with Linguloid and Oboloid shells, and often with Trilobites; but the most prolific Trilobite sandstones in the Mississippi Valley rarely contain them. The rare occurrence of HYOLITHES in the second and third horizons does not admit of faunal comparisons, and the same may be said of those occurring in the Upper Helderberg group. In the Hamilton group the association of HYOLITHES is with numerous Brachiopoda, many Lamellibranchiata (especially of the Nuculoid forms), some Gasteropoda and many Trilobites of a single species. The older forms occur in a nearly pure sandstone, and in calcareous sandstone, as well as in more argillaceous beds. The species of the second fauna occur in a semi-calcareous shale; and those of the third fauna in limestone. The two species of the Upper Helderberg group are in limestone or arenaceous limestone, and those of the Hamilton group in semi-calcareous shales.

Some, at least, of the older forms are chitinous or phosphatic in their structure, and we have observed the same conditions in some of those of the primordial zone of Sweden. Those of the second and third faunæ, and those referred to Devonian age, are calcareous. In the two former the shells are comparatively thick and strong, and in the latter they are thin and fragile.

HYOLITHES LIGEA.

PLATE XXXII, FIGS. 11-16.

Theca ligea, HALL. Descriptions of New Species of Fossils, etc., p. 34. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 62. 1862.
Hyolithes ligea, " Illustrations of Devonian Fossils: Pteropoda, pl. 27, figs. 13–16. 1876.

FORM an elongate subtriangular pyramid, with the lateral margins acute, gradually tapering from the base to an acute extremity. Transverse section somewhat semi-elliptical, with a moderate convexity on the ventral side, the lateral edges compressed and subacutely angular. Ventral face gently convex, both transversely and longitudinally. Dorsal face highly convex, slightly concave in a longitudinal direction, and obtusely angular

along the centre, the angularity gradually disappearing toward the aperture. Aperture oblique, the shell on the ventral side extending forward in a broadly spatulate expansion, while the dorsal margin is broadly sinuate, the peristome being apparently slightly thickened. Operculum unknown. No traces of septa in any part of the body.

Surface with some marks of arching transverse striæ, which curve towards the aperture on the ventral side, and in the opposite direction upon the dorsal side, or parallel to the margins of the aperture. The ventral side presents two longitudinal depressed lines, which are faintly visible on the surface of the cast. These lines are nearly parallel to the lateral margins, and rather more than one-third of the distance from the margin to the center, but running to the margin a little distance below the apex.

The typical specimen is represented in figs. 11, 12 and 13. The specimens figured are casts of the interior, the remains of the crystalline substance representing the shell having a thickness of about one millimetre.

A single specimen referred to this species is somewhat irregular in its mode of growth, and more attenuate towards the smaller extremity. In many respects this species is similar to what we may suppose to be the young of *H. principalis;* but that species is proportionally narrower in its upper part, and more abruptly expanding below.

Formation and localities. In the Schoharie grit at Schoharie, and in the upper part of the limestone at Clarence Hollow, in Erie county, N. Y.

Hyolithes principalis.

PLATE XXXII, FIGS. 17-21.

Hyolithes principalis, Hall. Illustrations of Devonian Fossils: Pteropoda, pl. 27, figs. 17-20. 1876.

Form an elongated triangular pyramid, which is slightly curving towards the dorsal side, apparently more abruptly expanding towards the aperture than in the upper part. A transverse section below the middle of the length is semi-elliptical, with a width twice and a half as great as the height; the lateral angles moderately acute. Ventral face gently convex

transversely, and somewhat curving longitudinally. Dorsal side strongly convex transversely, the two inclined faces meeting in a prominent, obtuse angularity along the middle of the length, slightly incurved or concave in a longitudinal direction. The aperture is oblique; the peristome on the dorsal side receding in a broad sinus, which has a depth of fully half the width of the shell at that point. Operculum unknown. The imperfect specimens give no evidence of the presence of septa.

Surface unknown, the shell not having been preserved. The casts present faint evidence of transverse striæ, which are also shown in a gutta-percha impression, from a mould of the external surface in figure 20.

This species, in its full extent, has had a length of more than one hundred millimetres, and the width of the shorter fragment at base is about thirty-five millimetres. The larger fragment, if complete, would have a width of about fifty millimetres.

Formation and locality. In the Schoharie grit at Schoharie, N. Y.

Hyolithes aclis.

PLATE XXXII, FIGS. 22-30; and PLATE XXXII A, FIGS. 23, 24, 25.

Hyolithes aclis, Hall. Illustrations of Devonian Fossils: Pteropoda, pl. 27, figs. 5, 6, 7, 10 and 11. 1876.

Form an elongate triangular pyramid, gradually and regularly tapering to an acute extremity. Transverse section somewhat semi-elliptical or subtriangular, a little convex on the ventral side, about twice as wide as high; the lateral margins obtusely angular, sometimes attenuate from compression. Ventral face gently convex, and slightly curving in a longitudinal direction; anterior portion extended in a subspatulate expansion. Dorsal face highly convex transversely, and obtusely angular along the middle; very slightly concave longitudinally. Aperture oblique, the margin extended on the ventral side; on the dorsal side the peristome is not fully determined, but is apparently nearly straight on the sides, with a sinus at the angle. Operculum in general form subelliptical, the body of

which is moderately convex; the ventral margin (or that corresponding to what may be termed the ventral side of the shell) is regularly curving. The umbo is situated about three-fourths of the width from the base, and extending thence on each side, almost rectangularly to the transverse axis, is a distinct fold which gradually expands towards the margins, and below which is a corresponding groove or channel. Above this fold is a narrow border or flange, which turns upward at a considerable angle (varying in two specimens from ten to more than thirty degrees), and in the centre of which is an abrupt angular depression (see figs. 27 and 28 of pl. 32). Shell thin, and usually very imperfectly preserved.

Surface of the shell concentrically or transversely striated, the marks often appearing in the casts. In well-preserved specimens these striæ are cancellated by extremely fine longitudinal ones, which are visible only under a strong lens, and are not preserved in all specimens. These striæ are much more conspicuous near the base of the shell, and especially on the ventral margin of the aperture. Surface of the operculum distinctly striated concentrically, and also obscurely marked by radiating striæ; the margin of the flange is striato-plicate.

In addition to the ordinary surface striæ, the dorsal face sometimes presents a distinct longitudinal groove on each side, at about one-third the distance between the lateral margin and the angular centre. These lateral grooves are shown in figs. 23 and 28, drawn from two different individuals, the latter being an enlargement. On the flattened ventral surface there are often two lines of depression or fracture, essentially opposite to the distinct dorsal grooves. This feature is slightly marked in fig. 22 (the ventral side of fig. 23), and more distinctly in fig. 30, which is seen from the inner side of the shell. Similar lines of fracture are visible in nearly all the compressed specimens of this species. See also plate 32 A, fig. 24.

In a few specimens the surface of the shell near the apex is marked by transverse undulations, and in one specimen with sharp transverse lines. These are the only indications of septa thus far observed, and are by no means satisfactory evidence of such structure.

The longest specimens are about thirty-five millimetres, and the greatest width near the base is about thirteen millimetres. The vertical diameter is about half as great as the lateral diameter.

In comparison with *H. ligea*, the form is more acute, its angularity more distinct, and the base narrower in proportion to the length. In general form, this species is not unlike *H. discors*, of BARRANDE (pl. 16, figs. 1–3), and the separated ventral portions of the young shells of our species resemble those of *H. obvius*, BARRANDE, as figured on plate 15, fig. 22 (*Sil. Syst. du centre de la Bohème*, vol. iii).

Formation and localities. In the semi-calcareous shales of the Hamilton group, on the east and west sides of Cayuga lake; Bellona, Yates county; Pratt's Falls and Delphi, in Onondaga county; and Sherburne creek, Chenango county, N. Y.

HYOLITHES STRIATUS.

PLATE XXXII, FIGS. 31, 32, 33, 34.

Hyolithes striatus, HALL. Illustrations of Devonian Fossils: Pteropoda, pl. 27, figs. 8, 9, 12. 1876.

FORM that of an extremely elongated triangular pyramid, which becomes gradually attenuated towards the apex, with scarcely a perceptible curvature. Transverse section triangular, more than twice as wide as high, the margins thin, and the sides apparently a little unequal. The dorsal angle well defined, and in one specimen a little rounded. The ventral face nearly flat, or with a moderate convexity, much extended and regularly rounded in front; the curvature in a longitudinal direction is scarcely perceptible. Dorsal face convex, angular, subcarinate along the centre, with the sides nearly plain; the median angle becoming more defined towards the apex. Aperture oblique, being much extended on the ventral side; the dorsal margin is unknown, the specimens being imperfect. The shell is thin, and in our specimens, very imperfectly preserved. No septa are perceptible. The operculum referred to this species is somewhat semi-elliptical, the lateral diameter being nearly twice

as great as the vertical, the body being flabelliform, with the apex much elevated, the sloping sides concave, and limited by a distinct groove. Above this groove is a slight fold, separating it from the flattened triangular area, which is turned forward at an angle of more than forty degrees to the plane of the axis of the operculum, and marked in the centre by a distinct pit; the whole presenting much the aspect of the area of a spiriferoid brachiopod, with the foramen in the centre. (See plate 32 A.)

Surface of the shell marked by fine concentric striæ of growth, which are sometimes crowded into fascicles; and these are crossed by stronger, equal and continuous longitudinal striæ. The body of the operculum is radiatingly striated from the apex, and the area presents some indistinct ridges or folds; the concentric striæ are not visible under an ordinary magnifier, but there are distant concentric folds parallel to the anterior margin, which are quite perceptible.

Length of fossil in one specimen measured about twenty-one millimetres, and another one, when entire, has been considerably longer; width at the base from five to six millimetres. This species is readily distinguished from *H. aclis* by its proportionally more slender form, and in its continuous, strong, longitudinal striæ being more obvious than the concentric ones; while in the former species the longitudinal striæ are much finer and usually invisible, except under a good magnifier.

In its form and characteristic markings it resembles the *H. solitarius* of Barrande (plate 13, figs. 34 and 35), and it has nearly the size and proportions of that species. The geological relations of the two species are, however, quite different. Our species, in its surface-markings, may be compared with *H. obvius* of Barrande, as given in figures 1–4, plate 12 (*Syst. Sil. du centre de la Bohême*, vol. iii).

Formation and locality. In the Hamilton group near Norton's Landing, on the east side of Cayuga lake, N. Y.

Hyolithes triliratus, n. sp.

PLATE XXXII A, FIGS. 20-22.

Form an elongate triangular pyramid, with a scarcely perceptible curvature. Transverse section subtriangular, with a width nearly twice as great as the height. Ventral face moderately convex, transversely and distinctly curving in a longitudinal direction. Dorsal side convex, scarcely angular along the centre, with the two sloping faces gently curved; the median line marked by a distinct longitudinal groove (one specimen having a slender carina along its centre); and the sloping sides with a narrow groove nearly parallel to the margins, and about one-fourth the distance from the margins to the median groove. Aperture undetermined, and the ventral and dorsal borders unknown—the two specimens known being imperfect.

Surface originally marked by extremely fine, longitudinal and concentric striæ, which, in the specimens examined, are obscurely visible under a good lens.

The specimens are either casts of the interior, or of the exterior surface where the shell has been extremely macerated, with scarcely more than a thin film remaining.

The length of this species, in the longest individual, is about twenty millimetres, with a width of seven or eight millimetres.

The form of this fossil is similar to *H. aclis* in its upper part, but it does not expand so rapidly towards the aperture. The summit on the dorsal side is more rounded, without the angularity and tendency to carination sometimes observed in that species. The surface-markings are more subtle, or less distinctly preserved under similar conditions. The form is less attenuate than *H. striatus*.

Formation and localities. In the coarse arenaceous shales of the Hamilton group on Sherburne creek, Chenango county, and in the argillaceous shales of the same formation on the east side of Cayuga lake, near Norton's Landing, N. Y.

Hyolithes singulus, n. sp.

PLATE XXXII A, FIG. 27.

Form an elongated triangular pyramid, very gradually tapering from the base; transverse section subtriangular. The ventral face of the pyramid nearly plane; the dorsal face obtusely subangular in the middle, with the two sides sloping in a gentle convexity to the lateral margins. The lateral angles somewhat abruptly acute. Aperture and operculum unknown.

Surface ornamented by fine, equal and regular transverse striæ, which are arched slightly backward on the summit of the dorsal face; thence, curving gently forward, are again recurved close to the lateral angle or suture line. There are no visible longitudinal striæ.

The only specimen known is a fragment, which is imperfect at both extremities, but sufficient remains for the generic determination, and the specific characters are so unlike those of any other known in the rocks of New York that it may be readily distinguished. It is preserved in a gray, calcareous shale with numerous Brachiopoda.

In its surface-markings it may be compared with *H. striatulus* of Barrande, as shown on figs. 47–49, pl. 12 (*Syst. Silurien du centre de la Bohème*, vol. iii, page 92). In this respect it differs from any American species which have come under my observation.

Formation and locality. In the calcareous shales of the Hamilton group, on the shores of Skaneateles lake, N. Y.

A single specimen of another species of this genus has been noticed among the collections from the Hamilton group. The form is terete, gently curved (perhaps from pressure), with an acute termination, and, so far as can be determined, a circular or subcircular section. The specimen preserves a length of eleven millimetres, and the margin of the aperture is apparently entire. The surface is obscurely striated transversely.

CLATHROCŒLIA, N. GEN.

Among the fossils of the Hamilton group from Western New York are two specimens of peculiar character, which do not appear to be properly referable to any described genus within my knowledge. The general form, as the fossil presents but a single face upon the surface of the rock, is that of a small, flattened ORTHOCERAS, or a longitudinal section of the same, with rapidly expanding walls; but a cursory examination shows that the two sides are not equally diverging from the apex, one being in a nearly vertical line and the other more oblique. The shell has apparently not been cylindrical, but may have been of a flattened, triangular or semi-conical form. The interior is marked by regular arching bands, which, as seen through the translucent shell, have the appearance of septa. These septa are unequally arched, the longer limb of the arch extending to the more sloping side of the shell, while the shorter limb extends to the straighter side of the shell, and, before reaching the margin, is recurved, and turns slightly backward or towards the apex. The straighter margin is likewise a little recurved towards the exposed face of the fossil. The latter feature, however, may be due to compression.

The slight recurving of the septa resembles, in a considerable degree, the arching of the chambers in the septate sheath of *Phragmotheca Bohemica* of BARRANDE; but our specimens are rigidly straight, and possess other features not conforming to that genus. Besides the arching, transverse lines or septa there are several, at least four or five, longitudinal lines or laminæ, which cross the others, and apparently penetrate the interior in like manner. These longitudinal lines give to the space included between the two central ones in the upper part of the shell the appearance of a siphuncle, but they are in nowise different from those on either side; and this apparent condition is modified as the lines become less conspicuous towards the aperture of the shell.

In the obliquely arching outline of the aperture, this fossil is somewhat similar to some forms of HYOLITHES; but the character of the shell and the

internal structure are distinctive features, as compared with other species in the same formation. The substance of the shell has been comparatively thin, and apparently hyaline, and from its mode of preservation, as well as from its peculiar form and characters, it may be inferred that the fossil belongs to the Pteropoda. The genus proposed for its reception may be characterized as follows:

Fossil an obliquely conical tube or sheath, expanding from the apex more rapidly on one side, while the other maintains a nearly vertical line; the interior crossed by arching septal lines, which are unsymmetrical on the two sides of the axis or summit of the arch, and on the shorter side are recurved near their junction with the exterior shell; the septa crossed by longitudinal lines, which apparently penetrate the cavity, and give a cancellated aspect to the interior. Shell thin, translucent, and marked by lamellose lines of growth, subparallel to the septal lines. Aperture and complete form of shell unknown.

Clathrocœlia eborica, n. sp.

PLATE XXXII, FIG. 10; AND PLATE XXXII A, FIGS. 28, 29.

The figures illustrate the only known form of the genus above described.

The length of one specimen is over forty-six millimetres, and the apex is incomplete. The greatest width at the aperture, measured in a directly transverse line, is about twelve millimetres.

Formation and localities. In the calcareous shale of the Hamilton group, east of Alden, Erie county, N. Y.; and in a calcareous band in the same shales, at Darien, Genesee county, N. Y.

CONULARIA, MILLER.

The genus CONULARIA was founded by MILLER (*Manuscript Catalogue*) in 1818 for the species *C. quadrisulcata*, figured by URE, in the *History of Rutherglen and Kilbride.*

The name was adopted by JAMES SOWERBY in the third volume of the *Mineral Conchology*, page 107, 1821, and figures of *C. quadrisulcata* (figs. 3–6), and *C. Teres* (figs. 1 and 2*), were given on Tab. CCLX. The accompanying generic description is as follows:

"A conical, hollow, univalved shell, divided by imperforate septa. Mouth half closed."

Before any careful study of the American forms of this genus had been made they were usually referred to *Conularia quadrisulcata*, and no species was described from our strata, so far as I know, until 1841.

In 1840 Prof. TROOST, in his *Fifth Annual Report on the Geology of Tennessee* (page 53), recognizes the *Conularia Sowerbyi* "in the mountain limestone near Nashville."

In 1841 Mr. CONRAD recognized the *Conularia quadrisulcata* as occurring in the middle series of his geological subdivisions (*Fifth Ann. Rep. Pal. State of N. Y.*). In the same report he describes *Conularia undulata*, from the Cazenovia shales (= Hamilton group), and *C. laqueata*, from the Niagara group.

In 1846 Prof. E. EMMONS described *Conularia Verneuilia* (*Amer. Quart. Journ. Agricult. and Science*, vol. 4, p. 330): also, 1860 (*Manual of Geology*, page 159, fig. 7, 7a). This species is apparently identical with *C. subcarbonaria*, MEEK and WORTHEN.

In 1847 JAMES HALL described *Conularia Trentonensis*, *C. granulata*, *C. gracilis*, and *C. papillata*, from the Trenton limestone (*Palæontology of New York*, vol. 1, pp. 222–224, pl. 59).

In 1852 the same author described *Conularia Niagarensis* and *C. longa*, from the Niagara group (*Palæontology of New York*, vol. 2, pp. 294, 295, pl. 65).

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* This form, as has been clearly shown by M. BARRANDE, is not a CONULARIA, but probably a fragment of a CYRTOCERAS.

In 1855 Prof. G. C. Swallow indicated the occurrence of a new species of Conularia in the horizon of the Chemung group (*Second Annual Report on the Geology of Missouri*, Appendix, p. 218).

In 1856 Prof. E. Emmons described *Conularia Hudsoni*, from the Utica slate (*American Geology*, vol. 1, p. 208).

In 1856 J. Hall described *Conularia subulata*, from the Carboniferous limestones (*Trans. Albany Inst.*, vol. 4, p. 32).

In 1859 the same author described *Conularia pyramidalis*, *C. Huntiana*, *C. lata* and *C.——?* [*desiderata*]; the first two species from the Lower Helderberg group, and the last two from the Oriskany sandstone (*Palæontology of New York*, vol. 3, pp. 347, 348, 479, 480, plates 62 A, 70 A and 111).

In 1860 Meek and Worthen described *C. subcarbonaria*, from Keokuk limestone (*Proceed. Acad. Nat. Sci. Phila.*, 1865, p. 253).

In 1860 G. C. Swallow described *Conularia Marionensis* and *C. triplicata*, from the Hamilton group, and *C. Missouriensis*, from the St. Louis (Carboniferous) limestone (*Trans. St. Louis Acad. Sci.*, vol. 1, p. 637).

In 1862 C. A. White described *Conularia victa*, from the Burlington group, and *C. Byblis*, from the Chemung group (*Proceed. Boston Soc. Nat. Hist.*, vol. 9, p. 22).

In 1863 G. C. Swallow described *Conularia Osagensis*, from the Keokuk limestone (*Trans. St. Louis Acad. Sci.*, vol. 2, p. 98).

In 1865 A. Winchell described *Conularia Newberryi*, from the Waverly group (= Lower Carboniferous), (*Proceed. Acad. Nat. Sci. Phila.*).

In 1866 E. Billings described *Conularia asperata* and *C. splendida*, from the Hudson River group (*Catalogue of Silurian Fossils of Anticosti*, page 21).

In 1868 J. W. Dawson described *Conularia planocostata*, from the Carboniferous rocks of Nova Scotia (*Acadian Geology*, pp. 307, 308, fig. 117).

In 1869 J. M. Safford described *Conularia Gattingeri*, from rocks of the age of the Hudson River group (*Geology of Tennessee*, page 289).

In 1871 F. B. Meek described *Conularia elegantula*, from the Upper Helderberg group, and *C. micronema*, from the Waverly group (*Proceed. Acad. Nat. Sci. Phila.*).

In 1876 C. A. White described *Conularia molaris*, from Devonian rocks (*Proceed. Acad. Nat. Sci. Phila.*).

In 1876 C. D. Walcott described *Conularia quadrata*, from the Trenton group (*Desc. New Species of Fossils, in advance of the Report of N. Y. State Museum of Nat. History*).

In 1876 J. Hall designated and illustrated *Conularia Cayuga*, *C. continens*, and *C. crebristriata*, from the Hamilton group, and *C. congregata*, from the Portage group (*Illustrations of Devonian Fossils, descriptions of plates* 28 and 29).

The geological distribution of these species is presented in the following table:

SPECIES.	LOWER SILURIAN.										MIDDLE SILURIAN.				UPPER SILURIAN.			DEVONIAN.						CARBONIFEROUS.						
	Potsdam.	Calciferous.	Quebec.	Chazy.	Birds-eye.	Black River.	Trenton.	Utica Slate.	Hudson River.	Quoida.	Medina.	Clinton.	Niagara.	Onondaga Salt.	Waterlime.	Lower Helderberg.	Oriskany.	Upper Helderberg.	Marcellus shale.	Hamilton group.	Portage group.	Chemung group.	Catskill group.	Waverly.	Burlington.	Keokuk.	Warsaw.	St Louis.	Chester.	Coal Measures.
CONULARIA, *Miller*:																														
asperata, *Billings*	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Byblis, *White*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.
Cayuga, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
congregata, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
continens, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
crebristriata, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
elegantula, *Meek*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.
Gattingeri, *Safford*	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
gracilis, *Hall*	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
granulata, *Hall*	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hudsoni, *Emmons*	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Huntiana, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.
infrequens, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
laqueata, *Conrad*	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
lata, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.
longa, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Marionensis, *Swallow*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.
micronema, *Meek*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.
Missouriensis, *Swallow*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.
molaris, *White*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.
Newberryi, *Winchell*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.
Niagarensis, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Osagensis, *Swallow*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•
papillata, *Hall*	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•
pianocostata, *Dawson*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
pyramidalis, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.
quadrata, *Walcott*	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
splendida, *Billings*	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
subcarbonaria, *M. & W.*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.
subulata, *Hall*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.
Trentonensis, *Hall*	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
triplicata, *Swallow*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.
undulata, *Conrad*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.	.	.	.	.	.
Verneuila, *Emmons*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.
victa, *White*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	•	.	.	.	.

Of these thirty-four species, fifteen are recognized as Silurian, nine of them occurring in the lower division, and three in each of the upper divisions. Regarding the Upper Helderberg, Hamilton, Portage and Chemung groups as Devonian, we have ten species in this period; and including the Waverly group with the Carboniferous limestones, we have nine species of CONULARIA in this division of the series.

In 1867 M. J. BARRANDE enumerated twenty-seven species of the genus as occurring in Bohemia; and in the Palæozoic formations of all countries, he enumerated eighty-three species, including one from the Lias (*Système Silurien du centre de la Bohème*, pages 24 and 30). In this catalogue, however, there are but fourteen species credited to the United States, while at this time we enumerate thirty-four. The species of this genus described from the rocks of this country have been more than doubled since that period, while the number of new forms added to the European list must, we presume, have been proportionally far less.

CONULARIA UNDULATA.

PLATE XXXIII, FIGS. 1-5, 7; AND PLATE XXXIV A, FIGS. 1-4.

Conularia undulata, CONRAD. Fifth Annual Report Pal. State of N. Y., p. 57. 1841.
" " " HALL: Descriptions of New Species of Fossils, etc., p. 34. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 62. 1862.
" " " " Illustrations of Devonian Fossils: Pteropoda, pl. 5. 1876.
" *grandis*, FERD. RŒMER. Lethea Geognostica II Lief, p. 434, plate 3, fig. 21; and plate 1, fig. 12. 1857. "Distinguished from *C. quadrisulcata* by having the striæ more crowded and undulated, and by the absence of lines crossing the furrows between the striæ."

FORM elongate-pyramidal, with a quadrangular base. Transverse section quadrangular, rhomboidal, with the faces subequal (equal?); angles indented by the longitudinal grooves. Faces of the pyramid slightly convex in well-preserved specimens, often entirely flat, or sometimes concave, the proportions modified from pressure; center of each face marked by a distinct shallow groove, along which there is a slight deflection of the transverse striæ. Angles of the pyramid furrowed by a strongly marked groove, which is conspicuous in all conditions of the shell, and traversed by the surface-markings. Aperture of the fossil unknown. Summit

truncated by a convex septum in the best preserved specimens. Shell extremely thin; in most of the specimens entirely dissolved.

Surface, as determined from the best preserved specimens, and from external moulds, marked by fine transverse striæ, which, upon the sides, are gently curving towards the aperture, and slightly recurved in crossing the median groove; the striæ are interrupted by minute pustulose elevations, which give the surface (as seen under a strong lens, in its usual condition of preservation) a minutely crenulate or pustulose aspect. These elevations do not extend to the narrow interstriate spaces, which are apparently quite smooth, and about twice as wide as the elevated striæ, but vary with the growth and age of the shell.

In the harder and more arenaceous shales the fossil is often preserved in its natural proportions; but it is more frequently compressed, and, where occurring in the softer shales, is always flattened. The greater proportion of the specimens have the shell entirely dissolved (in none is there any portion fully preserved); and it is often difficult or impossible to discover the crenulate markings on the surface of the cast. Impressions of the exterior often show the punctate impressions of the slender striæ, while the interspaces appear as flattened, narrow, elevated bands, crossing the face of the fossil.

This species is distinguished from *C. continens* and *C. congregata* by the usually closer arrangement of the transverse ridges, and by the absence of striæ crossing the interspaces. The larger examples attain a length of about six inches, and the one figured on plate 33 has a length of 140 millimetres, with a width of about 40 millimetres at the base of the widest face exposed.

The specimen illustrated in figure 1, plate XXXIV A, is distinguished from the ordinary specimens of *C. undulata* by its more slender form, and more closely arranged transverse striæ, which are nodulose on their crests, with the interstriate spaces smooth, as in typical individuals of the species.

Formation and localities. In the coarser shales of the Hamilton group of New York, at Cazenovia, Hamilton, Schoharie; at Plainfield in Otsego county, and at Pratt's Falls in Onondaga county.

Conularia crebristriata.

PLATE XXXIII, FIGS. 8, 9; AND PLATE XXXIV A, FIG. 5.

Conularia crebristriata, Hall. Illustrations of Devonian Fossils: Pteropoda, plate 29, figs. 8, 9. 1876.

Form comparatively slender, regularly pyramidal, with a quadrangular base. Transverse section quadrangular with the sides unequal, the proportions being about as two to three; a part of this inequality is owing to a slight distortion through a compression of the specimen. Angles of the pyramid marked by a very distinct groove, which is crossed by the surface striæ. Faces of the pyramid somewhat concave, with scarcely a defined median groove, which in nowise affects the continuity of the transverse striæ. Aperture oblique. The summit has apparently been truncated by a septum.

Surface marked with very fine salient, distinctly nodose or pustulose striæ, which curve gently forward on the middle of the face; not interrupted by the median depression, and somewhat gently recurved over the convexity bordering the furrows at the angles of the shell, and continuous across the depression; spaces between the striæ about twice as wide as the striæ, and apparently free from ornamentation. The ornaments of the surface are only visible under a lens.

In some parts of the shell the striæ are much more closely arranged than in others—an evidence of retardation in growth. In one specimen the striæ of the earlier growth, for at least one-third of the length of the shell, are much coarser than the later growth, and the change from the one to the other is quite abrupt.

This species is more slender in its mode of growth than *C. undulata*, and the transverse striæ finer, but the character of the ornamentation is precisely similar. Two specimens only, of this form, have been observed; one of these is a mould of the interior (the shell having been dissolved), which preserves the general form of the species; the other is, in part, an impression of the exterior in soft shale, preserving a portion of the interior surface of the shell.

The length of one specimen, imperfect at both extremities, is about ninety millimetres; the other, incomplete at the apex, is about eighty millimetres long; the shortest diameter at the base is about twenty millimetres, and the longest about thirty millimetres.

Formation and localities. In the soft calcareous shales of the Hamilton group of New York, in the Genesee Valley near Moscow, and in the coarser shales of the group at Morrisville in Madison county.

Conularia Cayuga.

PLATE XXXIV, FIGS. 2, 5.

Conularia Cayuga, Hall. Illustrations of Devonian Fossils: Pteropoda, plate 28, figs. 2, 3. 1876.

Form elongate-pyramidal, the adjacent faces apparently equal, and gradually expanding from the apex. The transverse section unknown, as also the form of the aperture. Faces of the pyramid apparently a little convex, with a shallow, depressed, median line, and strongly marked furrows at the angles. The summit is truncated.

Surface marked by moderately strong, sharply elevated striæ, with interspaces about three or four times as wide in the earlier growth of the shell, and becoming much narrower towards the base of the pyramid; the striæ minutely tuberculose on their crests, and the interspaces striate; the direction of these striæ sometimes nearly vertical, but usually oblique, and in some parts distinctly diverging from the median line.

The surface characters, as given above, are drawn from a gutta-percha impression, taken from a mould of the exterior, from which the shell had, for the most part, been dissolved and removed, but with small portions remaining, which show the internal surface.

This species, in its general form, is not dissimilar to *C. undulata*, but the striæ are stronger, and the interspaces between them are much greater, especially in the upper part of the shell, while towards the aperture these spaces are very narrow, and the striæ much crowded. The presence of striæ crossing the interspaces is a distinctive feature; but these are not visible in all

conditions of the shell. The striæ towards the base of the shell are so closely crowded that fragments of this part, when compared with the portions of the surface towards the summit, might be mistaken for a distinct species.

Portions of two individuals from the same locality preserve similar features; but other specimens are required for a full determination of the distinctive characters. The length of the portion preserved in the specimen figured is about 11 centimetres.

Formation and locality. The only specimens of this species yet recognized are in a calcareous shale, in the higher beds of the Hamilton group, upon the east shore of Cayuga lake, N. Y.

Conularia continens.

PLATE XXXIII, FIG. 6, PLATE XXXIV, FIGS. 3, 4, 6; AND PLATE XXXIV A, FIG. 6.

Conularia continens, Hall. Illustrations of Devonian Fossils: Pteropoda, plate 28, figs. 4–6. 1876.

Form regularly pyramidal, with the sides gently sloping from the apex, and the angles a little projecting. Transverse section rectangular, with the sides equal or subequal, and usually slightly concave in the middle, convex towards the margins, and abruptly inflected into the furrow at the angles. Faces of the pyramid equal, and without a distinct groove or depression along the centre, which, however, is marked by an interruption of the striæ. Angles marked by a narrow, distinctly rounded furrow, into which the surface-markings are extended. Aperture unknown; the summit has been truncated by a septum.

Surface marked by regular and abruptly elevated, transverse striæ, which curve gently forward, and along the mesial line are interruptedly alternating and interlocking with each other, the extremities gradually dying out in the interstriate spaces; in some places the striæ appear as if abruptly bent forward, without alternation, along the middle. These striæ are distant from each other about three times their own width, and their crests are ornamented by regularly arranged minute pustules, from which, on the lower side, extend very slender ridges, reaching one-third or one-half

across the otherwise smooth intermediate space. Usually the crests of the ridges appear to be smooth and flat, and the pustules or tubercles are seen only under favorable conditions. This ornamentation of the surfaces is not visible to the naked eye.

The surface characters, as given above, are from portions of the very thin shell preserved in many specimens, and from distinct impressions of the exterior in the softer shales from which the shell has been dissolved; also from the moulds of the interior, preserving in some degree the external ornamentation.

The specimens are all imperfect; the largest fragment (making allowance for the absent portion) indicates an original length of about 100 millimetres, while the ordinary specimens are scarcely more than sixty-five or seventy millimetres long; the width, measuring the flattened faces, may have been about twenty to twenty-five millimetres.

This species differs from all the others in our rocks in the interlocking of the striæ along the median line of each face. The striæ are proportionally more distant than in *C. undulata* and *C. crebristriata*, and are very similar in this respect to *C. Cayuga*, in which they are stronger and much more coarsely tuberculate, while the intermediate spaces are more strongly striate. In well preserved specimens, the transverse striæ are sharply elevated and distinctly pustulose, and where partially exfoliated the crest is sometimes punctate from the breaking of the pustules. In its flattened condition, in the shales, the general appearance of this fossil is similar to *C. congregata*, in which the striæ are more closely arranged, and the tubercles upon their summits much stronger. The pyramid is not so robust as in *C. undulata*, and has more nearly the degree of attenuation of *C. crebristriata*. Compared with *C. Newberryi*, in which the striæ are interrupted on the face of the pyramid, it is distinguished by its finer and more closely arranged striæ and broader form. When occurring in the softer shales this species is flattened, the surface ornamentation often obscure, and the details difficult of determination. From the coarser shales, we have a few fragments in which the original form is pretty well preserved, and the surface-markings more distinct.

Formations and localities. In the Marcellus shale at Schoharie, and Bridgewater, N. Y., and in the lower part of the Hamilton group near Unadilla Forks, and at Cherry Valley, N. Y.

Conularia congregata.

PLATE XXXIV, FIG. 1; AND PLATE XXXIV A, FIGS. 9, 10, 11.

Conularia congregata, Hall. Illustrations of Devonian Fossils: Pteropoda, plate 28, fig. 1. 1876.

Form regularly pyramidal, with the sides somewhat rapidly expanding. Transverse section quadrangular, with the sides equal. Faces of the pyramid equal, having apparently been nearly or quite plane, usually not marked by a median furrow, or such furrow but faintly indicated. Angles marked by a narrow, abrupt furrow, into which the striæ of the surface are continued. Aperture of the shell unknown. Summit broadly truncated, apparently by a thin septum.

Surface marked with fine, elevated striæ, which are regularly and closely tuberculated along their crests, separated from each other by interspaces two or three times their width in the upper part of the shell, and in the lower part by interspaces equal to their width; striæ distinctly and rather deeply curved towards the aperture of the shell; interspaces, in well preserved specimens, distinctly striate across their width, a feature probably not structural, but probably due to a wrinkling of the shell under pressure; all the ornamentation uninterrupted in crossing the median line, being continued quite into the depression of the narrow grooves of the angles.

The surface-markings, as given above, are from impressions of the thin and but partially preserved test, which has been left in the soft shale in which the fossil is imbedded. As the shell increases in age, the spaces between the transverse striæ diminish, not always gradually, but frequently by a sudden crowding together. Such bands of finer striæ occur in all parts of the shell; following which, the surface again resumes its original character, except on

approaching the aperture, where the change, once induced, continues to the margin.

All the known specimens of this species occur in thinly laminated shale, and are extremely flattened; the surface-markings are frequently complicated by the shell of two sides being pressed one upon the other, producing thereby the appearance of intermediate, and not unfrequently the aspect of interlocking striæ. This interlocking is not usually coincident with the axis, and, therefore, readily distinguishable from the specific character of the preceding species.

In its general features this species presents a stronger and broader pyramid than the *C. continens;* the angles are less rounded and the furrow sharper. The transverse striæ and tubercles are stronger, and the longitudinal striæ more continuous across the interspace. The crowding together of the transverse striæ towards the aperture is not a distinguishing feature of *C. continens* as in this species.

In many respects this species resembles the *C. Cayuga;* but the transverse striæ in the upper part of the shell are less distant than in that species, and the interstriate ornamentation in the specimens examined is different. The transverse striæ are stronger than in *C. undulata*, and much stronger than in *C. crebristriata.*

Formation and locality. In the shales of the Portage group near Ithaca, N. Y. It has not been satisfactorily determined in any other locality.

Conularia continens var. rudis.

PLATE XXXIV A, FIGS. 7, 8.

A single specimen in a coarse, arenaceous matrix, preserves the pyramidal form, with a slight distortion from pressure. The faces are perceptibly concave in the middle, becoming convex and prominently rounded on approaching the margin, and are somewhat abruptly curved into the longitudinal furrow, in the bottom of which the transverse striæ are regularly alternating. Along the median line of each face the striæ are very irregular, sometimes slightly and

abruptly bent forward in the centre, but absolutely continuous, though more frequently alternating and interlocking, while often there is no visible departure from a regular curving line.

The ornamentation upon the crests of the striæ and the upper half of the interstriate spaces is precisely the same as already described; but the striæ are stronger. The specimen has a much coarser and stronger aspect than any other one observed, and the pyramid is more abruptly expanded from the apex. The single specimen known does not afford satisfactory evidence of specific distinction, and I have therefore recorded it as a variety of the form with which it preserves many characters in common.

Formation and locality. In the coarse arnenaceous shales of the Hamilton group in Schoharie county, N. Y.

The conditions of preservation in nearly all the species of Conularia are such as to preclude any satisfactory determination of the angle subtended by the sides of the pyramid. The specimens have, in nearly every case, been more or less distorted by pressure, and more frequently completely flattened, so that the original form is never fully preserved. In these conditions the measurement of the apical angle is attended with difficulty, and the results are far from satisfactory.

The following species have been carefully measured, and the angle given is the sum of the angles of two adjacent faces—the result corresponding to the angle inclosed between the edges of a flattened specimen. By this mode of measurement *C. undulata*, in several individuals, gives a range of 21° to 30°, and an average of 25°; *C. crebristriata*, 20° to 29°, and an average of 24½° in two individuals; *C. Cayuga* gives an angle of 28°; *C. continens* ranges from 28° to 41°, and in four measurements gives an average of 35°; *C. congregata*, in four measurements, gives a range of 22° to 29°, and an average of 26°. These variations of the included angle are probably due, in a great degree, to the varying direction of the pressure which has flattened the shell; it rarely happening that this force is exerted in a vertical direction upon the face or upon the angle of the shell, but upon some intermediate point or in an oblique direction.

CEPHALOPODA.

ORTHOCERAS, Breynius.

HISTORICAL SKETCH.

The earliest notice of fossils of this genus, or of generically related forms, from America, so far as known to the writer, was published in England by Charles Stokes, Esq.

In 1823 Mr. Stokes published a description of the genus Huronia, and described the species *H. Bigsbyi*, *H. vertebralis*, *H. turbinata*, *H. obliqua*, and *H. sphæroidalis*, from the limestones of Drummond Island in Lake Huron (*Notes on the Geography and Geology of Lake Huron*, by John J. Bigsby, M. D.—*Trans. Geol. Soc. London*, 2d series, vol. 1).

In 1832 Prof. Amos Eaton published descriptions and figures illustrating "*Orthocera circularis*, *O. striata*, *O. undulata*, *O. annulata*, *O. conica*, and *O. paradoxica*." The first four named species were obtained at Thessalon Island in Lake Huron. All these, with the exception of *O. conica*, appear to have been identified, by Eaton, with species described under the same names in Sowerby's *Mineral Conchology*. It is evident from the figure of *O. paradoxica*, given by that author, that the fossil is a portion of a species of Gyroceras, from the Upper Helderberg limestone.

In 1834 Prof. H. G. Bronn established the genus Actinoceras, founded upon the illustrations of the Orthoceratites of Thessalon Island, Lake Huron, published in the *Transactions of the Geological Society of London*. (*Lethæa Geognostica.*)

In 1837, Mr. Stokes described *Actinoceras Lyonii*, *A. Bigsbii*, and *A. Richardsoni*,

from limestones of Lower Silurian age; the genus ORMOCERAS and the species *O. Bayfieldi*, *O. Backii*, and *O. Whitei*, the last three named species being from Drummond Island; also, *Huronia Portlocki*, from the same locality (*On some species of Orthocerata: Trans. Geol. Soc. London*, 2d series, vol. 5).

In 1838 Prof. GERARD TROOST proposed the genus CONOTUBULARIA for certain forms of ORTHOCERAS (which are, in part, referred to ENDOCERAS), and described the following species from the Lower Silurian: *Conotubularia Brongniarti*, *C. Cuvieri*, *C. Defranci* and *C. Goldfussi* (*Mem. Soc. Geol. de France*, T. III).

In the same year Mr. T. A. CONRAD described *O. constrictum*, from the Hamilton group (*Rep. Pal. Dept. N. Y. Geol. Survey*).

In 1839 Mr. J. DE C. SOWERBY described *O. imbricatum* and *O. virgatum* from the Ludlow and Wenlock formation (*Murch. Silur. Syst.*). These species have been identified with forms in the Niagara group of North America.

In 1840 Dr. D. D. OWEN described and illustrated *Orthoceras marginale*, OWEN, from the Upper Magnesian limestone; *O. undulatum*,* O., from the "Magnesian Cliff limestone;" and figured an Orthoceras [=ENDOCERAS], "from the substrata of the Blue and Gray limestones" of Iowa and Wisconsin. He also designated *Orthoceras annulatum?* and *Actinoceras*, with double siphuncle, as occurring in the "*coralline beds*" of the Magnesian Cliff limestone; and cited *Orthoceras anellum*, CONRAD, from the Blue and Gray limestones (*Report on the Geol. Explor. of part of Iowa, Wisconsin and Illinois*). [Communicated to the General Land Office in 1840, published in 1844.]

In 1842 Mr. CONRAD published descriptions of the genera CAMEROCERAS and DIPLOCERAS [=ENDOCERAS, Hall, 1847], with the species *Cameroceras Trentonensis* and *Diploceras Vanuxemi* (*Jour. Acad. Nat. Sci. Phila.*, vol 8, pt. 2).

Dr. E. EMMONS published *Orthoceras multicameratum* (CONRAD, in MS.), from the Birdseye limestone; *O. multilineatum*, *O. Trentonensis* [=CYRTOCERAS] and *Cameroceras Trentonensis*, from the Trenton limestone; *Orthoceras æqualis*, from the Loraine shales = Hudson-river group; and illustrated other forms of ORTHOCERAS from the Trenton limestone, without specific designation (*Geol. Surv. of N. Y., Second Dist.*).

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* *O. undulatum* in this place is apparently a cast of *O. annulatum* of SOWERBY.

Mr. L. Vanuxem described *Orthoceras primigenium*, from the Calciferous group; the "Marcellus Orthocera" [=*O. Marcellensis*], from the Marcellus shale; and *O. constrictum*, from the Hamilton group (*Geol. Surv. of N. Y., Third Dist.*).

In 1843 M. F. de Castelnau described and illustrated the following as new species: *Orthoceras Hercules*, *O. conicum*, and *O. filiformis*, from Drummond Island, Lake Huron; *Actinoceras Blainvillei*, and *A. Cordieri*, from Manitouline Island, Lake Huron; *A. Beaudanti*, *A. Beaumonti*, and *A. Dufresnoyi*, from Drummond Island; *A. Deshayesi*, Green Bay; *Huronia obliqua*, from Drummond Island; and *H. Stokesi*, from the "Calcaires schisteux de Schoharie." He also described and illustrated *Actinoceras Richardsoni* (*?*) Stokes, from Manitouline Island, Lake Huron; and *A. Lyoni*, Stokes, from Lac des Bois.

He also described two new genera, Sidemina and Nelimenia, which he places under the Cephalopoda, and the species, *S. infundibiliformis*, from Manitouline Island, and *N. incognita*, from the Falls of Montmorensi (*Essai sur le Système Silurien de l'Amérique*).

Mr. Conrad described *Orthoceras anellum*, from the Black-river and Trenton limestones (*Jour. Acad. Nat. Sci. Phila.*).

James Hall described *Orthoceras læve* [=*O. sublæve*, d'Orbigny, 1850], from the Onondaga Salt group; *O. subulatum*, from the Marcellus shale; and *O. acicula* [=*Coleolus acicula*], from the Portage group (*Geol. Surv. of N. Y., Fourth District*).

In 1847 Mr. Hall described *Orthoceras laqueatum*, from the Calciferous and Trenton limestone; *O. moniliforme*, *O. subarcuatum* (=*O. Clintoni*, Hall, 1877), and *O. tenuiseptum*, from the Chazy limestone; *O. rectiannulatum*, from the Chazy and Birdseye; *O. recticameratum*, from the Birdseye limestone; *O. arcuoliratum* and *O. fusiforme*, from the Black river and Trenton limestones; *O. coralliferum*, from the Utica slate and Hudson-river group; *O. bilineatum*, from the Chazy, Black-river, Trenton and Hudson-river groups; *O. laqueatum* var. *a*, *O. latiannulatum*, *O. strigatum*, *O. teretiforme*, *O. textile*, *O. vertebrale* (=*O. Olorus*, H., 1877), *O. bilineatum* var. *a*, *O. clathratum*, *O. undulostriatum*, and *O. junceum*, from the Trenton limestone; and *O. lamellosum*, from the Hudson-river group; also the following species of Ormoceras: *Ormoceras* (*?*) *gracile*, *O. tenuifilum* and *O. tenuifilum* var. *distans*, from the Black-river limestone; and *O. crebriseptum*, from the

Hudson-river group; also the genus ENDOCERAS, embracing the following species: *E. gemelliparum* and *E. subcentrale*, from the Black-river limestone; *E. longissimum* and *E. multitubulatum*, from the Black-river and Trenton limestones; *E. angusticameratum*, *E. annulatum*, *E. approximatum*, *E. arctiventrum*, *E. distans*, *E. duplicatum*, *E. magniventrum*, *E. proteiforme* var. *elongatum*, *E. proteiforme* var. *lineolatum*, *E. prot.* var. *strangulatum*, *E. prot.* var. *tenuistriatum* and *E. prot.* var. *tenuitextum*, from the Trenton limestone; *E proteiforme*, from the Trenton and Hudson river groups; also, *Gonioceras anceps*, from the Black-river limestone (*Palæontology of New York*, vol. 1).

In 1850 Mr. HALL described *Endoceras lativentrum* and *Ormoceras remotiseptum*, from the Trenton limestone; and *Colpoceras virgatum* [=*Endoceras virgatum*], from near the junction of the Birdseye and Black-river limestones.

In 1851 Mr. HALL described *Huronia annulata*, from the Niagara group (*Report on Lake Superior Land District:* Foster & Whitney.

In 1852 Mr. HALL described *Orthoceras abruptum* [=*Cyrtoceras?*] and *O. multiseptum*, from the Medina sandstone; *O. virgulatum*, from the Clinton and Niagara groups; and *O. cancellatum* [=*O. subcancellatum*, H., 1877]; and identified *O. imbricatum*, WAHL., *O. annulatum?* SOW., O. *undulatum*,* HIS., and *O. virgatum?* SOW., from the Niagara group; *Ormoceras vertebratum* and *Discosorus conoideus*, from the Clinton group (*Palæontology of New York*, vol. 2).

In 1857 Mr. E. BILLINGS published the following species: *Orthoceras cornuum*, from the Chazy group; *O. Allumettense* and *O. Minganense*, from the Chazy and Black-river groups; *O. decrescens*, *O. hastatum*, *O. Murrayi* and *O. Ottawaense*, from the Black-river and Trenton groups; *O. Huronense*, *O. Python*, *O. vulgatum* and *O. Xiphias*, from the Trenton group; *O. Anticostiense*, *O. balteatum*, *O. Lyelli*, *O. magnisulcatum*, *O. propinquum*, *O perannulatum*, *O. Crocus* and *O. Sedgwicki*, from the Hudson-river group; *O. formosum*, from the Trenton, Hudson-river and Anticosti groups; *O. rotulatum*, from the Niagara group; *O. persiphonatum* and *O. Canadense* (=*Huronia vertebralis*, STOKES, 1823), from the Middle Silurian; and *O. Bucklandi*, from the Upper Silurian (*Rep. of Progr. Geol. Survey of Canada for* 1857).

* The species *O annulatum* and *O. undulatum* are identical, the former having precedence in time.

In 1858 Mr. Jules Marcou described *Orthoceras Nova-Mexicanum*, from the Lower Carboniferous (*Geol. North America*).

Mr. Hall described *Orthoceras epigrus*, from the Lower Carboniferous (*Trans. Alb. Inst.*, vol. 4).

Prof. G. C. Swallow described *O. aculeatum*, *O. moniliforme* (not *O. moniliforme*, Hall, 1847) and *O. occidentale*, from the Coal Measures; and *O. Kickapooense*, from the Upper Permian (*Trans. St. Louis Acad. Sci.*).

In 1859 Mr. Billings described *Orthoceras Antenor*, *O. Maro* and *O. Shumardi*, from the Chazy group; *O. Becki*, *O. deparcum*, *O. Lamarcki* (=*Endoceras Lamarcki*), *O. Montrealense* (=*Endoceras Montrealense*) and *O. sordidum*, from the Calciferous group (*Canadian Nat. and Geol.*, vol. 4); also *O. Simpsoni*, from the Silurian (*Geolog. Surv. Canada: Rep. of Progr.*).

Mr. Hall described *Orthoceras clavatum* (=*O. desideratum*, H., 1877), *O. Helderbergiæ*, *O. longicameratum*, *O. pauciseptum*, *O. perstriatum*, *O. rigidum*, *O. rude*, *O. subtextile* and *O. tenuiannulatum*, from the Lower Helderberg group; and *O. arenosum*, from the Oriskany sandstone (*Palæontology of New York*, vol. 3).

In 1860 Prof. J. W. Dawson described *Orthoceras elegantulum*, and *O. exornatum*, from the Upper Silurian (*Canad. Nat. and Geol.*, vol. 4).

Mr. Billings described *O. pertinax*, *O. tenerum* and *Endoceras rapax*, from the Black-river group (*Canad. Nat. and Geol.*, vol. 5).

Mr. Hall described *Orthoceras punctostriatum*, from the Upper Silurian (*Canad. Nat. and Geol.*, vol. 5); *O. medullare* and *O. columnare* (=*Orus*, H., 1877), from the Niagara group (*Geolog. Surv. Wisconsin: Rep. of Progr.*); and *O. Indianense*, from the Goniatite limestone of Rockford, Indiana (*Thirteenth Rep. on N. Y. State Cab. Nat. Hist.*).

Prof. Swallow described *O. Chemungense*, from the Chemung, and *O. Chouteauense*, from the Chouteau group (*Trans. St. Louis Acad. Sci.*)

Mr. F. B. Meek described *O. baculum*, from the Lower Carboniferous (*Proc. Acad. Nat. Sci. Phila.*).

Messrs. F. B. Meek and H. A. Worthen published *O. expansum*, from the St. Louis group (*Proc. St. Louis Acad. Sci.*).

In 1861 Mr. HALL described *Orthoceras planoconvexum*, from the Black-river and Trenton groups; *O. gregarium* (=*O. sociale*, H., 1877), from the Hudson-river group; and *Gonioceras occidentale*, from the Trenton group (*Geolog. Surv. Wisconsin: Rep. of Progr.*); *O. Hageri*, from the Calciferous group (*Geol. of Vermont, Hitchcock*). Also *O. baculum* (=*O. stylus*, H., 1877), *O. foliatum* (=*Cyrtoceras* [? *Gyroceras*] *Eugenium*), *O Hyas* (=*O. Thoas*), *O. multicinctum*, *O. Pelops*, *O. tetricum* and *O. Thoas*, from the Schoharie grit; *O. profundum*, from Upper Helderberg limestone; *O. Ægea*, *O. crotalum*, *O. emaceratum*, *O. exile*, *O. nuntium*, and identified *O. perelegans* of SALTER, with doubt, from the Hamilton group (*New Species of Fossils*, pp. 45–52, and republished in 1862 in the *Fifteenth Rep. on N. Y. State Cab. Nat. Hist.*, pp. 73-80).

Mr. J. H. MCCHESNEY described *O. Knoxense* and *O. Rushense*, from the Coal Measures; *O. cameolare*, *O. Hoyi*, *O. irregulare* (=*O. Woodworthi*), *O. Laphami*, *O. lineolatum* (not *O. lineolatum*, PHILLIPS, 1841), *O. nodocostum*, *O. Scammoni*, *O. striatolineatum* and *O. Woodworthi*, from the Niagara group (*New Pal. Foss.*). In a revision of this publication by Mr. MEEK, two Silurian species of Orthoceratites, viz., *O. Woodworthi* and *O. nodicostatum*, are recognized. The last named is undoubtedly *O. annulatum*.

MEEK and WORTHEN described *O. annulato-costatum*, from the Chester group, Carboniferous (*Proc. Acad. Nat. Sci. Phila.*).

In 1862 Mr. BILLINGS described *O. Autolycus*, from the Quebec group; *O. Menelaus* and *O. perparvum*, from the Black-river limestone; *O. Piso*, from the Hudson-river group; and *O. Selwyni*, from the Guelph formation (*Palæozoic Fossils*).

Mr. A. WINCHELL described *O. gracilius*, from the Portage group, and *O. multicinctum*, from the Marshall group (*Proc. Acad. Nat. Sci., Phila.*); *O. arcuatellum*, *O. Barquianum*, *O. clinocameratum*, *O. Marshallense* and *O. robustum*, from the Marshall group (*Amer. Journ. Sci. & Arts*, 2d series, vol. 33); and *O. occidentale*, from the Marshall group (*Trans. St. Louis Acad. Sci.*).

The species described by Mr. HALL, and published in 1861, were republished in this year in the *Fifteenth Report on N. Y. State Cab. Nat. Hist.*, pp. 73–80.

In 1863 Dr. B. F. SHUMARD described *O. Ozarkense*, from the Calciferous group (*Trans. St. Louis Acad. Sci.*).

Prof. Swallow described *O. Chesterense*, from the St. Genevieve group = Carboniferous (*Trans. St. Louis Acad. Sci.*).

Prof. Winchell described *O. heterocinctum* and *O. Whitei*, from the Kinderhook group = Waverly group (*Proc. Acad. Nat. Sci. Phila.*).

In 1865 Mr. Billings described *O. Atticus*, *O. Catalina*, *O. Cato*, *O. Catullus*, *O. explorator*, *O. Flavius*, *O. hæsitans*, *O. Missisquoi*, *O. Perseus*, *O. piscator*, *O. Priamus*, *O. repens*, *O. Sayi*, *O. servile*, *O. Tityrus* and *O. Xerxes*, from the Quebec group; *O. diffidens*, *O. Drummondi* and *O. velox*, from the Chazy group; *O. edax*, *O. furtivum*, *O. Glaucus*, *O. indagator*, *O. ordinatum* and *O. veterator*, from the Calciferous group (*Palæozoic Fossils*).

Meek and Worthen described *O. crebristriatum* and *O. Jolietense*, from the Niagara group (*Proc. Acad. Nat. Sci. Phila.*).

In 1866 Mr. Billings described *O. bellatulum*, *O. infelix* and *O. Medon*, from the Clinton group; *O. Brontes*, *O. Cadmus*, *O. Oberon*, *O. Pylades*, *O. Remus* and *O. Varro*, from the Niagara group; *O. Crocus* and *O. fulger*, from the Hudson-river group; *O. ferum* and *O. Sieboldi*, from the Hudson-river and Anticosti groups; and *O. pileolum* and *O. raptor*, from the Medina group (*Catalogue Silur. Foss. Anticosti*).

Prof. H. B. Geinitz described *O. cribrosum*, from the coal measures (*Carb. und Dyas in Nebraska*).

Mr. H. A. Worthen published *O. subaculum* (not defined), from the Niagara group (*Geolog. Surv. Illinois*, vol. 1).

Messrs. Meek and Worthen described *O. Winchelli*, from the Devonian (*Proc. Acad. Nat. Sci. Phila.*).

Mr. Winchell described *O. pustulosum*, from the Hamilton group (*Rep. Lower Penin. Mich*).

M. J. Barrande described *Orthoceras* (*Endoceras*) *Rottermundi*, from the Trenton limestone; and *Huronia distincta* (=*Huronia* sp.? Stokes, 1840), from the Niagara limestone (*Syst. Silur. du centre de la Bohème*).

Mr. Hall described *O. abnorme*, *O. alienum*, *O. crebescens*, *O. Niagarense*, and recognized *O. angulatum*, of Wahl., from the Niagara group; also *O. Loxias*, from Lower Silurian (*Twentieth Rep. N. Y. State Cab. Nat. Hist.*).

In 1868 Mr. Billings described *O. Darwini*, from the Guelph limestone (*Palæozoic Fossils*).

Prof. H. D. Rogers published *O. pressum*, from the Trenton limestone (*Bigsby: Thesaurus Siluricus*).

Mr. Salter published *O. Ommaneyii*, from the Niagara group (*Bigsby: Thesaurus Siluricus*).

Prof. C. F. Hartt published *O. laqueatum* [not *O. laqueatum*, Hall, 1847] (*Acadian Geology*).

Prof. Dawson described *O. dolatum*, *O. perstrictum* (not *O. perstrictum*, Barrande), *O. Vindobonense*, *Actinoceras inops*, and cites *O. laterale*, Phil., from the Carboniferous system; republishing *O. elegantulum*, *O. exornatum*, Daw., and *O. punctostriatum*, Hall, from the Upper Silurian. He also cites, on the authority of Mr. Salter and Dr. Honeyman, *O. nummulare*, *O. Ibex* and doubtfully *O. bullatum* Sow., from the Upper Silurian of Arisaig (*Acadian Geology*).

In 1869 Mr. J. M. Safford described *O. capitolinum* and indicated *O. Foxense* (not defined), from the Trenton group (*Geol. of Tenn.*).

M. Barrande described *O. Clouei*, *O. recedens*, *Endoceras Atlanticum*, *E. insulare* and *E Marcoui*, from the Quebec group; and *Huronia minuens*, from the Clinton group (*Syst. Sil. du centre de la Bohème*).

In 1872 Mr. Meek described *O. Ortoni*, from the Cincinnati = Hudson-river group (*Proc. Acad. Nat. Sci. Phila.*).

In 1874 M. Barrande described *Huronia Romingeri* (*Syst. Sil. du centre de la Bohème*).

Mr C. A. White described *O. colon*, from the Quebec group (*Rep. Invert. Foss. U. S. Geol. Survey*).

In 1875 Mr. Billings described *O. Anax*, from the Upper Helderberg limestone (*Canad. Nat. and Geol.*).

Hall and Whitfield described *O. Carleyi*, *O. Duseri* and *O. turbidum*, from the Hudson-river group; *O. Jamesi*, from the Clinton group; and *O. Strix*, from the Niagara group (*Geolog. Surv. Ohio:* Pal. vol. 2).

Mr. S. A. Miller described *O. Byrnesi*, *O. Cincinnatiense*, *O. Dyeri*, *O. Fosteri*, *O. Halli* (= *Hallanum*, M., 1877), *O. Harperi*, *O. Meeki*, *O. Mohri* and *O. transversum*, from the Cincinnati group = Hudson-river group (*Cin. Quart. Jour. Sci.*, vol. 2).

Mr. WORTHEN described *O. rectum* and *O. Unionense*, from the Niagara group (*Geolog. Surv. Ill.*, vol. 6).

In 1876 Mr. HALL published *O. luxum* and *O. procerus*, from the Schoharie grit; *O. molestum*, *O. Pelops* var. *Ohioense* and *O. rudicula*, from the Upper Helderberg limestone; *O. Bebryx* and *O. robustum* (=*O. Eriense*, H., 1877), from the Hamilton group; and identified *O. typus*, SAEMANN (=*O. Marcellense*, VANUXEM), from the Marcellus shale (*Illus. Devon. Foss.*);* and *O. simulator*, from the Niagara group (*Twenty-eighth Rep. N. Y. State Mus. Nat. Hist.*).

In 1877 Mr. HALL proposed the following names for species before published by him under preoccupied names: *Orthoceras Clintoni* for *O. subarcuatum* H., 1847; *O. Olorus* for *O. vertebrale* H., 1847; *O. sociale* for *O. gregarium* H., 1861; *O. Orus* for *O. columnare* H., 1860; *O. subcancellatum* for *O. cancellatum* H., 1852; *O. desideratum* for *O. clavatum* H., 1852; *O. stylus* for *O. baculum* H., 1862 (S. A. MILLER'S *Catalogue of American Palæozoic Fossils*).

In 1879 Mr. HALL described *Orthoceras Amycus*, from the Niagara group at Waldron, Indiana (*Trans. of the Albany Institute*, vol. X).

Mr. C. D. WALCOTT described *Orthoceras Oneidaense*, from the Utica slate of New York (*Trans. of the Albany Institute*, vol. X).

The following American species of ORTHOCERAS have been identified in Great Britain, according to *Morris' Catalogue of British Fossils*, 1854:

Orthoceras arcuoliratum	HALL	Lower Silurian, Broughton.
O. bilineatum	"	Lower Silurian, Ayrshire.
O. Brongniarti	TROOST	Lower Silurian, Tyrone.
O. laqueatum	HALL	Upper Silurian, Westmoreland.
O. vertebrale	"	Upper Silurian, Presteign.

* In 1853 Dr. L. SAEMANN described *Orthoceras typus*, from the limestone of the Marcellus shale, near Cazenovia, N. Y. (*Dunker and Von Meyer: Palæontographica*). This species was recognized as identical with *O. Marcellense* of VANUXEM, in the *Thirteenth Report on the State Cabinet of Natural History*, 1860.

The following American species of ORTHOCERAS, ORMOCERAS, ACTINOCERAS, ENDOCERAS and HURONIA, from Newfoundland, Canada, the island of Anticosti and the United States, have been described and illustrated by M. Barrande (*Syst. Silurien du centre de la Bohème*):

SPECIES.	SILURIAN FAUNA. I.	II.	III.	Localities.	Plates.
ORTHOCERAS, *Breynius:*					
abnorme, *Hall*	.	.	*	Racine, Wis.	456
Allumettense, *Bill.*	.	*	.	Allumette Island, Can.	437
Anticostiense, *Bill.*	.	*	.	Saguenay river, near Lake St. John,	434
Clonei, *Barr.*	.	*	.	Newfoundland	432–434
recedens, *Barr.*	.	*	.	Newfoundland	433
rotulatum, *Bill.*	.	.	*	Temiscamang, Can.	433
sp. indet., *Bill.*	.	.	*?	Ottawa, Can.	220
sp. indet., *de Verneuil*	.	.	*?	On the Ohio river	216
ORTHOCERAS = ORMOCERAS, *Stokes:*					
Backii, *Stokes*	.	.	*	Drummond Island, Lake Huron	437
Baytieldi, *Stokes*	.	.	*	Drummond Isl., Lake Huron	231
crebriseptum, *Hall*	.	.	*	Pulaski, N. Y., and Canada	431
ORTHOCERAS = ACTINOCERAS, *Bronn:*					
Bigsbyi, *Stokes*	.	.	*	Thessalon Island, Lake Huron, Can.,	231, 437
sp., *Bronn*	.	.	*		231
Richardsoni? *Casteln.*	.	.	*	Manitoulin Isl., Lake Huron, Can.,	234
sp. (siphon), *Saemann*	.	.	*	North America	232
Subgenus ENDOCERAS, *Hall:*					
Atlanticum, *Barr.*	.	*	.	Newfoundland	430
insulare, *Barr.*	.	*	.	Newfoundland	430, 431
Marcoui, *Barr.*	.	.	*	Phillipsburg, Can.	431
sp. (siphon)	.	.	*	Phillipsburg, Can.	431
Rottermundi, *Barr.*	.	.	*	Islands in Lake Huron	220
longissimum, *Hall*	.	*	.	Watertown	236
sp. indet.	.	*	.	United States	236
Subgenus HURONIA, *Stokes:*					
Bigsbyi, *Stokes*	.	.	*	Drummond Island	436
minuens, *Barr*	.	.	*	Drummond Island	435
distincta, *Barr.*	.	.	*	North America	431
Portlocki, *Stokes*	.	.	*	Drummond Island	232
Romingeri, *Barr.*	.	.	*	Point Detour, Mich.	
sphæroidalis, *Stokes*	.	.	*	Drummond Island	
sp, *Stokes*	.	.	*	North America	231
vertebralis, *Stokes* =Canadense, *Bill.*	.	.	*	Drummond Island and Anticosti	231, 435, 436

After a review of all the literature upon the Orthocerata, and a final revision of the generic and subgeneric relations of ORTHOCERAS, M. Barrande has presented the following tabular view in his *Système Silurien du centre de la Bohème.* I accept for the present this arrangement, hoping at some future time to be able to prepare a revision of the Lower Silurian forms of ORTHOCERAS, ENDOCERAS, etc., with better means of comparison and illustration than heretofore possessed.

GENUS ORTHOCERAS, Breynius.

1732. Orthoceras, BREYNIUS . .
- 1. 1834. Actinoceras, BRONN.
- 2. 1837. Ormoceras, STOKES.
- 3. 1837. Conilites, PUSCH.
- 4. 1838. Conotubularia, TROOST.
- 5. 1843. Koleoceras, PORTLOCK.
- 6. 1829. Melia, FISCHER DE WALDHEIM.
- 7. 1837. Sannionites, FISCHER DE WALDHEIM.
- 8. 1844. Thoracoceras, FISCHER DE WALDHEIM.
- 9. 1844. Cycloceras, McCOY.
- 10. 1844. Loxoceras, McCOY.
- 11. 1851. Trematoceras, EICHWALD.
- 12. 1857. Cochlioceras, EICHWALD.
- 13. 1857. Dictyoceras, EICHWALD.
- 14. 1860. Heloceras, EICHWALD.

A. 1844. s. g. Endoceras, HALL .
- 1. 1842. Cameroceras, CONRAD.
- 2. 1850. Colpoceras, HALL.
- 3. 1860. Nothoceras, EICHWALD.

B. 1823. s. g. Huronia, STOKES.

C. 1847. s. g. Gonioceras, HALL.

The species of the genus ORTHOCERAS described in the following pages embrace those at present known from the Schoharie grit and Upper Helderberg limestone, the Hamilton, Portage, and Chemung groups. The Schoharie grit is separately mentioned in this place because the Orthoceratites are more numerous, both in species and individuals, in that rock than in any other member of the series, except perhaps in the Hamilton group. In the one case, we have a formation of about thirty feet, and the other has a thickness of one thousand or twelve hundred feet in its greatest expansion, gradually thinning to three hundred feet in its western extension. The difference in the amount of accumulated material in the two formations is extremely great; and we may infer that the difference in time was in some degree correspondent.

The Schoharie grit consists of a coarse, irregular rock, varying from a

calcareous sandstone to an arenaceous limestone; and gradually passes upward into the limestone of the Upper Helderberg group, of which it forms an important member. With the passage of this rock into a limestone, the occurrence of Orthoceratites almost entirely ceases,—at least, in the eastern part of the State.

Notwithstanding the number of species, and the great number of individuals, a very small proportion of the whole preserve the surface-markings. They are almost invariably in the condition of casts of the interior, the shell having been dissolved by the percolation of water through the coarse material of the rock. In some examples, where the rock is less charged with arenaceous matter, the matrix adheres so closely, seemingly cemented to the fossil, that no satisfactory evidence of surface-markings can be obtained. It is rarely possible to determine the character or thickness of the exterior shell of the Orthoceratites in the Schoharie grit. The septa are extremely thin, often broken or distorted, through the process of filling with sediment, while the external form of the shell is preserved. The siphuncle, though usually well marked in its passage through the septa, is rarely to be found in the intermediate space, and, in the best examples, is only partially preserved. Specimens which have been cut longitudinally directly through the siphuncle, as shown on the septa at the two extremities, preserve no evidence of that organ in its passage through the chambers, and only a simple mark or notch in the intermediate septa. We can account for this absence only upon the supposition that the tube has been so thin that its walls have been dissolved or broken away during the process of filling the cavity with the surrounding sediment. In many cases it appears as if the siphuncular tube may have been absorbed or otherwise removed before the filling of the cavity began. Numerous specimens have been cut for the purpose of determining the presence and character of the siphuncle, but, in by far the greater number, without any satisfactory result.

In addition to these difficulties, the fact that the specimens are nearly all fragmentary, much compressed and often distorted, will render it evident that the study of these fossils must be in the last degree difficult, and the final result unsatisfactory.

The plates illustrating the species of Orthoceratites from the Schoharie

grit are chiefly made up from the results of many years' collections in the Helderberg mountains, and at Schoharie, for the State Museum. The few specimens in which surface characters are preserved will at once be apparent, while the otherwise imperfect condition of the greater number will sufficiently explain the difficulty of presenting a satisfactory monograph of the species.

In the limestone coming above the Schoharie grit we have few species, and comparatively few individuals, of the genus; and these, so far as known to the writer, are in an imperfect condition, though often presenting the surface-markings. All the collections made from the limestones within the limits of the State of New York number less than fifty individuals. This fact may seem remarkable, when it is known that several species of GYROCERAS attain their maximum development in the same horizon.

At the base of the Hamilton group, the Marcellus shale affords six species of the genus, associated with NAUTILUS and GONIATITES. In the mass of the same group, in a higher position, we have at least twenty species, some of which are extremely numerous in individuals. At the present time, however, we must regard this group of shales and shaly sandstones as not sufficiently explored to enable us to present a full account of its Cephalopodous fauna.

In the Portage group the species and individuals yet known are not numerous, though it is quite probable that, in favorable localities, additional species will be found. The Chemung group has afforded few species, and these are fragmentary, and in an unsatisfactory condition of preservation.

In comparing the Orthoceratites of the New York strata with those of Bohemia, so amply and beautifully illustrated by M. BARRANDE, we find that the surface-markings in the latter are almost universally imbricating lamellose striæ. Corresponding American forms have generally a reticulate surface.

The curved forms, of which there are many in Bohemia, are very imperfectly represented among the American species. The "*brevicones*," of BARRANDE, are scarcely known among the Orthoceratites of America, unless they may have been confounded with GOMPHOCERAS.

The annulated forms in Bohemia are usually marked with imbricating lamellæ or lamellose striæ, while in America many of the Lower Silurian

forms, and all those from the base of the Upper Helderberg to the Chemung, inclusive, are cancellated, or marked only by longitudinal striæ. The Bohemian species, which approach those of America in general form, surface-markings, and position of siphuncle, are generally of the curved forms. Of these, several are apparently allied with species described in the present volume, and will be noticed in the comparison of species.

The number of species of Orthoceratites, including those of the genus or subgenus ENDOCERAS, heretofore described and recorded from the American formations, so far as known to me at the present time, is three hundred and eight, to which will be added in the present volume forty-six species. The species described in the present and preceding publications are distributed in the geological formations according to the following table.

Of the subgenus ENDOCERAS, twenty-seven species and varieties have been described and recorded; but all the forms of this type, with a single exception, are restricted to the Quebec group, the Black River and Trenton limestones,* and are included in the second column of the table.

FORMATION.	ORTHOCERAS. No. of species.	ENDOCERAS. No. of species.
Potsdam sandstone	.	.
Calciferous sandstone	15	.
Quebec group	21	3
Chazy limestone	17	.
Black River limestone	20	5
Trenton limestone	41	17
Utica slate	2	1
Hudson River group	32	1
"Anticosti group"	3	.
Medina sandstone	3	.
Clinton group	12	.
Niagara group	40	.
Lower Helderberg group	9	.
Oriskany sandstone	1	.
Upper Helderberg group	30	.
Hamilton group	29	.
Portage group	4	.
Chemung group	19	.
Waverly group	7	.
Lower carboniferous	8	.
Coal measures	8	.
Permian	2	.
Total	323†	27

* *Endoceras longissimum*, and *E. multitubulatum* are recorded as occurring in the Black River and Trenton limestones, and *E. proteiforme* in the Trenton limestone, Utica slate, and Hudson River groups.

† The discrepancy between the number of species, as stated in the text above, and the summary given in this table, is owing to the omission of three synonymic names, and the transfer of *O. acicula* to the genus COLEOLUS.

The vertical distribution of the species of Orthoceratites, as indicated in the preceding table, offers some facts of general interest.

The Potsdam sandstone, with its wide geographical range in the United States and Canada, has not afforded a single species of ORTHOCERAS, although prolific in its Trilobitic fauna, and its Linguloid and Oboloid forms, which are known in numerous localities over an extent of more than two thousand miles. In these respects the formation corresponds to the primordial zone of Europe. In the Calciferous, Quebec and Chazy groups we have fifty-three species of ORTHOCERAS and three of ENDOCERAS; of which, only three species pass into any succeeding formation. In the Black-river and Trenton groups we have sixty-one species of ORTHOCERAS and twenty-two of ENDOCERAS; of which, only four pass into succeeding formations. The Hudson-river group, including the Utica slate and Anticosti group, contains thirty-five recorded species of ORTHOCERAS and two of ENDOCERAS; of these, two species pass upward from the Trenton limestone. While there are the most intimate relations between the fauna of the Trenton and Hudson-river groups in all other classes, the Cephalopoda form a marked exception. In the Clinton and Niagara groups we have sixty-two species of ORTHOCERAS recorded. In the Lower Helderberg group we have but nine species recorded, although a few other forms are known to occur in that horizon. This is in most striking contrast with the Niagara group, while the fauna in the other classes strikingly correspond.

In the character and abundance of the Brachiopoda these two formations are almost identical; while the Gasteropoda are even more abundant in the Lower Helderberg than in the Niagara group. In the growth and development of the Corals and Bryozoa these formations are extremely similar; and there is a great similarity in the physical conditions of the groups throughout, except in the absence, to a great extent, of the deposition of Magnesian limestone in the Lower Helderberg period.

In the Upper Helderberg group, of which the total thickness is less than the Lower Helderberg, we have thirty species of ORTHOCERAS recorded; while the Hamilton group, with a thickness more than five times as great, has yet afforded but twenty-nine species. The Chemung group, with its greater thick-

ness, but of a less calcareous character, has afforded nineteen species; while the Waverly, the Lower Carboniferous limestones and the Coal Measures have recorded seven, eight and eight species respectively.

So far as we now perceive, the development of the Orthoceratites does not depend upon the duration of the deposition, or thickness of the formation. The Black-river limestone, of a few feet in thickness, and the Schoharie grit, of not more than thirty feet in thickness, have each as many species of ORTHOCERAS recorded as any single group, except the Hudson-river, Niagara, and the Hamilton.

The following table shows the vertical distribution of eighteen species of the preceding table, which are known to occur in more than one geological formation:

SPECIES.	LOWER SILURIAN.							MIDDLE SILURIAN.			
	Calciferous sandstone.	Quebec group.	Chazy limestone.	Black River limestone.	Trenton group.	Utica slate.	Hudson River group.	"Anticosti group."	Medina sandstone.	Clinton group.	Niagara group.
ORTHOCERAS, *Breynius:*											
allumettense, *Billings*	.	.	*	*	.	.	.	.	.	.	.
amplicameratum, *Hall*	.	.	.	* * *	* *	.	.	.	.	.	.
anellum, *Conrad*	.	.	.	. * *	* *	.	.	.	.	.	.
annulatum, *Sowerby*	.	.	.	. *	* *	.	.	.	.	*	*
arcuoliratum, *Hall*	.	.	.	* *	* *	.	.	.	.	.	.
bilineatum, *Hall*	.	.	.	*	* * *	.	*	.	.	.	.
decrescens, *Billings*	.	.	.	*	* *	.	.	.	.	.	.
ferum, *Billings*	.	.	.	.	.	.	*	*	.	.	.
formosum, *Billings*	.	.	.	.	*	.	*	*	.	.	.
fusiforme, *Hall*	.	.	.	* *	* *	.	.	.	.	.	.
hastatum, *Billings*	.	.	.	* *	* *	.	.	.	.	.	.
laqueatum, *Hall*	*	*	*	*	*	.	.	.	.	.	.
Minganense, *Billings*	.	.	*	* *	.	.	.	.	.	.	.
Murrayi, *Billings*	.	.	.	* *	* *	.	.	.	.	.	.
Ottawaense, *Billings*	.	.	.	* *	* *	.	.	.	.	.	.
planoconvexum, *Hall*	.	.	.	*	*	.	.	.	.	.	.
Sieboldi, *Billings*	.	.	.	.	.	.	*	*	.	.	.
tenuifilum, *Hall*	.	.	.	*	*	.	.	.	.	.	.
virgulatum, *Hall*	.	.	.	.	.	.	.	.	.	*	*

ORTHOCERATA OF THE SCHOHARIE GRIT.

DESCRIPTIONS OF SPECIES.

SECTION *a.—Robust forms, showing a gradation from a simple areola on the septum surrounding the siphuncle, to a decided and complex organic deposit.*

ORTHOCERAS PELOPS.

PLATES XXXV, FIGS. 1-3; XXXV A, FIGS. 1-6; XXXVII, FIGS. 3, 4; LXXVIII B, FIG. 2.

Orthoceras Pelops, HALL. Descriptions of New Species of Fossils, etc., p. 45. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 73. 1862.
" " " *in part.* Illustrations of Devonian Fossils: Cephalopoda, pl. 35. 1876.

SHELL robust, straight, elongate. Transverse section circular in specimens not compressed; the flattening often amounts to a change in the relations of the diameters of from 1–1 to 1–3. Cone gradually and regularly enlarging from the apex. Apical angle 7° to 9½°. Initial extremity unknown.

Chamber of habitation well developed, sometimes measuring more than twenty-five centimetres in length, and at least five or six times as long as the diameter at the last septum; a broad, gentle constriction near the aperture is generally present. Depth of the air-chambers about one-sixth of the width of the tube; four to eight in the space of sixty mm., depending on the diameter of the tube or the distance from the apex.

Septa thin, with a small areola around the insertion of the siphuncle, regularly concave; concavity equal to an arc of from 120° to 126½°; part of this variation being probably due to compression, or other influences which have affected the true curvature. In the more perfect specimens, the sutures are horizontal and straight, the various degrees of distortion observed having in many cases made them curved and oblique to the axis.

Siphuncle central, or very slightly excentric; walls thin, seldom preserved; width equal to about two-thirds the depth of the adjacent chambers, or approximately from four to five mm. The presence of an areola on the septa indicates that the siphuncle was moniliform, or slightly expanding.

Test about one mm. thick, preserved in very few of the numerous individuals observed. Surface marked by irregular, lamellose striæ of growth.

Some of the specimens referred to this species have been more than sixty centimetres in length. The diameter of the tube towards the aperture in the larger specimens is from sixty to one hundred mm. In all the specimens examined, the interior is filled with the same material as the surrounding rock. The septa are often partially destroyed, broken or distorted, and the siphuncle, as shown in figs. 2, 4, of plate 35 A, is very imperfectly preserved, showing no decisive characters in sections thus far made, or any evidence of an organic deposition. The specimen, fig. 1, pl. 35 A, has a length of thirty-five centimetres, and is imperfect at both extremities (a part only being figured).

This species is scarcely known except in the condition of casts of the interior, of which specimens are rarely found having a length of sixty centimetres, but are always imperfect. In the ordinary conditions of preservation, where the specimens are more or less compressed, and imbedded in a coarse grit, it is impracticable to recognize the less conspicuous differences of character between this and other species, the most marked feature being the larger size and greater distance of the septa in this, as compared with other similar forms in the same rock, except *O. masculum*, in which the distance between the septa is so much greater as to be readily distinguished. From *O. Zeus*, this species is distinguished by its smaller apical angle and lesser convexity of the septa; the other characters are not unlike. This form bears some degree of external resemblance to a species in the Hamilton group (*O. Eriense*), but the internal characters are quite distinctive.

In its vertical range it is confined, so far as known, to the Schoharie grit, the variety formerly designated as *O. Ohioense*, from the Upper Helderberg limestone of Ohio, proving a very distinct species.

Several large, imperfect individuals have been observed among collections made from the Upper Helderberg limestone of Cherry Valley, N. Y., of Ohio, and Ontario, Canada, which possess characters in common with *O. Pelops*. The apical angle is about 7°. Air-chambers slightly irregular in depth, varying

from three to four in the space of thirty-five mm. Siphuncle central. One specimen, preserving the chamber of habitation and twelve air-chambers, has a length of 230 mm., with a diameter of seventy mm. at the largest part of the tube. The septa are more frequent than in undoubted *O. Pelops;* but without more distinctive material, these forms from the limestone cannot be specifically characterized.

Formation and localities. In the Schoharie grit at Schoharie, and at numerous localities in the Helderberg range, and in the outcrop of this formation along the Hudson River valley as far as Orange county, N. Y. It probably occurs in the same formation in New Jersey, as it appears to be coextensive with the Schoharie grit.

Orthoceras Zeus, n. sp.

PLATE LXXV, FIGS. 1-3.

Shell robust, forming a straight, elongate cylindro-conical tube, which diminishes very gradually in receding from the chamber of habitation. Transverse section circular. The apical angle is about 8½°, measuring from fragments preserving the chamber of habitation and the lower septate portion. Initial point unknown.

Chamber of habitation large, and subcylindrical, being about twice as long (in an imperfect specimen) as the diameter at its base, and very gradually expanding towards the aperture, below which it is marked by a wide, shallow, curved constriction. Aperture unknown, but the tube is apparently gently expanded beyond the constriction. Air-chambers large.

Septa thin, and distant from each other about one-fourth the diameter of the tube, or in actual distance, where the tube measures from fifty to sixty mm., they are about twelve mm. distant from each other. Surface of the interspaces, or casts of the interior of the chambers smooth, and flat on the exterior. Concavity of the septa equal to about eighteen mm., one-third the diameter of the tube, or equal to an arc of 132°.

Siphuncle central, having a diameter of five mm. where it penetrates the

septum, and its walls are apparently nearly uniform and straight in its passage through the air-chambers.

The test, inferring from the crystalline matter remaining on some parts of the surface, has had a thickness of about two mm. Surface marked by irregular, lamellose striæ. Internal cast smooth, with the exception of the constriction of the outer chamber, before noticed, and without special elevation or depression of the interseptal spaces.

This species differs from *O. Pelops*, which it closely resembles, in the more gradual expansion of the tube towards the aperture, and in the greater proportional distance of the septa, which are about as five to seven, and also in their greater concavity. In the gradual expansion of the tube, and distance of the septa, it approaches some of the forms in the higher rocks, from which it is otherwise very distinct. See *O. Eriense*, plate 40, of the Hamilton group, and *O. Atreus*, of the Portage group.

Formation and locality. This species occurs in the upper beds of the Schoharie grit, near Clarksville, Albany county, N. Y.

Orthoceras Ohioense.

PLATES XXXV A, FIGS. 8, 9; XXXVI, FIG. 4.

Orthoceras Pelops, var. *Ohioense*, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 36, fig. 1. 1876

Shell slightly curved—curvature exogastric. Transverse section circular. Cone regularly and gradually enlarging. Apical angle about 9°. Initial extremity unknown.

Chamber of habitation large, the portion preserved in an imperfect specimen being about twice as long as its diameter at the base. Aperture unknown, apparently slightly contracted.

Septa thin, obliquely curved with regard to the axis of the shell, the margins being advanced further forward on the concave or dorsal side of the shell; in the smaller part of the shell (in the specimen figured), distant about one-sixth, and in the larger portion, near the outer chamber, about one-seventh of the diameter, varying in actual measurement from five to seven

mm., the last air-chamber being shallower than any of the preceding. The depth of curvature of the arc measuring the concavity of the septa is about one-fourth the diameter of the tube at the same point; and the arc of the circle subtends an angle of about 95°.

Siphuncle slightly excentric, being nearer to the convexo-ventral side of the shell, small at its passage through the septa; but a longitudinal section has given no satisfactory evidence of its character, or of its existence in the interseptal spaces.

Test entirely unknown, and no evidence of ornamentation visible upon the cast of the interior. Internal cast of the outer chamber apparently smooth, the septate portion showing a moderate convexity of the filling of each air-chamber, which may, however, be in part due to the mode of weathering.

The specimen figured, and the only one positively identified, has a length of about 240 mm., with a diameter at the larger extremity of fifty-eight mm., and at the smaller extremity of thirty-five mm. The chamber of habitation measures 100 mm., and the septate portion, on the exterior, measures 130 mm., and embraces twenty air-chambers.

This species, from cursory examination, was originally noticed as a variety of *O. Pelops*, the slight curvature being regarded as accidental. A study of the specimen proves it to be a very distinct species. The curvature is apparently normal, and the extension of the septa on the concave side offers farther evidence of this fact. In the dimensions of the siphuncle at the septa, and the distance and curvature of the septa, it resembles the *O. Tantalus*, as shown in pl. 35, figs. 8–10, and pl. 35 A, fig. 7. In its external characters it might not readily be distinguished from that species, but the curvature and obliquity of the septa, and the excentricity of the siphuncle, are characteristic features. Besides, it has not the peculiar organic deposit on the septa and siphuncle possessed by *O. Tantalus*.

Formation and locality. This species is known to me only in the limestone of the Upper Helderberg formation, at Delaware, Ohio.

Orthoceras masculum, n. sp.

PLATE LXXVIII B, FIG. 1.

Shell large, straight. Transverse section circular. Tube very gradually expanding. Initial extremity unknown.

Chamber of habitation not observed. Depth of air-chambers varying from ten to sixty-five mm.; their internal casts, in the specimen figured, show a crenulated or tuberculated band at the anterior portion of each.

Septa irregular, generally very distant, straight and horizontal; concavity unknown.

Position of the siphuncle not determined. Test removed from all observed specimens.

The internal mould is essentially smooth, with the exception of the crenulated bands above mentioned. The chamber walls are flat, with the septal sutures but slightly impressed. The specimens are often covered with numerous individuals of a species of Spirorbis.

One fragment having a diameter of eighty mm., and containing four air-chambers, measures 200 mm. in length. A similar specimen, with a diameter of nearly 100 mm. and seven air-chambers, has a length of 220 mm. A smaller fragment with a diameter of the tube of sixty mm., and possessing nearly four air-chambers, has a length of 180 mm. Several large sections, referred to this species on account of their size, have a diameter of from 105 to 125 mm.

This species is remarkable for the large size and very gradual enlargement of the tube, and the extreme variation in the depth of the chambers. These characters distinguish this form from any associated species, or any species now known in the Devonian period.

Formation and localities. From the Schoharie grit, in the vicinity of Schoharie, and near Clarksville, Albany county, N. Y.

Orthoceras fluctum, n. sp.

PLATE LXXVI, FIGS. 4–7.

Shell straight, gradually enlarging from the apex to the outer chamber. Transverse section subcircular, or broadly elliptical. Apical angle 8°. Initial point unknown.

Chamber of habitation large and regularly expanding towards the aperture, without any constriction so far as observed. Aperture unknown. Air-chambers numerous and comparatively shallow, having a depth of four or five mm. when the diameter of the tube is thirty to thirty-five mm., but often showing variation of depth in adjacent chambers.

Septa thin, the concavity greater than the interspaces, being about seven mm., or equal to an arc of 100° to 108°. Sutures much curved, but not oblique to the axis.

Siphuncle central or subcentral in well-preserved specimens, and small at its insertion in the septa, participating in the effects of pressure, as shown in fig. 7. Its passage through the interseptal spaces has not been traced; but in some specimens the convex sides of the septa present an elevated areola, with vascular markings surrounding the siphuncular scar.

There is rarely any evidence of test preserved, it having been dissolved and removed; and the surface-markings are unknown. The internal casts are essentially smooth, the interseptal spaces being flat, with an intermediate groove made by the solution of the calcareous matter at the margins of the septa. The greatest length of the fragmentary specimens is about 200 mm.; but the length of entire individuals has probably been twice as great. The diameter of the tube at the last septum, in a well-preserved specimen, is thirty-five mm.

This species in many respects resembles the *O. procerus;* but it is less attenuate and proportionally less expanded in the outer chamber. The position of the siphuncle is also distinctive, while the septa, which are of the same frequency in both species, are in this one curved upon their exterior

margins, and the curvature unsymmetrical. All the specimens referred to this species agree in this feature of the septa. Figure 3, of the same plate, resembles this species, except in the greater distance between the septa. The view of the specimen represented is the much flattened and weathered dorsal side. The ventral side of the specimen is less compressed, and shows the septa to be straight and horizontal; the air-chambers are grooved and ornamented by a longitudinal carina, as partially represented in figure 2 of *O. cingulum*. In some of its phases this species resembles *O. luxum;* but the septa are more closely arranged, and the position and character of the siphuncle is quite different. In its vertical distribution this species is not known beyond the limits of the Schoharie grit, and its geographical distribution is confined, so far as at present known, within the counties of Albany and Schoharie.

Formation and localities. In the Schoharie grit in Schoharie, and at the base of the Helderberg mountains, N. Y.

Orthoceras cingulum, n. sp.

PLATE LXXVI, FIGS. 2, 3.

Shell straight, regularly and gradually enlarging. Transverse section, judging from the degree of compression, subcircular. Apical angle varying in compressed specimens from 6° to 8½°. Initial extremity unknown.

Chamber of habitation having only a small portion of the base preserved in the specimens examined; the internal cast of this portion is smooth, and very gradually enlarging. Air-chambers numerous, regularly increasing in depth from the apex of the specimen to the chamber of habitation, varying in depth from five to ten mm. in the space of 140 mm. Internal cast of the walls essentially smooth, except at the base of each chamber in weathered specimens, where the produced septal margins are dissolved, giving the specimens a peculiar banded or zoned appearance.

Septa horizontal and straight on the margins, presenting a rigid appearance in specimens not disturbed by compression; marked by a raised areola around the insertion of the siphuncle, which is surrounded by vascular markings.

Siphuncle central or subcentral, small, the diameter being about two mm. where the tube has a diameter of thirty-five mm. The character of the siphuncle in the interseptal spaces is unknown.

Cast of the interior essentially smooth. The ventral side is indicated by a longitudinal raised line or carina on the cast of the septate portion. Test and surface-markings unknown.

The incomplete individual, fig. 2, pl. 76, has a length of 220 mm., and a diameter, at the base of the chamber of habitation, of fifty-five mm.

The accompanying figures offer an explanation of the appearance, described above, as produced by weathering. Figure 1 is a portion of a longitudinal section of the tube of a perfect specimen, showing the epidermal layer, *e*, and the nacreous layer, *n*. Portions of the septa are represented, continuing from *s* to *z*. *C*, *C*, are air-chambers filled with infiltrated matter, or material similar to the surrounding rock. Figure 2, a section of a weathered specimen, with the consequent removal of all exposed shelly matter. *z*, *z*, are the zones, or narrow, shallow furrows, as represented in figure 2, plate 76.

FIG. 1.

FIG. 2.

This form is distinguished from *O. fluctum* by the distance and rigid appearance of the septa, and their produced margins, and by the keel along the ventral side. It also resembles *O. Tantalus*, but the septa are not so frequent or oblique.

Formation and locality. This species is known only from the Schoharie grit, in the vicinity of Schoharie, N. Y.

ORTHOCERAS TANTALUS, n. sp.

PLATES XXXV, FIGS. 8-10; XXXV A, FIGS. 7, 10.

SHELL large, straight, regularly expanding from the apex. Transverse section circular. Apical angle 9° to 10° 30′.

Chamber of habitation large; but its proportions are not fully determined, owing to the imperfection of the specimens. Aperture unknown. Air-chambers numerous, regularly increasing in depth to the chamber of

habitation, varying from five to eight mm. This species also presents, in a less marked degree, the zoned appearance of *O. cingulum*, caused by the removal of the shelly margins of the extended septa; otherwise the cast of the interior is smooth.

Septa having a concavity equal to an arc of about 110°. Plane of the septa straight, and slightly oblique; convex surface ornamented by an elevated areola around the siphuncular scar, and generally by an irregular, vesiculose, organic deposit around the siphuncle, which sometimes reaches a diameter of more than one-third that of the tube. Occasionally this deposit consists of irregular tubercles and flattened expansions, extending nearly to the septal margins. The character and appearance of this organic deposit on the septa and siphuncle varies greatly in the same individual, depending upon the distance from the chamber of habitation. Near the apex it assumes a more marked complexity of detail, often nearly filling the chambers, and obscuring the characters of the septa and siphuncle.

Siphuncle apparently straight, with the walls sometimes variously thickened on the exterior.

Test unknown. Casts of the interior marked by an elevated line along the septate portion, indicating the ventral side of the shell, and free from any other markings so far as observed.

This fossil is only known in a fragmentary condition. When entire, the tube probably had a length of one foot and a half, or about 450 mm.

From *O. Ohioense* this species is distinguished by the absence of any curvature of the tube, and by the organic deposit on the septa and siphuncle. It resembles *O. Pelops* in the character of the surface of the casts; but the septa are more closely arranged, and their concavity not so great. In the incomplete examinations made previously to the publication of the *Illustrations of Devonian Fossils*, this form had not been separated from *O. Pelops*, and in the crushed and imperfect condition of a large proportion of the specimens of this formation, the distinction between the two species is not always conspicuous. In the distance of the septa and comparative attenuation of the tube, this form differs little from well-preserved specimens of *O. luxum;* but the concavity of

the septa in the latter is greater, and the siphuncle is expanded between the septa. The organic deposit is very similar in the two species.

Formation and localities. In the Schoharie grit at Schoharie, and the Helderberg mountains, N. Y.

Orthoceras obliquum, n. sp.

PLATE LXXVIII, FIGS. 1-4..

Shell straight, robust, transverse section subcircular. Tube regularly and somewhat rapidly expanding from the apex. Apical angle from 9° to 10°. Initial extremity unknown.

Chamber of habitation very large, regularly expanding to the aperture. The cast of the interior is smooth. Aperture not observed. The air-chambers numerous and shallow, having a depth of from one-sixth to one-seventh of the diameter of the tube, or from three to five mm.

Septa thin, smooth, with a small areola around the insertion of the siphuncle. The suture line is curved on two of the sides, and very oblique over the other two sides. The arc of curvature of the septa, measured from specimen, fig. 3, is about 130°. The small specimen, fig. 4, apparently belongs to this species, but is much flattened, and the curvature of the septa destroyed.

Siphuncle subcentral, small, diameter at the septa equal to about one-third the depth of the chamber. The character of the siphuncle in its passage between the septa has not been observed; one longitudinal section indicates that it was probably expanded or moniliform.

The largest fragment has a length of 220 mm., and a diameter of fifty mm., at a point near the aperture. None of the specimens referred to this species preserve any evidence indicating the thickness and ornamentation of the test,—all being in the condition of casts of the interior.

This species somewhat resembles *O. fluctum*, but is distinguished by its more rapidly enlarging tube, the greater obliquity and lesser curvature of the septa; which are also more convex than in that species. In its vertical

distribution, so far as known, this species is confined to the upper beds of the Schoharie grit.

Formation and locality. Schoharie grit, Schoharie, N. Y.

Orthoceras luxum.

PLATES XXXV, FIGS. 4-7; LXXVI, FIG. 1; LXXVII, FIGS. 1-8; LXXVIII, FIGS. 5-7; LXXVIII B, FIG. 3; LXXXI, FIG. 13; CXII, FIGS. 12-14.

Orthoceras luxum, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 35, fig. 5. 1876.

Shell straight, regularly and gradually enlarging from the apex. Transverse section, in the better preserved individuals, circular. Apical angle varying, owing to the compressed condition of the specimens, from 9° to 11°. Apex unknown.

The chamber of habitation is rarely preserved, and has no unusual characters. So far as observed, it regularly enlarges to the aperture without any constriction or contraction. Aperture unknown. The air-chambers are regular, gradually increasing in depth from the apex to the grand chamber. The depth of the interseptal spaces varies from six to three mm. in the same and in different individuals. In specimens retaining their normal form, the outer walls are flat, not deviating from the general attenuation of the tube. In compressed forms, the walls are conspicuously concave.

Septa thin, regularly concave; the concavity equal to an arc of about 113°. Many of the specimens vary from this amount of concavity according to the various degrees of compression and distortion to which they have been subjected. The convex side of the septum is marked by a distinct areola surrounding the siphuncle, and extending in a kind of vascular expansion unequally, and on one side, often reaching to the margins of the septum, and affecting the ventral portion of the cavity. This areolar marking is often thickened, becoming striated at the margin, and spreading over the septum as a mammillary organic deposit.

Siphuncle central, moniliform, greatest diameter between the septa equal to nearly three times the diameter in its passage through the septa, or equal

to the depth of the chambers. Specimens in which the siphuncle has become exposed by weathering, show that it was obscurely lobed and longitudinally ribbed.

The test was probably thin. No portions of it are preserved in any of the specimens observed. The surface, as shown by the internal casts of several individuals, was marked by lamellose, transverse striæ.

The appearances of the internal mould of this species are very characteristic. The exsolute, or lax condition of the chambers, together with their concave margins — a uniform condition of the compressed specimens — is a distinguishing feature. The organic deposit is shown in all casts of the interior, and is peculiar to the species.

The largest fragment referred to this species has a length of 200 mm. Other fragments have been found belonging to larger individuals. The maximum length was probably not more than 400 mm.

The organic deposit on the septa, around the siphuncle, and on the ventral walls of the air-chambers, presents many different aspects, and has been observed in numerous individuals. It increases in amount and complexity of detail, from the chamber of habitation to the apex. In some specimens the siphuncle has been absorbed or obliterated by the deposit. Other specimens show a deposit formed on the interior of the siphuncular tube. The filling up of the chambers is not, however, carried to such a remarkable extent as in *O. oppletum*, but is much more marked than in any of the preceding species. The deposit on the septa varies in different portions of the tube, and on different sides. Sometimes the amount is very marked on one side (see fig. 3, pl. 78 B), and less prominent or nearly absent on the other. The appearance produced is generally a pitting or erosion of the material filling the chambers. In well-preserved specimens, it is shown that these pits are the casts of the original deposit, which consists of closely arranged, irregular, mammillary aggregations of calcareous matter. The globules composing these masses are usually very small, occasionally reaching a diameter of two mm. The appearance around the siphuncle is, at first, that of a simple areola; the amount of deposit increasing till it becomes thickened, and

forms an irregular, sharply-furrowed cylinder with the sides concave between the septa. This filling is deposited to such an extent in some individuals as to nearly fill the cavity of the chambers. Figure 13, pl. 81, represents this phase. The pitted or eroded appearance is carried, not only over the septa, but over the deposit around the siphuncle, and occasionally over the walls of the chambers, figs. 12–14, pl. 112.

All the better specimens of the interior casts observed, show a deposit along the middle of the ventral side of the chamber walls, adjacent to a narrow carina, which indicates the existence of a groove upon the interior surface of the original shell, and through which a communication may have been continued between the interseptal spaces, successively, as the animal has advanced its chamber of habitation. An evidence of this is furnished by the fact that the carina is always more prominent at the anterior portion of each chamber, where it penetrates the margin of the septum. The functional connection of this feature with the organic deposit around the siphuncle is indicated by its presence in species where the deposit is very marked, as in the present form. This connection is generally preserved as a longitudinal raised line or carina; but the specimens figured on plate 35, figures 5 and 6, show a variation from a simple line to a complex deposit, having a somewhat symmetrical form, arranged in straight or curving lines on both sides of the central carina; and the latter, with these accessory depositions in other portions of the tube, assuming the form of oval or rounded nodes. This feature upon the inner walls of the shell is visibly a continuation from the areola which surrounds the siphuncle, and its extension on one side, which is continued to the margins of the septa and along the ventral walls of the chambers.

This species is the most common and characteristic one found in the Schoharie grit. The external shell was probably very thin, rendering the tube liable to the great degree of compression and distortion which is exhibited by the majority of specimens. Frequently the chambers are oblique to the axis, and displaced, as shown in fig. 4, pl. 35, and figs. 3, 7, pl. 77. The siphuncle has rarely been preserved. Only one of the numerous sections made, affords

satisfactory evidence as to its true elements. In two specimens it has been exposed by the process of weathering, and preserves its moniliform character.

According to BARRANDE, the apparent explanation as to the nature and purpose of the organic deposit, is that it was secreted by the animal to give strength and weight to the shell, and that it appears to be the analogy of the large and complicated siphuncles of ENDOCERAS, HURONIA, and ACTINOCERAS. (See *Syst. Silurien du centre de la Bohème*, vol. ii, Text iv, p. 280.) It has been suggested that the shells of ORTHOCERAS and other related genera were probably carried in a vertical position. The volume of the septate or chambered portion being considerably in excess of the chamber of habitation, and the external shell comparatively thin, a deposit on the interior of the chambers would afford the required strength and gravity. The thinness and delicacy of the septa and chamber walls is very marked in HURONIA and ACTINOCERAS, when compared with the size and strength of the siphuncular tube. M. BARRANDE describes several species of ORTHOCERAS, presenting an organic deposit similar to *O. luxum*. (See pl. 227 and pl. 446, of *Syst. Silurien du centre de la Bohème*.) Plates 228, 229, 282, 404, 482 represent species which may be referred to for additional features illustrating various phases of the organic deposit. On plate 415 he figures a species (*O. arcitenens* Barr.), showing a deposit or marking on the ventral side of the chambers, similar to specimens of *O. luxum* and several species from the Schoharie grit and Hamilton group. M. BARRANDE also remarks that this and one other obscure species are the only ones with this peculiar deposit that have come under his observation.

From *O. Tantalus* this species is distinguished by its smaller size, its more frequent septa, and the amount and character of the organic deposit. It somewhat resembles *O. oppletum*, but is distinguished by its central siphuncle, the smaller distance between the septa, and the lesser development and different aspect of the organic deposit. *O. rudicula*, from the Upper Helderberg limestone at Stafford, N. Y., closely resembles this species in some of its phases.

In its vertical distribution, this species is confined, so far as known, to the Schoharie grit. In its horizontal distribution it has been observed only in the Helderberg range, and in the vicinity of Schoharie.

Formation and localities. In the Schoharie grit at Schoharie, Clarksville, Knox, and other points in the Helderberg mountains.

Orthoceras oppletum, n. sp.

[PLATES LXXXI, FIGS. 9–12; CXII, FIG. 11.

Shell robust, straight; tube gradually enlarging. Transverse section subcircular.

Chamber of habitation unknown. Air-chambers regular, having a depth of about six mm.

Septa, and also some portions of the organic deposit, ornamented by fine, irregular, lamellose striæ, which are sometimes concentric about different points on the septa and chamber-walls, generally parallel, and running in the direction of the longitudinal axis of the shell.

The siphuncle is situated at about one-third the diameter of the tube from the ventral(?) side. Its diameter at the septa is very small. Between the septa the characters have not been observed.

The organic deposit around the siphuncle is similar to that of *O. luxum*, forming a sharply furrowed cylinder between the septa—the furrows in this species being much larger and more irregular than in *O. luxum*. The deposition is carried to such an extent as almost or entirely to fill the cavity of the chambers, as represented in fig. 12, pl. 81. The separate globular masses of the deposit sometimes have a diameter of six mm. Towards the chamber of habitation the deposit is at first a large areola, with a lamellose striate margin, and a fascicle of the striæ extending to the margin of the septum. On the septa the deposit is composed of very small globular masses, and in appearance is similar to the same deposit in *O. luxum*.

One individual of this species has a diameter of the tube of about forty mm.

The appearances of the internal mould are sufficiently marked to readily distinguish the species. The peculiarities of the organic deposit and the ornamentation on the septa are very characteristic.

This species somewhat resembles *O. luxum* in the amount and appearance of the organic deposit. It is, however, much more developed and coarser in its

aspect in this species. *O. luxum* has not the lamellose-striate markings on the septa, and the position of the siphuncle is very different. The septa are also more distant in this species.

This form is comparatively rare; only four imperfect specimens have been observed in the large collections made from the different localities.

Formation and locality. In the Schoharie grit at Schoharie, N. Y.

SECTION *b.*—*Slender forms, with numerous regular septa.*

ORTHOCERAS PROCERUS.

PLATES XXXV, FIGS. 15, 16; LXXVIII A, FIGS. 1-8; LXXIX, FIGS. 5-8.

Orthoceras procerus, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 35, fig. 4. 1876.

SHELL straight, slender, very gradually enlarging from the apex. Transverse section subcircular. The apical angle in different individuals measures 6°, 7½°, and 8°. The initial extremity of the shell is unknown.

The chamber of habitation is large, measuring from 80 to 100 mm. in length. Aperture unknown, but probably entire, with a constriction of the tube below. The air-chambers are numerous, having a depth of five to six mm. in the larger part of the tube, where the diameter is about twenty-five mm.; while in the smaller portion of the tube they are about four mm. in depth, the diameter at the same point being seventeen mm.; and in both cases the tube is a little compressed. Toward the apex, where the tube has a diameter of only eight mm., the air-chambers have a depth of four mm., or about the same as in the larger portion of the tube. In another specimen not compressed the septa are distant five mm., where the diameter of the tube is eighteen mm. In specimen, fig. 8, of pl. 78 A, there are twelve chambers in the space of fifty-five mm., the diameters at the two extremes being twenty-two and twenty-six mm. respectively. In another individual of this species there are nine chambers in fifty-four mm.

The septa are thin, moderately concave, the depth of the curvature being about equal to the distance between the septa, or to an arc of 95° to 98°.

Siphuncle small, slightly excentric. Its character in its passage between the septa has not been observed.

The organic deposit consists of an areola on the septa, surrounding the siphon, from which in some specimens there are obscure, radiating, vascular ridges. On the exterior walls of the air-chambers in the cast, and indicating the ventral side, there is a longitudinal raised line or keel, represented in fig. 4, pl. 78 A. The other specimens also show this line, but it is not represented in the figures. Sometimes the line is made more prominent by a distinct, shallow groove on either side.

The test is usually so far dissolved, or otherwise removed, that no evidence as to its thickness remains. Several of the specimens preserve traces of the surface-markings, which consist of fine and closely arranged sharp, transverse striæ, crossed by very fine, longitudinal striæ. The transverse striæ curve backward over the dorsal and ventral sides, and forward over the lateral portions of the shell.

No entire individuals of the species have been observed. One specimen has a length of 260 mm. Others measure about 250 mm. in length, and are incomplete towards the apex, and we may infer that they have been at least 100 mm. longer. The greatest diameter in incomplete specimens is less than forty mm.

This species bears some resemblance to special conditions of *O. luxum*, but may be distinguished by the excentric siphuncle, and absence of the conspicuous organic deposit. *O. inoptatum*, pl. 37, fig. 1, is of similar form and proportions, but differs in having a very excentric siphuncle, and no evidences of an areola on the septa.

This species is unknown to me in any formation except the Schoharie grit.

Formation and localities. In the Schoharie grit at Schoharie, and in the Helderberg mountains; but is unknown beyond the limits of this formation in the eastern part of the State of New York.

Orthoceras tetricum.

PLATES LXXVIII B, FIG. 4; LXXX, FIGS. 2, 5, 6, 8, 9.

Orthoceras tetricum, Hall (see *O. pravum*). Descriptions of New Species of Fossils, etc., p. 45. 1861.

Shell straight, regularly and very gradually enlarging from the apex. Transverse section circular. Apical angle varying from 4° to 5½°. Initial extremity unknown.

A small portion of the chamber of habitation has been observed, having a length of fifty mm. This fragment shows nothing more than a regular expansion conforming with the general contour of the tube. Air-chambers large, extremely irregular in depth, varying from twelve to twenty-two mm. Aperture unknown.

Septa thin, smooth, very concave. The concavity is equal to an arc of about 140°. Sutures straight, and horizontal.

Siphuncle excentric, situated a little less than one-third the diameter of the tube from the ventral(?) side. Its elements, in its passage through the chambers, have not been observed; at the septa the diameter is nearly four mm., where the entire tube has a diameter of thirty mm.

The test was probably very thin, as it has only been observed in two individuals. Its thickness, as imperfectly preserved, is not more than one mm. Surface marked by very fine, sharp, regular, gently-curving, concentric striæ, as shown in fig. 4 of pl. 78 B.

The internal mould shows the walls of the chambers to be smooth, and continuous with the regular enlargement of the tube.

No entire individuals have been observed. The longest fragment has a length of 130 mm., with a diameter at the larger end of forty mm., measuring twenty-eight mm. in diameter at the smaller extremity. The entire specimen was probably several times the length of this fragment. Several fragments of larger individuals have a diameter of about fifty mm.

This species is easily distinguished from *O. procerus* by its more gradually enlarging tube, and large, deep air-chambers; and also that none of the specimens

show an organic deposit. It is closely allied to *O. collatum*, and may be distinguished by its more distant septa and their greater concavity. The specimens do not preserve enough of the chamber of habitation to admit of comparisons with *O. collatum* in this particular.

Formation and localities. In the Schoharie grit at Schoharie, and in the Helderberg range.

Orthoceras collatum, n. sp.

PLATE LXXX, FIGS. 1, 3, 4.

Shell straight, regularly and gradually enlarging from the apex to a point near the aperture. Transverse section subcircular, often much flattened from compression. Apical angle varying from 4° to 6° in the specimens. Initial point unknown.

Chamber of habitation large, slightly expanding beyond the general enlargement of the tube, to a point anterior to the middle, where it is abruptly constricted. In front of the constriction the tube expands gradually towards the aperture. Aperture not observed. Air-chambers regular, having a depth of about eleven mm.; walls flat and smooth. The ventral side is indicated by a low, longitudinal carina on the chamber walls, which is more prominent on the anterior portion. This line is shown on the casts of the interior, and has a width of about one mm.

Siphuncle large, slightly excentric, having a diameter at the septa of nearly four mm. Its elements in its passage through the chambers have not been observed.

The characters of the test and its ornamentation are not shown on any of the specimens at hand. It was probably thin and has been dissolved, leaving a cast of the interior.

The internal mould is essentially smooth. The ventral carina and the marked constriction of the chamber of habitation are the only distinctive features.

A fragment preserving eight air-chambers measures eighty-eight mm. in length, and has a diameter of forty-five mm. One specimen retaining the chamber of habitation and five ordinary chambers, has a length of 125 mm., with a diameter near the aperture of thirty-five mm.

This species closely resembles *O. tetricum*, but is readily distinguished by its more regular and frequent septa, their lesser concavity, and the decided constriction of the chamber of habitation,

Formation and localities. In the Schoharie grit at Schoharie, and in the Helderberg mountains.

Orthoceras stylus.

PLATES XXXVI, FIGS. 2, 3; AND LXXIX, FIGS. 1, 3.

Orthoceras baculum, Hall. Descriptions of New Species of Fossils, etc., p. 46. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 73. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 36 figs. 3, 4. 1876.
Not " " Meek. Proc. Acad. Nat. Sci., Phila. 1860.
Not " *baculus*. Barrande. Syst. Sil. du centre de la Bohème, vol. 11, text 3, p. 118. 1874.
" *stylus*, Hall. Catalogue of American Palæozoic Fossils (S. A. Miller), p. 245. 1877.

Shell an extremely slender, straight, cylindro-conical tube. Transverse section circular. Apical angle 2°. Apex unknown.

Chamber of habitation long, cylindrical, length more than six times the transverse diameter, showing no variation from the general contour of the tube. Aperture not observed. Air-chambers regular, shallow, the depth being about five mm. Usually the last two are shallower than the posterior chambers.

Septa thin, ornamented with a small, circular areola around the insertion of the siphuncle; concavity equal to an arc of from 115° to 120°. Sutures straight and horizontal.

Siphuncle small, subcentral or slightly excentric, diameter 1.5 mm. at the septa, where the diameter of the tube is fifteen mm. Its characters have not been observed in its passage through the chambers.

The test has not been preserved, but the surface characters are sometimes

retained by the casts of the interior, and show that it was marked by fine, curving, transverse striæ.

The internal mould is smooth, and the chamber walls essentially flat.

A specimen 130 mm. long, and preserving about ninety-five mm. of the chamber of habitation, is scarcely appreciably diminished towards the apex, the greatest actual diameter being in the middle of the length. Another fragment of ninety-five mm. in length, of which thirty-five mm. pertain to the chamber of habitation, shows scarcely a diminution in the diameter. The first of these specimens has a diameter of fifteen mm., and the second of twelve mm.

This species is remarkable for its slender, cylindrical form, resembling *O. exile* of the Hamilton group, but is distinguished by its smaller size, greater attenuation, and the absence of any constriction of the chamber of habitation. From *O. tetricum* it differs in its very small apical angle, the much greater frequency of the septa, and the central or slightly excentric siphuncle.

In its vertical distribution this species is confined to the Schoharie grit, but it is one of a small group of forms continuing through the Upper Helderberg limestones, and the Hamilton group.

Formation and localities. In the Schoharie grit at Schoharie, and the Helderberg range.

Orthoceras medium, n. sp.

PLATE LXXIX, FIGS. 11, 12.

Shell straight, gradually expanding. Transverse section circular. Apical angle about 5°. Initial point unknown.

Chamber of habitation not observed. Air-chambers irregular in depth, increasing toward the grand chamber, varying from five to ten mm. in the length of forty mm. In the cast, the ventral side of the chamber walls is ornamented by a elongate-conical carina, extending from the anterior portion of each chamber about two-thirds of its length.

Septa thin, smooth. Sutures horizontal, straight.

Siphuncle slightly excentric, having a diameter at the septa of two mm. where the tube has a diameter of eleven mm. It has not been observed in its passage through the interseptal spaces.

The test has not been preserved. Surface characters unknown.

The internal mould is smooth with the exception of the ventral carina. The walls of the chambers sometimes become concave, and occasionally the concavity is shown as a flat, slightly depressed constriction or belt.

One small fragment has five chambers in the space of thirty-five mm., with a diameter at the larger end of twelve mm. A fragment of the septate portion of a larger individual has ten chambers in the space of sixty-five mm.

This species is intermediate in its characters between *O. stylus* and *O. pravum*. It differs from *O. stylus* in its greater apical angle, generally deeper and more irregular chambers, and the prominent line on the ventrum. From *O. pravum* it is distinguished by the absence of any areolar markings and ornamentation on the septa.

Formation and locality. Observed only in the Schoharie grit at Schoharie, N. Y.

ORTHOCERAS PRAVUM, n. sp.

PLATES XXXV, FIG. 14; XXXVI, FIG. 1; LXXXI, FIGS. 1-8; AND CXII, FIGS. 15-17.

Orthoceras tetricum, HALL. Descriptions of New Species of Fossils, etc., p. 45. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 73. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 36, fig. 2. 1876.

SHELL straight, regularly and gradually enlarging, usually very much distorted from compression. Transverse section circular, often flattened and unsymmetrical. Apical angle about 5°.

Only a small portion of the chamber of habitation has been observed. This fragment presents no unusual features. Air-chambers regular, deep, varying from eight to fourteen mm. in depth, in the same and in different individuals.

Septa regularly and deeply concave, the concavity being equal to an arc of 140°. Sutures straight and horizontal, often curved and oblique from distortion. Septa ornamented by a raised lamellose-striate areola around

the siphuncle, extending as an ovate expansion to the ventral margin; the whole surrounded by concentric striæ, which are often continued in a low, broad ridge over the cast of the ventral walls of the chambers. Occasionally this ornamentation is obscured and obliterated by an organic deposit, consisting of a coarse, mammillary mass, surrounding the expansion extending to the margin; and a similar deposit, but composed of finer globules, is continued over the septa and the exterior walls. This deposit presents the same structural appearance as that in *O. luxum* and *O. oppletum*.

Siphuncle small, cylindrical, slightly excentric, nearer the ventral side, indenting the septa. The diameter at the septa is 2.5 mm.

Test very thin, rarely preserved, having a thickness of .5 mm. Surface marked by fine, sharp, transverse striæ, of which there are ten in the space of two mm.

The appearances of the internal mould are usually remarkably characteristic. Specimens not subjected to compression might be mistaken for *O. tetricum;* but the ornamentation of the septa is a distinguishing feature. The compressed specimens present a decidedly exsolute appearance, as may be seen by reference to the figures of the species on plate 81. The chambers are often partially separated and variously distorted, leaving the walls concave and convex in the same individuals, and frequently becoming subspherical or unsymmetrical.

One individual, preserving a small portion of the chamber of habitation, and eight adjacent air-chambers, has a length of 150 mm., with diameters of twenty-seven and twelve mm. respectively at the two extremities. Another fragment, of twelve chambers, has a length of 120 mm.

This species is distinguished from other similar forms by the ornamentation on the septa. It is further separated from *O. tetricum* by its somewhat smaller size. The chambers are deeper and more regular than in *O. medium* and *O. stylus*, and it has not the narrow carina of the former.

M. Barrande figures and describes several species having the septa ornamented in a measure like the present species; notably, *O. cruciferum*, Barr., and *O. bonum*, Barr. (*Syst. Sil. du centre de la Bohème*, vol. ii, text 3, pp. 123, 482).

He ascribes this ornamentation to markings on the surface of the mantle at the base of the chamber of habitation, which have been impressed upon the successive septa. In the species described in the present volume there is an evident connection, functional or structural, between the ventral carina, the areola around the siphuncle, and various markings and ornamentation of the septa, and the ability of the mollusk to form an organic deposit in the posterior air-chambers.

Formation and localities. In the Schoharie grit at Schoharie, and Clarksville, Albany county, N. Y.

SECTION *c.—Species of undetermined relations.*

ORTHOCERAS PERVICAX, n. sp.

PLATE LXXIX, FIGS. 9-10.

SHELL straight, somewhat rapidly enlarging. Transverse section circular. Apical angle about 10°. Initial extremity unknown.

A portion of the chamber of habitation has been observed, possessing no distinctive features. Air-chambers regularly increasing in depth from the apex of the specimen to the grand chamber, varying from three to five mm. The interior cast of the walls is smooth and flat, with the exception of a distinct, raised longitudinal line or carina, extending the entire length of the septate portion on the ventral side.

Septa smooth, thin; concavity equal to an arc of 90°. Sutures very slightly oblique.

Siphuncle small, having a diameter of two mm. where the shell has a diameter of eighteen mm.; excentric, nearer to the ventral side, the distance being about one-third the diameter of the tube. Its characters have not been observed in the interseptate spaces.

Test and surface-markings unknown.

A specimen preserving a portion of the chamber of habitation, and twenty-two adjacent air-chambers, has a length of 113 mm.; the diameter of the

smaller extremity is eight mm., and the chamber of habitation has a diameter of twenty-three mm.

This species, of which only one specimen has been observed, is distinguished from *O. procerus* by its large apical angle, the concavity of the septa, and the greater excentricity of the siphuncle.

Formation and locality. The Schoharie grit at Schoharie, N. Y.

Orthoceras carnosum, n. sp.

PLATE XXXV, FIG. 11.

Shell small, straight, regularly enlarging to a point near the middle of the chamber of habitation. Transverse section broadly elliptical. Apical angle about 9°. Apex unknown.

Chamber of habitation short, somewhat gibbous; point of greatest transverse section near the middle, whence the shell contracts slightly, and again expands before reaching the aperture, forming a shallow constriction. Air-chambers regular, having a depth of from two to three mm., and less near the base of the chamber of habitation.

Septa smooth, having a concavity equal to an arc of 109°. Sutures straight and horizontal.

Siphuncle subcentral, large, having a diameter of two mm. where the diameter of the tube measures ten mm. The elements have not been observed in its passage through the chambers.

Test thin, rarely preserved. Surface marked by fine, regular, lamellose, transverse, arching striæ, six in the space of two mm., crossed by finer, longitudinal, cancellating striæ. The striæ are curved, forming a broad, distinct sinus over the ventral side.

The internal mould is essentially smooth, with the chamber walls flat, and the sutures but little impressed.

The only individual yet observed, which is referred to this species, has a length of fifty-eight mm., including the outer chamber, with ten of the attached air-chambers.

This and the succeeding species are the only small forms observed from the Schoharie grit. *O. carnosum* is distinguished by its size, the slightly ventricose appearance of the chamber of habitation, and the surface characters.

Formation and locality. In the Schoharie grit at Schoharie, N. Y.

Orthoceras varum, n. sp.

PLATES LXXIX, FIGS. 2, 4; AND CXII, FIGS. 5, 6.

Shell straight, slender, subfusiform, point of greatest transverse section near the base of the chamber of habitation. Transverse section broadly elliptical or subcircular. Initial extremity unknown.

Chamber of habitation gibbous, contracting rapidly toward the aperture, where it is slightly expanded; length more than twice the diameter at the base. The anterior extremity is usually flattened, giving the aperture the appearance of Gomphoceras. Much of this feature is probably due to compression, but it is distinctly shown in nearly all of the individuals referred to the species. Air-chambers regular, having a depth of from three to four mm.

Septa smooth, oblique, concavity nearly equal in depth to that of the chambers. Sutures oblique, slightly curving.

Siphuncle observed only at its insertion in the septa, where it is small, having a diameter of one mm.; the diameter of the shell at that point being fifteen mm.

Test and surface-markings not observed.

The cast of the interior is smooth, with the sutures moderately impressed.

Mature individuals of this species have had a length of about eighty mm. One specimen having ten air-chambers and the greater portion of the grand chamber, has a length of sixty-five mm. A smaller individual, with the outer chamber and nine of the air-chambers, measures fifty-five mm. in length. The smallest example of the species observed has a length of 40 mm., with a diameter of eleven mm. at the chamber of habitation.

This species has no allied form in the Schoharie grit, and is easily distinguished by its size, form, and the peculiarities of the chamber of habitation.

Formation and locality. In the Schoharie grit, Schoharie, N. Y.

SECTION *d.—Species having the cone longitudinally fluted.*

ORTHOCERAS CREON, n. sp.

PLATE LXXIX, FIGS. 14, 15.

SHELL small, straight, rapidly enlarging. Transverse section, allowing for the degree of compression of the specimen, subcircular. Apex unknown.

Only the base of the chamber of habitation has been preserved, which presents no unusual features. Air-chambers regular, having a depth of about two mm.

Septa smooth, thin, having a concavity equal to an arc of about 100°. The sutures, on a specimen somewhat compressed, are slightly curved and oblique.

Siphuncle small, subcentral. Its elements have been observed only at the septa.

Tube ornamented with regular furrows, formed by sharp, elevated, longitudinal striæ, of which there are four to five in the space of five mm.

The only specimen of this species observed in the Schoharie grit has a length of thirty mm., and preserves a portion of the outer chamber and four of the air-chambers. A small fragment of the test from the Upper Helderberg limestone at West Avon, Genesee county, N. Y., and differing from *O. Œdipus* and *O. profundum*, appears to belong to this species. This fragment shows the longitudinal striæ to be cancellated by fine lines of growth, and without the finer intermediate, longitudinal striæ of *O. Œdipus*.

This species, as occurring in the grit, may be distinguished from *O. profundum* by its rapidly expanding tube, and finer surface ornaments. From *O. Œdipus* it is distinguished by its regular, sharp, longitudinal striæ.

Formation and locality. In the Schoharie grit at Schoharie, N. Y.

SECTION *e.—Annulated forms.*

ORTHOCERAS THOAS.

PLATES XLI, FIGS. 1-9; LXXVIII B, FIG. 5; LXXIX, FIG. 13; LXXX, FIGS. 7, 10, 11; CXII, FIGS. 7, 8.

Orthoceras Thoas, HALL. Descriptions of New Species of Fossils, etc., p. 47. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 75, pl. 7, fig. 4. 1862.
" *Hyas*, " Descriptions of New Species of Fossils, etc., p. 47. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 75, pl. 7, fig. 5. 1862.
" *Thoas*, " Illustrations of Devonian Fossils: Cephalopoda. Explanation of pl. 41. 1876.
Compare *Huronia Stokesi*, CASTELNAU. Essai sur le Syst. Sil. de l'Amérique Septentrionale, p. 33, pl. 9, fig. 2. Paris, 1843.

SHELL straight, very gradually enlarging from the apex to the aperture. Transverse section circular. Apical angle from one to two degrees. Initial point not observed.

Chamber of habitation well developed, cylindrical, without any marked constriction or expansion near the aperture; length more than three times the diameter at its base. Aperture unknown. Air-chambers regular, corresponding in number with the annulations, and having a depth of about five mm. near the chamber of habitation.

Septa smooth, slightly indented by the siphuncle, having a concavity equal to an arc of about 140°. Suture lines straight and horizontal.

Siphuncle central, moniliform, having a diameter at the septa of two mm. where the tube measures twenty mm., and expanding in its passage through the chambers to a diameter of four mm.

Test rarely preserved, but the surface-markings are impressed upon the internal casts of many of the specimens. Its thickness, as observed from specimens in the Upper Helderberg limestone, is .75 of one mm. The ornamentation of the tube consists of regular, more or less sharp, horizontal annulations, increasing in frequency toward the apex. The furrows between the annulations are regularly concave, becoming flat as the distance between the annulations increases. These distances vary from three to eleven mm. on different portions of the tube. Surface of the test marked by fine, regular, continuous, transverse striæ, crossed by more distant, sharp, elevated,

longitudinal striæ. Most of the specimens from the grit preserve only traces of the latter.

The internal mould is smooth, with the exception of the annulations. The septal sutures are in the furrows between the annulations, and are but slightly impressed.

The largest fragment referred to this species has a length of 170 mm., with diameters of forty and twenty-seven mm. respectively, at the two extremities, and showing twenty-eight of the annulations in its entire length. Another example has nineteen annulations in the length of eighty-eight mm.

This species is associated with *O. multicinctum*, and may be distinguished from it by the more gradual enlargement of the tube, greater distance between the septa and annulations, and the concavity of the septa. It differs from *O. crotalum*, of the Hamilton group, in the coincidence of the furrows and the septa, their horizontal position with regard to the longitudinal axis of the shell, the apical angle, and the coarser surface-markings.

Owing to the great variation in the frequency of the annulations, and the fragmentary condition of the examples, this species was originally described as *O. Thoas*, to include those with distant annulations, and *O. Hyas*, embracing the forms ornamented with more frequent annulations. The discovery of specimens such as fig. 6, pl. 41, and fig. 5, pl. 78 B, show the variation to which the annulations are subject on the same individual, and the specific identity of the various fragments.

This is probably the species indicated by M. F. DE CASTELNAU (*Essai sur le Système Silurien de l'Amérique Septentrionale:* Paris, 1843), as *Huronia Stokesi*, and cited as occurring in the calcareous schists at Schoharie, N. Y. The evidently erroneous locality references, for many of the fossils, imperfectly figured in the above work, render any changes in the nomenclature of the present recognized species undesirable without farther knowledge.

In its vertical distribution this species is known to occur in the Schoharie grit, in the limestone immediately above, and the Upper Helderberg limestones

proper, in their eastern and western extensions. This inference regarding the extensive distribution of the species is based upon very imperfect material, and may be in part due to the obscurity of the specimens from the upper limestones, which do not admit of specific distinction.

Formations and localities. In the Schoharie grit at Schoharie, and at various localities in the Helderberg range; in the Upper Helderberg limestone at Caledonia, Livingston county; Clarence Hollow, Erie county; and at Onondaga Valley, Onondaga county, N. Y. It has also been identified among collections from the limestones at Columbus and Dublin, Ohio.

ORTHOCERAS MULTICINCTUM.

PLATE XLIII, FIGS. 1-3.

Orthoceras multicinctum, HALL. Descriptions of New Species of Fossils, etc., p. 48. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 76. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 43, figs. 1-3. 1876.
Not " " WINCHELL. Proceedings of the Academy of Natural Sciences, Phila. 1862.

SHELL straight, regularly enlarging. Transverse section circular. The apical angle, measured in a small fragment from near the apex, is 9°. The larger specimens do not admit of this measurement, as they are much compressed or weathered; but they show that the tube was more rapidly expanding than in *O. Thoas*. Initial point unknown.

Chamber of habitation well developed, slightly ventricose, gradually contracting toward the aperture from a point near the middle. Air-chambers numerous, regular, having a depth of about three mm. where the tube has a diameter of twenty mm.

Septa thin, moderately concave. Sutures straight and horizontal.

Siphuncle not observed.

Some traces of the surface ornaments, consisting of regular, longitudinal striæ, are shown upon the casts. The shell is ornamented by numerous, rounded annulations, of which there are four, eight and fifteen in the space of twelve mm., as shown by measurements taken from two specimens. In specimens not compressed, the annulations are straight, and not oblique on any part of the tube.

The largest fragment referred to this species has a length of 100 mm., and is septate throughout its entire length, of thirty-three chambers. A portion of a small individual shows nineteen annulations in the length of seventeen mm. Another example, preserving the chamber of habitation, has thirty-six annulations in the space of seventy-five mm.

This species closely resembles *O. Thoas*, but may be distinguished by its more rapidly enlarging tube, and its much more frequent annulations and septa.

Formation and locality. In the Schoharie grit at Schoharie, N. Y.

ORTHOCERATA OF THE UPPER HELDERBERG LIMESTONES.

In the limestones above the Schoharie grit, included in the Upper Helderberg group proper, the variety of forms in this genus is very limited. This is in part due to the paucity of material: the whole number of individuals observed, among collections made during a series of years, not amounting to more than fifty fragmentary examples of the genus. The number of species recognized bears a large ratio to the actual number of individuals observed. The condition of preservation of the specific characters is, however, in general better than in the Schoharie grit; but the extremely few examples and fragmentary mode of occurrence, render any attempt at a satisfactory determination of the entire characters impossible. The species here described are only those presenting decided marks of distinction from the established forms.

Appended below is a list of the species occurring in the limestone, which have been doubtfully identified with species occurring in other geological horizons:

Schoharie Grit.

Orthoceras Pelops,	HALL.	See page 233, under description of *O. Pelops.*
" *tetricum,*	"	Fragments have been observed having the dimensions, apical angle, and depth of air-chambers of this species.
" *obliquum,*	"	(=*O. vastotor,* H.)* A specimen having the general aspect and proportions of the individuals referred to this species.
" *Thoas,*	"	Noticed under the description of *O. Thoas,* and in the explanation of plate 41.
" *Creon,*	"	A fragment of the test referred to this species, and noticed in the description.

* See explanation of plate 78, and corrections.

Hamilton Group.

Orthoceras crotalum, HALL. Several small fragments preserving the surface characters, which cannot be distinguished from this species.

" *nuntium*, " Fragments resembling this species have been observed from the limestone in Ontario, Canada West.

In addition to the species in the foregoing list there are eight forms known, which constitute the characteristic species of the formation. Those described in this work are as follows:

Orthoceras Ohioense, . . .	HALL.	*Robust forms* (Section *a*).
" *molestum*, . .	"	
" *jacutum*, . . .	"	
" *inoptatum*, . .	"	
" *rudicula*, . . .	"	
" *sirpus*, ...	"	*Slender forms* (Section *b*).
" *viator*, ...	"	
" *profundum*, . .	"	*Cone-fluted* (Section *d*).

ORTHOCERAS MOLESTUM.

PLATE XXXV, FIG. 13.

Orthoceras molestum, HALL. Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 35, figs. 6, 8. 1876.

SHELL straight, rapidly enlarging from the apex. Transverse section circular. Apical angle 9°. Initial extremity unknown.

Chamber of habitation large, regularly and rapidly enlarging to the aperture, having a diameter at the smaller extremity less than two-thirds of the diameter at the aperture. Air-chambers regular, with a depth of nearly four mm.; the internal cast of the walls is smooth, and does not depart from the general contour of the tube.

Septa slightly indented by the siphuncle. Sutures distinct, straight and horizontal.

Siphuncle small, excentric, nearer the ventral side. Its other characters not observed.

The test is thin, having a thickness of .3 mm. Surface marked by broad, lamellose, subimbricating lines of growth, which make a slight retral curve on the ventral side over the siphuncle.

One fragment embracing the chamber of habitation nearly entire, and a portion of five of the adjacent air-chambers, has a length of eighty-three mm., with diameters of twenty-six and sixteen mm. at the two extremities respectively. A smaller portion of an individual referred to this species has the test preserved over nearly the entire exterior of the tube.

From *O. rudicula*, this species may be distinguished by its excentric siphuncle; and from *O. jaculum* by its greater apical angle and more frequent septa.

Formation and localities. In the limestone of the Upper Helderberg group, Clarence Hollow, Erie county, N. Y., and Dublin, Ohio.

Orthoceras jaculum, n. sp.

PLATE XXXV, FIG. 12.

Orthoceras molestum, Hall (in part). Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 35, fig. 8. 1876.

Shell straight, regularly expanding. Transverse section circular. Apical angle 6°. Initial extremity unknown.

A small portion of the chamber of habitation preserved in the specimen, possesses no unusual characters. Air-chambers regular, having a depth of about five mm. adjacent to the chamber of habitation.

Septa moderately concave; concavity equal to an arc of about 85°. Sutures straight and horizontal. Traces of an areola are seen, surrounding the insertion of the siphuncle, with an expansion and vascular markings extending to the ventral margins of the septa. The ventral margins of the septa, and the posterior portion of the cast of the chamber walls, are elevated into transverse nodes, which become more conspicuous toward the apex of the tube. This elevation is evidently an extension of the areolar deposit around the siphuncle.

Siphuncle large, moniliform, subcentral, nearer to the ventral side of the tube, expanding in the cavity of the air-chambers to twice its diameter at the septa, which is nearly equal to the depth of the chambers, or more than one-third of the diameter of the tube.

Test thin, ornamented by transverse striæ of growth of varying strength. The surface-markings are well preserved over portions of the tube that have been replaced by calcite, the remainder of the tube being filled and replaced by the material of the surrounding rock.

The specimen has a length of sixty mm., embracing a portion of the chamber of habitation and eight of the air-chambers. The diameter at the two extremities is thirteen and eight mm. respectively.

This species is distinguished from *O. inoptatum* by the position of the siphuncle, the greater distance between the septa, and the surface-markings. It furnishes some further evidence of the connection between the expanded siphuncle, the areolar extension to the ventral margins, and the carina or other markings upon the ventral walls of the casts of the air-chambers.

Formation and locality. Upper Helderberg limestone, Clarence Hollow, Erie county, N. Y.

Orthoceras inoptatum, n. sp.

PLATES XXXVII, FIG. 1; CXII, FIGS. 9, 10.

Orthoceras molestum, Hall (in part). Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 35, figs. 6, 8, and plate 37, fig. 1. 1876.

Shell straight, regularly and gradually enlarging from the apex. Transverse section circular. Apical angle $5\frac{1}{2}°$. Initial extremity unknown.

Chamber of habitation regularly expanding to the aperture, without special characters. Air-chambers regular, having a depth of 4.5 mm. near the outer chamber.

Septa smooth, thin, having but a slight concavity. Sutures straight and horizontal.

Siphuncle quite excentric, showing evidence of a slight expansion between the septa.

The test is thin, having a thickness of .1 of one mm. Surface marked by regular, sharp, continuous, longitudinal striæ, about ten in the space of two

mm., crossed by fine, irregular, lamellose lines of growth. The internal mould retains the impression of the strong longitudinal, surface striæ.

A specimen, consisting of a portion of the chamber of habitation, and about seventeen of the preceding air-chambers, has a length of 100 mm., and is imperfect at both extremities.

This species is separated from *O. jaculum* on account of its shallower air-chambers, more excentric siphuncle, and longitudinal surface striæ.

Formation and locality. In limestone of the Upper Helderberg group, from Western New York.

Orthoceras rudicula.

PLATES XXXVII, FIG. 2; CXII, FIGS. 1, 2.

Orthoceras rudicula, Hall. Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 37, fig. 7. 1876.

Shell straight, rapidly enlarging. Transverse section subcircular. Apical angle about 11°. Initial extremity unknown.

Chamber of habitation not observed. Air-chambers increasing in depth from the apex to the outer chamber, and varying from three to seven mm.

Septa with a concavity equal to an arc of 115°. There is a large, elevated areola around the insertion of the siphuncle, which becomes more prominent toward the apex, and is surrounded and covered by a minute mammillary deposit of organic matter.

Siphuncle subcentral, expanding between the septa; the walls are very thin, and are obliterated or absorbed in the majority of the air-chambers. Its diameter at the septa is about two mm. where the tube has a diameter of twenty-four mm.

Test and surface ornamentation unknown.

The specimen embraces about twenty air-chambers, and has a length of 100 mm.

The air-chambers have been separated and displaced by compression, and the external walls in the cast have become concave. The appearances of

the internal mould in this species are very similar to *O. luxum*. In its mode of occurrence and condition of preservation, together with several specific characters, it is very similar to that species. It is distinguished by its greater apical angle and more regular organic deposit.

Formation and locality. In the Upper Helderberg limestone at Stafford, N. Y.

Orthoceras sirpus, n. sp.

PLATE CXII, FIGS. 3, 4.

Shell straight, slender, very gradually enlarging. Transverse section circular. Apical angle about 4°. Apex unknown.

Chamber of habitation cylindrical, with a gentle constriction near the aperture. Air-chambers regular, large, having a depth of about seven mm. where the tube has a diameter of nine mm. On the internal mould the walls are smooth and flat.

Septa and siphuncle not observed. Sutures straight and horizontal, but slightly impressed on the cast of the interior.

Surface marked by fine, rounded, slightly-curving, regular, transverse striæ of growth.

One specimen preserving the chamber of habitation, and several of the adjacent air-chambers, with traces of the surface ornamentation, has a length of forty-five mm., with a diameter of nine mm. at the outer chamber. Another individual in the same association, and retaining the test over the entire tube, has a length of seventy-eight mm.

This species somewhat resembles *O. jaculum*, but has a more attenuate tube and distant septa. It is distinguished from *O. stylus*, of the Schoharie grit, by the much greater depth of the air-chambers, and the gentle constriction of the outer chamber.

Formation and locality. From the Corniferous limestone at Columbus, Ohio.

Orthoceras viator, n. sp.

PLATE XXXVII, FIG. 5.

Orthoceras baculum, Hall (*in part*). Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 37, fig. 2. 1876.

Shell straight, very gradually enlarging to the aperture. Transverse section circular. Apical angle 2½°. Initial point unknown.

Chamber of habitation cylindrical, well developed, length five times the diameter at the last septum. The tube regularly and very gradually expands to a point near the middle, from which it gently contracts for a distance equal to one-fourth the entire length of the chamber; then expanding rapidly, and again constricting, it enlarges somewhat abruptly to the aperture. Air-chambers regular, so far as observed, having a depth of about four mm.

Septa and siphuncle not observed.

The test, as preserved on some portions of the tube, has had a thickness of 1.5 mm., and the exterior was marked by fine lamellose lines of growth.

The appearances of the internal mould with the double constriction of the outer chamber are very characteristic.

A specimen, consisting of the chamber of habitation nearly entire, and two of the air-chambers, has a length of 104 mm., with a diameter of twenty-four and twenty-two mm., respectively, at the two extremities.

This species is distinguished from *O. stylus*, of the Schoharie grit, by its larger size and the constricted chamber of habitation. It more nearly resembles *O. exile*, of the Hamilton group, but differs in its somewhat larger size, more cylindrical form of the tube, and much larger chamber of habitation. *O. Telamon* has comparatively deeper air-chambers, and has not shown evidences of a constricted chamber of habitation.

Formation and locality. From the Upper Helderberg limestone at Clarence Hollow, Erie county, N. Y.

Orthoceras profundum.

PLATE XXXVII, FIGS. 7-9.

Orthoceras profundum, Hall. Descriptions of New Species of Fossils, etc , p. 48. 1861.
" " " Fifteenth Rep, N. Y. State Cab. Nat. Hist., p. 76, pl. 7, fig. 8. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 37, figs. 3-6. 1876.

Shell straight, regularly and gradually enlarging from the apex to the aperture. Transverse section circular. Apical angle 4°. Initial extremity unknown.

Chamber of habitation well developed. Its full extent has not been observed. Air-chambers, septa and siphuncle unknown.

The test, as preserved on the chamber of habitation, has a thickness of nearly .5 mm. Surface marked longitudinally by sharp ridges, distant from each other two to four mm. where the tube has a diameter of about thirty-five mm., with very fine intermediate striæ, which are visible only under a strong lens. These longitudinal ridges and the interspaces are crossed by regular, sharp, transverse, crenulating striæ, of which there are seven in the space of five mm. There is a gentle sinus in the transverse ornamentation over the ventral side.

The internal mould retains the imprint of the strong longitudinal ridges, and the transverse striæ.

This species, in its surface-markings, resembles *O. Creon*, from the Schoharie grit; *O. Œdipus* and *O. Ægea*, from the Hamilton group; the four species constituting a natural group with the cones fluted. It differs from *O. Creon* in its more gradual enlargement and distant longitudinal ridges. And from *O. Œdipus* it is distinguished by the absence of smaller intermediate ridges and annulations, and by its much coarser concentric striæ. It has not the annulations and low undulations of the tube, as in *O. Ægea*.

Formation and localities. In the Upper Helderberg limestone at Williamsville, and Black Rock, Erie county, N. Y.

ORTHOCERATA OF THE HAMILTON GROUP.

In the eastern part of the State, where the strata above the Marcellus shales are composed of coarse and finer shales without calcareous matter, the Orthoceratites are very rarely seen. It is only where these shales, in their western extension, become in some degree calcareous, that we find these fossils in any considerable number; and as the group becomes attenuated in the same direction, and the formation consists almost entirely of soft, calcareous shaly beds, the Orthoceratites diminish in number, and become extremely rare, except in a few irregular or concretionary calcareous layers, where some specimens have been found as far west as the shore of Lake Erie.

The species in their geographical distribution are essentially limited to the zone mentioned, which has a considerable breadth in its gradation from the coarser materials on the east, to the finer calcareous shaly beds on the west. Owing to this condition, we have by far the larger proportion of specimens coming from localities in the central portion of the State.

In the same horizon or zone we have also the greatest development among the Gasteropoda, and few species only of both classes are found in the more westerly extension of the formation, and fewer still in the coarse beds of the extreme eastern portions of the group.

This partial limitation of the species to a certain zone is probably not alone due to the physical or mineral composition of the sediments, but in some degree to the depth of water required for their development; for while the deposits on the east are clearly littoral in their character, those of the west are off-shore or deeper sea deposits, and carry a much larger proportion of Brachiopoda than of any other class of fossils. At the same time, the periodical oscillations to which this original shore-line and sea-bed have been subjected, have served to give a wider horizontal distribution than would have occurred in a permanently quiet sea-bottom.

It is an interesting fact, however, that while the distribution of the Orthoceratites and some other forms is so clearly affected by the causes mentioned, the Nautilus is known from almost the most easterly outcrops of the formation,

to the extreme western limits of the State, being most abundant in the central area. The smaller Goniatites, which are nowhere numerous in beds above the Marcellus shale, have an extreme westerly extension, and are more abundant in Canada West than in New York.

The Marcellus shale, however, which is regarded as the lower member of the Hamilton group, must be considered in a somewhat different aspect. The Goniatite limestone of this shale, which is known in the most easterly exposures of this formation, continues to the Genesee valley, and is known as an interrupted calcareous band, as far as Lake Erie This limestone bears numerous forms of Cephalopoda, more especially the Orthoceratites, Goniatites, and some Nautiloid forms throughout its range, from Schoharie county to Cayuga lake; while the thinning extension of the stratum and its associated shales carry one form of Orthoceras (*O. subulatum*) as far as the Genesee valley.

The rocks of this group, as a whole, although very fertile in the number of individuals, are comparatively poor in the variety of forms. Among the twenty-six species described, only six may be said to occur at all abundantly. In the softer shales of the group, the surface-markings are often preserved, but the specimens are usually much distorted from compression.

In the Marcellus shales, *O. Marcellense* in the harder and coarser beds, and *O. subulatum* in the softer shales, the latter continuing into the central members of the group, are the characteristic and common species. The softer shales of the middle and upper portions of the group have furnished a greater variety and abundance of individuals. The beds of the upper portion contain few forms, and these without any special character; *O. Bebryx* continuing into the lower Chemung.

SECTION *a.*—*Robust forms.*

ORTHOCERAS ERIENSE.

PLATES XL, FIGS. 1-4; LXXXVII, FIGS. 1, 2.

Orthoceras robustum, HALL. Illustrations of Devonian Fossils': Cephalopoda. Explanation of pl. 40. 1876.
Not *Orthoceras robustum*. WINCHELL. Am. Jour. Sci.-Arts, 2d series, vol. 33. 1862.
Not " " BARRANDE. Syst. Silur. du centre de la Bohème. 1866.
" *Eriense*, HALL. Catalogue Am. Pal. Fossils, S. A. MILLER, p. 174. 1877.

SHELL very large, straight, robust, regularly enlarging to the aperture. Transverse section circular. Apical angle 8°. Initial extremity unknown.

Chamber of habitation well developed, having a length equal to twice its transverse diameter through the centre, with a diameter at the last septum of three-fourths the diameter at the aperture. The tube regularly expands to the aperture, which is slightly contracted. Aperture entire, with a gentle retral curve on the ventral margin; margins acute. Air-chambers regular, numerous, having a depth of from ten to fifteen mm., gradually becoming more numerous toward the apex. The internal cast of the walls is smooth and flat, with a minutely longitudinal, striate band around the anterior margin of each air-chamber, with more irregular, slightly undulating, concentric striæ over the central portion

Septa thin, smooth, having a concavity equal to an arc of 116°, or a depth greater than that of the chambers. Sutures straight and horizontal.

Siphuncle large, straight, cylindrical, with a diameter of eight mm. where the tube has a diameter of seventy-five mm.

The test has a thickness of nearly one mm. on the chamber of habitation. Surface cancellated; marked by regular striæ of growth, interrupted by fine longitudinal striæ.

The internal mould is essentially smooth, with the septal sutures but slightly indented. The very fine, longitudinal and transverse striæ over a portion of the chamber walls are characteristic but not prominent.

A specimen preserving an apparently entire chamber of habitation, and two of the adjacent air-chambers, has a length of twenty-one centimetres,

and a diameter at the aperture of ninety-five mm. A septate fragment containing thirteen air-chambers has a length of 155 mm.

This species differs from *O. Bebryx* in its larger size, more distant septa, and cylindrical siphuncle. It more nearly resembles *O. Pelops* and *O. Zeus* of the Schoharie grit, but it has not the constriction of the chamber of habitation of the latter, and the prominent areola around the siphuncle of the former species.

Formation and localities. In the Hamilton group on Lake Erie shore, and at Otisco, Onondaga county, N. Y.

Orthoceras Bebryx.

PLATES XXXVIII, FIG. 10; XXXIX, FIG. 2; LXXXIII, FIG. 14; LXXXIV, FIGS. 11, 12.

Orthoceras Bebryx, Hall. Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 39, figs. 1, 2. 1876.

Shell robust, straight, regularly enlarging from the apex. Transverse section, allowing for the degree of compression, subcircular. Apical angle eight to ten degrees; the variation being due to the compressed condition of the specimens.

Chamber of habitation not fully observed. Air-chambers regular, increasing in depth from the apex, and varying in different individuals from six to ten mm.

Septa smooth and thin, so far as observed. Sutures, in specimens not distorted by compression, straight and horizontal.

Siphuncle moniliform, expanding between the septa, and having a diameter equal to, or two-thirds, the depth of the air-chambers. The septa are usually macerated, or broken from compression, and the position of the siphuncle has not been satisfactorily determined. One small fragment, referred to this species with doubt, retains the septa, and shows the siphon in a slightly excentric position.

The test has not been preserved. The casts of the interior indicate a transversly lamellose-striate surface.

A fragment, embracing a portion of the chamber of habitation and seventeen of the adjacent air-chambers, has a length of 220 mm.

This species is distinguished by its size, the moniliform siphuncle, and the distance between the septa.

In its vertical distribution it is found in the upper beds of the Hamilton, and cannot be specifically distinguished from a form in the lower strata of the Chemung, noticed below as a variety.

Formation and localities. From the Hamilton group, in various localities in Central New York.

Orthoceras Bebryx, var. Cayuga, n. var.

PLATES XXXIX, FIG. 1; LXXXVI, FIGS. 3-5; XCI, FIGS. 1-5; XCII, FIGS. 1-5.

Orthoceras Bebryx, Hall. Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 39. 1876.

Numerous individuals have been observed among collections from the base of the Chemung group which appear to be specifically identical with this species as occurring in the Hamilton. The only difference noticed is the comparatively deeper air-chambers, which are about as three to four in the two forms, when measurements are made at points on the tube having the same diameter in the different specimens. From the specimens included in this variety several additional features have been observed, not clearly shown in the individuals from the Hamilton group. The transverse section is circular. Chamber of habitation cylindrical, well developed, its full extent not being observed. Septa smooth and thin. Siphuncle excentric, distant from the dorsal and ventral margins in the ratio of 3 to 7, or twelve and twenty-eight mm., where the tube has a diameter of forty mm.

A small individual, referred to this variety, embracing the greater portion of the chamber of habitation and nine of the adjacent air-chambers, has a length of 124 mm., and shows a broad, gentle constriction anterior to the middle of the grand chamber. A larger specimen, consisting of a portion of the chamber of habitation and nineteen air-chambers, has a length of 240 mm., of which 75 mm. pertains to the chamber of habitation, which has a diameter of fifty-five mm. Large fragments of the grand chamber have been observed, having a diameter of seventy-five mm.

The specimens embraced in this variety and in the species as above constituted are all very imperfect. Those from the quarries at Ithaca, N. Y., show considerable variation, although occurring in the same association. This variation is principally owing to the conditions of preservation. The specimens are nearly all very much compressed, and the important specific characters obscured. The individuals from the Hamilton group exhibit very similar conditions, rendering a separation and specific distinction of the two forms impossible without more perfect material.

Formation and locality. In the lower members of the Chemung group, in the quarries about Ithaca, and at Cortland, Cortland county, N. Y.

Orthoceras linteum, n. sp.

PLATE LXXXVII, FIGS. 3, 4.

A portion of the chamber of habitation, and the last air-chamber of an individual, is recognized as a distinct species, on account of the decided character of the surface ornamentation. The tube is much compressed and without any evidences as to the transverse section, the concavity of the septa, or the elements and position of the siphuncle.

The chamber of habitation, so far as observed, shows no evidences of a constriction, or a departure from the general contour of the tube. The last air-chamber has a depth of seven mm.

The test has been dissolved. The surface-markings, as shown on the internal mould, are very fine, sharp, regular, longitudinal striæ, of which there are fourteen in the space of three mm., crossed by equally regular, sharp, transverse striæ.

This species, in external form, somewhat resembles *O. Bebryx;* but the surface characters are very distinctive.

Formation and locality. In the Hamilton group, Leonardsville, Madison county, N. Y.

SECTION *b.*—*Slender forms.*

ORTHOCERAS MARCELLENSE.

PLATES XXXVIII, FIGS. 4, 5, 6, 7, 9; LXXXIII, FIGS. 1-10, 12; CXIII, FIG. 18.

Marcellus orthocera, VANUXEM. Geolog. Surv. of N. Y.: Report of the Third District, p. 147. 1842.
Orthoceras typus, SAEMANN. Dunker and von Myer. Palæontographica, Dritter Band, 3. Lieferung, p. 165, pl. 20. 1853.
" *Marcellensis* (VANUXEM), HALL. Thirteenth Rep N. Y. State Cab. Nat. Hist., p. 106. 1860.
" *typum* (SAEMANN), HALL, *in part*. Illustrations of Devonian Fossils: Cephalopoda. Explanation of pl. 38. 1876.
" *Marcellense*, VANUXEM. Catalogue Am. Pal. Fossils, S. A. MILLER, p. 175. 1877.

SHELL straight, extremely elongate, very regularly and gradually expanding from the apex to the aperture. Transverse section circular Apical angle varying from six to eight degrees in specimens apparently undisturbed by compression. Initial extremity very acute; the remaining characters are obscure.

Chamber of habitation well developed, having a length of about four times the diameter at the last septum, regularly expanding to a point near the aperture where there is a very gentle constriction. Air-chambers numerous, about sixty in the length of the tube; regularly increasing in depth from the apex to the outer chamber, having a depth of about ten mm. near the grand chamber.

Septa thin, with a variable concavity, usually equal to an arc of about 115°. Sutures straight, or sometimes slightly oblique. On the convex side of the septa, near the chamber of habitation, there is a simple areola surrounding the insertion of the siphuncle. Towards the apex this areolar marking is much thickened and elevated, with a prominent process, extending to the ventrum (pl. 83, figs. 4, 5); the whole having a furrowed and pitted margin, and surrounded by radiating, vascular markings over the septa (pl. 83, figs. 6, 7).

The process, extending to the ventral margin, is continued, as shown in the cast of the interior of the tube, along the ventral walls of the air-chambers, and sometimes along a portion of the grand chamber, as a carina. Sometimes this central line has a similar, smaller carina on each side,

extending parallel with it. It is obscured, towards the central portions of the tube, by an organic deposit on each side of the median line, having a symmetrical form, and presenting the appearance of a sculpturing, or scarring of the ventral walls, and consisting of a palmate arrangement of ridges and nodes of the organic deposit. This ornamentation on the internal mould is finally obliterated near the apex by the predominance of the organic deposit in the air-chambers. The organic deposit is formed over the walls of the air-chambers, and over the surface of the septa, consisting of a vesicular aggregation of calcareous matter, similar in some respects to *O. luxum* of the Schoharie grit; and, as in that species, it increases in amount and complexity toward the apex.

Siphuncle excentric, near the ventral side, straight, cylindrical, slightly constricted in its passage through the septa. The distance from the dorsal and ventral sides are as ten to eighteen, and its diameter is four mm. where the tube has a diameter of thirty mm.

Test strong, having a thickness of from one to one and a half mm. Surface marked by fine, regular, slightly-curving striæ of growth, eleven to seventeen in the space of four mm., crossed by indistinct, irregular, longitudinal striæ. Towards the apex the longitudinal striæ are sharper and stronger, becoming more prominent and regular than the concentric lines, which are here more crowded than in the anterior portions of the tube. A broad, gentle sinus in the direction of the striæ, over the siphuncle, indicates the position of the ventral side.

The internal mould is obscurely, longitudinally striate, and the chamber walls essentially smooth and flat, with the exception of the characteristic ornamentation of the ventral walls. Septal sutures but slightly indented.

One of the largest individuals has a length of forty centimetres, with a diameter at the aperture of nearly fifty mm., embracing the chamber of habitation and about sixty air-chambers.

This species is quite variable, both in proportions and in general appearance, as may be seen by consulting the illustrations of the species. The variation in the character of the surface-markings is quite conspicuous on different

individuals, and over different portions of the tube. There are also slight variations in the depth of the chambers. It is distinguished from *O. aptum*, with which it is associated, by its more distant septa, its greater apical angle, and straight, septal sutures. And from *O. fustis* by the greater development of the chamber of habitation, the absence of any decided constriction or abrupt contraction at the aperture, the depth of the chambers, the excentric and smaller siphuncle, and the surface ornamentation. In many respects it resembles *O. luxum;* but the position of the siphuncle, its elements, and the dimensions of the tube, are very different. From the other species in the present group, it is distinguished by its proportions, surface characters and the organic deposit.

In this species, as in all the species described in this volume, which have developed an organic deposit, the appearances of this deposit depend upon the mode of weathering, the conditions of preservation, the material filling the cavities, and the manner in which the chambers separate at the septa. The elevated areola and its processes may separate from the convex surface of the septa, and remain imbedded in the filling of the air-chambers, leaving the septa apparently smooth. Or it may remain attached to the convex surface, giving to the septa a totally different aspect. From the condition of preservation in many of the specimens, the raised areola, which has been considered as a deposit, may be explained by supposing the deposition to have been made on the concave surface of the septa, from the margins toward the siphuncle; and which has remained attached to the filling of the air-chambers, leaving an elevated expansion around the insertion of the siphuncle on the convex side of the septa. In support of this view, the areola is always larger and has less of an elevation near the chamber of habitation, gradually diminishing in diameter, and becoming more prominent toward the apex, where the amount of organic deposition is at the maximum. Whatever may have been the original purpose of the deposit, the shells in which it is more fully developed always present the appearance of deterioration or disease.

The markings on the ventral walls of the air-chambers, as described, are evidently the cast or the reverse of the original conditions. These suggestions

can only be verified by a critical examination of numerous individuals in all conditions of preservation, and from sections made with a view of ascertaining the extent and position of the organic deposit.

This species, so far as known, is confined within the limits of the Goniatite limestone in the Marcellus shales, and is the "Marcellus orthocera" of VANUXEM (*Report of the Third District*, p. 149: 1842), and mentioned on p. 147 of his report as "a large Orthocera, the *Marcellus*." Dr. SAEMANN cites Cazenovia, Madison county, N. Y, as the original locality for his species. This is an evident error in the locality reference; but there is no doubt as to the present identification, as he describes this species, the formation, and its association with GONIATITES, GOMPHOCERAS, etc.

Formation and localities.- In the Goniatite limestone of the Marcellus shale, at Manlius, Marcellus, and other localities in the central portion of the State.

ORTHOCERAS FUSTIS, n. sp.

PLATES LXXXIII, FIG. 11; CXIII, FIGS. 16, 17.

SHELL straight, very regularly and gradually enlarging to near the aperture. Transverse section circular. Apical angle 4½°. Initial point unknown.

Chamber of habitation short, having a length of about twice the diameter at the last septum, with several obscure undulations throughout the length, except the one near the aperture, which is a very distinct and abrupt constriction following the sinuosities of the margin. Aperture abruptly contracted, with two or three broad sinuosities in the margin. Air-chambers regular, numerous, having a depth of five mm. near the grand chamber, where the diameter of the tube is thirty-five mm.

Septa thin, smooth near the outer chamber, having a concavity equal to an arc of nearly 90°. Sutures straight and horizontal.

Siphuncle central, straight, nearly cylindrical, abruptly constricted in its passage through the septa, where it has a diameter equal to about two-thirds as great as in the air-chambers. Its diameter is 3.5 mm. where the tube has a diameter of about thirty-five mm.

Test strong, having a thickness of from one to two mm. on the chamber of habitation. Surface marked by very fine, minutely undulating irregular, lamellose lines of growth, crossed by indistinct, longitudinal striæ. The ventral side is indicated by a broad sinus in the aperture and surface-markings, and a carina on the cast of the interior.

The internal mould of the chamber of habitation is made characteristic by the constrictions of the tube, and the abrupt contraction of the aperture. These features of the interior are less conspicuous on the exterior of the shell.

An individual, consisting of the chamber of habitation entire, and about thirteen attached air-chambers, has a length of 115 mm., with a diameter near the aperture of over forty mm.

This species is distinguished from *O. Marcellense* by its more gradually enlarging tube, its much shorter and more characteristic chamber of habitation, the position and size of the siphuncle, the depth of the chambers, and the ornamentation of the test. It was formerly not distinguished from *O. Marcellense;* but an examination of all the characters has shown the very unlike features possessed by this species. The want of sufficient material precludes any comparisons based on the organic deposit, which is probably present in this species, as indicated by the ventral carina on the internal mould of the air-chambers.

Formation and locality. In the Goniatite limestone of the Marcellus shale at Schoharie, N. Y.

Orthoceras aptum, n. sp.

PLATE XXXVIII, FIG. 8.

Orthoceras typum (Saemann), Hall (in part). Illustrations of Devonian Fossils: Cephalopoda Explanation of pl. 38, fig. 8. 1876.

Shell straight, regularly and gradually enlarging from the apex to the aperture. Transverse section circular. Apical angle 5°. Initial extremity unknown.

Chamber of habitation having a length of about three times the diameter at the last septum, expanding slightly beyond the general enlargement of the tube, with a very gentle constriction near the middle, which is shown on the cast of the interior. Chambers numerous, regularly increasing in depth

toward the outer chamber, varying from three to five mm. in the length of ninety mm.

Septa and siphuncle not observed. Sutures curving and oblique, but slightly impressed on the internal mould. Ventral side indicated by a longitudinal carina along the cast of the chamber walls.

The test has a thickness of nearly one mm. Its surface-markings are unknown.

The specimen figured has a length of 190 mm., and embraces more than thirty of the air-chambers, with a portion of the chamber of habitation, which has a diameter of thirty mm. near the aperture.

This species is associated with *O. Marcellense* in the Goniatite limestone of the Marcellus shale, and is distinguished by its more frequent septa, the curved and oblique sutures, and more gradually enlarging tube.

Formation and locality. From the Goniatite limestone of the Marcellus shale at Manlius, N. Y.

ORTHOCERAS SUBULATUM.

PLATES XXXVIII, FIG. 3; LXXXIV, FIGS. 1, 2, 4, 6–10; LXXXVI, FIGS. 1, 2.

Slender Orthocera.	VANUXEM.		Geolog. Survey of N. Y.: Rep. Third Dist., p. 148. 1842.
Orthoceras subulatum,	HALL.		Geolog. Surv. of N. Y.: Rep. Fourth Dist., p. 180, fig. 1. 1843.
"	"	"	Descriptions of New Species of Fossils, etc., p. 49. 1861.
"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 77. 1862
"	"	"	Illustrations of Devonian Fossils: Cephalopoda. Explanation of pl. 38. 1876.

SHELL straight, regularly enlarging from the apex to near the aperture. Transverse section circular. Apical angle varying, in normal and compressed specimens, from six to nearly eight degrees. Initial extremity observed, but the characters are obscure.

Chamber of habitation well developed, having a length equal to about three times its diameter at the last septum, regularly expanding to a point near the aperture where it is slightly contracted. Air-chambers numerous, increasing in depth from the apex to the outer chamber, where the depth is about three mm.

Septa smooth, thin, having a concavity equal to an arc of about 125°. Sutures straight and horizontal, but little impressed on the internal mould.

Siphuncle small, subcentral, only observed at the septa, where its diameter is one mm., the tube having a diameter of fifteen mm. at the same point.

Test thin, usually showing a thickness of .2 mm.; sometimes it is considerably stronger over the anterior portion of the chamber of habitation. Surface marked by very fine, irregular, lamellose striæ of growth. Some of the specimens show longitudinal striæ, and more rarely very fine, filiform, longitudinal markings.

The internal mould is essentially smooth, and the specimens from the softer shales often present a black and polished appearance.

The individuals of this species never reach a large size. The nearly entire examples have a length of from 85 to 130 mm.

This species is distinguished from *O. exile* and *O. emaceratum* by the position of the siphuncle, and much shallower air-chambers. It more nearly resembles *O. constrictum;* but the absence of the broad constriction removes it from that species. *O. tenere*, from the same horizon at the Falls of the Ohio, closely resembles this species, but has a larger apical angle, and more regular, rounded, transverse striæ.

This is evidently the species referred to by Mr. VANUXEM as the "slender orthocera." It is very common in the softer shales of both the lower divisions of the group, and is chiefly confined to the central portions of the State.

Formation and localities. In the Marcellus shales at Bloomfield, and in the Hamilton shales at Delphi, Pratt's Falls, and numerous other localities in the central portions of the State.

Orthoceras tenere, n. sp.

PLATE CXIII, FIG. 15.

Shell small, straight, rapidly enlarging. Transverse section subcircular. Apical angle about 10°. Initial point unknown.

Chamber of habitation not defined. Air-chambers regular, having a depth of one mm. In the cast the walls are smooth and flat.

Septa having a concavity nearly equal in depth to the depth of the air-chambers. Sutures straight and horizontal, but little impressed on the cast of the interior. Siphuncle not observed. Surface marked by fine, slightly curving, rounded, concentric striæ of growth.

The specimen on which the characters of this species are based has a length of fifty mm., and a diameter of thirteen mm. at the larger extremity.

This species is distinguished from *O. subulatum* by its greater apical angle and rounded, transverse striæ; and from *O. textum*, with which it is associated, by the surface ornamentation.

As in the succeeding species, this form occurs in a completely silicified condition, the internal characters being obliterated by the deposit of calcedony on the interior of the tube, while the external form and markings are in a very perfect state of preservation.

Formation and locality. In the cherty beds, above the Corniferous limestone, at the Falls of the Ohio, near Louisville, Ky., which are referred to the age of the Hamilton group.

Orthoceras textum, n. sp.

PLATE CXIII, FIG. 14.

Shell small, straight, rapidly enlarging. Transverse section subcircular. Apical angle about 11°. Initial extremity unknown.

Chamber of habitation and the air-chambers not defined in the specimen.

Septa not determined. The siphuncle lies close to the interior surface of the test, and the septa are not visible. This position may be owing to the

septa having been destroyed, and the siphuncle falling down against the interior surface. Its diameter is 1.5 mm. where the tube has a diameter of ten mm.

Test thin. Surface marked by fine, sharp, longitudinal striæ, crossed by concentric striæ, forming a regular reticulation of the surface ornamentation.

The specimen has a length of eighty-five mm., and a diameter at the larger extremity of twenty-four mm.

This species differs from *O. tenere*, with which it is associated, in the decided reticulation of the surface striæ, which, in that species, are curving lines of growth, without longitudinal markings.

This form, of which but a single specimen has been observed, occurs in a completely silicified condition in the compact cherty limestone at the Falls of the Ohio. The surface-markings are very perfectly preserved, and are characteristic of the species.

Formation and locality. In the upper limestone layers belonging to the Hamilton group, at the Falls of the Ohio, near Louisville, Ky.

Orthoceras tersum, n. sp.

PLATE LXXXIV, FIG. 5.

Shell slender, straight, regularly and gradually enlarging from the apex. Transverse section subcircular. Apical angle about 7°. Initial extremity unknown.

Chamber of habitation not observed. Air-chambers regular, very gradually increasing in depth toward the outer chamber, varying from two to three mm. in the length of thirty-five mm. The ventral side is indicated on the internal mould by a low, longitudinal, continuous carina.

Septa smooth, so far as observed, with the exception of an areola around the insertion of the siphuncle. Sutures straight and horizontal.

Siphuncle small, subcentral, nearer to the dorsal side, having a diameter of less than one mm. at the septa, where the diameter of the tube is about ten mm. Its elements in the interseptal spaces have not been observed.

Test thin, and in the specimen described, remaining imbedded in the surrounding rock. Surface ornamentation unknown.

The internal mould presents a very smooth appearance, and is marked by the ventral carina with traces of fine longitudinal striæ.

The specimen has a length of nearly sixty mm., and comprises about thirty air-chambers.

This species somewhat resembles the apical portion of *O. Marcellense*, with the ventral carina on the internal mould; but the position and size of the siphuncle are distinctive, and its geological position is very different.

Formation and locality. In the coarse shales of the Hamilton, belonging to the upper members of the group, in the central portion of the State.

Orthoceras spissum, n. sp.

PLATE LXXXV, FIGS. 6-9.

Shell straight, regularly enlarging. Transverse section very broadly elliptical. Apical angle about 6½°. Initial extremity unknown.

Only a small fragment of the chamber of habitation has been observed, which possesses no distinctive features. Air-chambers very numerous, and gradually increasing in frequency toward the apex, having a depth of from two to three mm., in the length of thirty mm., where the tube has a diameter of about fifteen mm. Ventral side indicated in the cast by an obscure, flat carina, visible only under a lens.

Septa smooth, thin, slightly flattened in the centre, with a concavity equal to an arc of about 67°. Sutures straight and horizontal.

Siphuncle small, nearer to the dorsal side, having a diameter of one mm. at the septa, where the tube has a diameter of fifteen mm. Its elements have not been observed in the interseptal spaces.

The test has a thickness of five mm., but the surface characters are not preserved in the specimens.

The internal mould is marked, in a well-preserved fragment, by indistinct,

transverse striæ, crossed by finer longitudinal lines. The walls of the air-chambers are flat, and the septal sutures but slightly impressed.

A fragment, embracing fifteen mm. of the length of the chamber of habitation, and fourteen of the attached air-chambers, has a length of fifty-three mm. A septate portion of a larger individual has eleven air-chambers in the length of thirty-five mm.

This form is distinguished by its transverse section, the peculiarities of the septa, and the size and position of the siphuncle. The specimens present an unusually compact and smooth appearance, owing to the numerous and regular septa.

Formation and locality. From the coarse, calcareous beds of the Hamilton group at Pratt's Falls, Onondaga county, N. Y.

Orthoceras constrictum.

PLATES LXXXIV, FIGS. 13, 14, 16; LXXXV, FIGS. 5, 10, 11, 13.

Orthoceras constrictum, Vanuxem. Geolog. Surv. of N. Y.: Rep. Third Dist., p. 152, fig. 1. 1842.
" " (Vanuxem). Hall. Descriptions of New Species of Fossils, etc., p. 49. 1861.
" " " " Fifteenth Rep. State Cab. Nat. Hist., p. 77. 1862.
Not " " Conrad. Geolog. Survey of N. Y.: Pal. Dept., Annual Rep., p. 117. 1838.

Shell straight, regularly enlarging from the apex to the chamber of habitation. Transverse section circular. Apical angle about 6°. Initial point unknown.

Chamber of habitation cylindrical, well developed, having a length equal to four times the diameter at the last septum. Anterior to the middle there is a very broad, gentle constriction, which, in its position and strength, varies considerably, sometimes becoming a very conspicuous feature. Air-chambers numerous, regular, with a depth of from two to three mm.

Septa smooth, thin; the concavity equal to an arc of nearly 90°. Sutures straight and horizontal. Siphuncle central. Its elements in the interseptal spaces have not been observed.

Test not preserved. Some of the casts exhibit traces of lamellose striæ of growth.

The internal mould of the chambers is smooth, with the sutures but little impressed.

One fragment, comprising a portion of the outer chamber and twenty-one of the attached air-chambers, has a length of eighty-five mm. A septate fragment, retaining nearly its normal form, measures fifty-three mm., with diameters of seventeen and eleven mm. respectively, at the two extremities. The chamber of habitation has a length of seventy mm. in one individual, with a diameter of about fifteen mm., and is apparently not entire.

This species is distinguished from *O. subulatum* by its constricted and much more developed chamber of habitation. In the depth of the air-chambers and the position of the siphuncle the two species are very similar. It is farther removed from *O. exile* by the depth of the air-chambers and its central siphuncle. The constriction is also generally broader and nearer the middle of the chamber of habitation, sometimes becoming nearly as prominent a feature as represented in VANUXEM's original figure of the species. *O. emaceratum* may be readily distinguished by the much greater depth of the air-chambers.

Mr. CONRAD* gave this name to an annulated form, which has not since been recognized. The absence of an illustration and the want of sufficient definition in his description renders it undesirable to change the present recognized species of VANUXEM.

Formation and localities. In the Hamilton group, in the counties of Ontario and Madison, N. Y.; and at Cumberland, Md.

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* Mr. Conrad's description is as follows:

Orthoceras constrictum.—Shell smooth, tapering gradually, with a few remote transverse furrows. *Locality*, town of Madison, Madison county. (Geolog. Surv. N. Y.: Pal. Dep., Annual Report, p. 117. 1838.)

Orthoceras exile.

PLATES XXXIX, FIG. 3; LXXXIV, FIG. 3; LXXXV, FIGS. 1, 2, 14, 15.

Orthoceras exile, Hall. Descriptions of New Species of Fossils, etc., p. 50. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 78, pl. 8, fig. 5. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda. Explanation of pl. 39, fig. 3. 1876.

Shell straight, slender, regularly and gradually enlarging from the apex. Transverse section circular. Apical angle 5°. Initial extremity unknown.

Chamber of habitation cylindrical, large; length equal to more than three times the diameter at the last septum. Some of the specimens show a broad, undefined constriction toward the aperture; but this feature is not always conspicuous. Air-chambers numerous, increasing in depth toward the outer chamber, varying from two or three mm. to five mm. in the length of 100 mm., or about thirty chambers.

Septa smooth, thin, with a concavity equal to an arc of 104°, or equal to the depth of the chambers. Sutures straight and horizontal.

Siphuncle excentric, distant from the nearest point on the walls of the air-chambers about one-third the diameter of the tube. Its elements in the interseptal spaces have not been observed. The diameter at the septa is two mm., where the tube has a diameter of seventeen mm.

Test and surface-markings not observed.

Internal mould smooth, showing no traces of the surface-markings, or of an organic deposit.

An individual, retaining the chamber of habitation and about forty air-chambers, has a length of 165 mm., with a diameter of fifteen mm. near the aperture. Other fragments have been observed belonging to larger individuals, having a diameter of twenty-three mm.

This species differs from *O. constrictum* and *O. subulatum* in its excentric siphuncle and more distant septa. The septa are comparatively more frequent than in *O. Telamon* and *O. emaceratum*, and the siphuncle is smaller and less excentric than in the former. It somewhat resembles *O. stylus* of the Scho-

haric grit; but the air-chambers have a greater depth, the chamber of habitation is not so much developed, and the apical angle is larger.

Formation and localities. Hamilton group, on the south shore of Lake Erie; at Cayuga lake; and at Cazenovia, Madison county, N.Y. It has also been identified in the rocks of this formation at Cumberland, Maryland.

Orthoceras Telamon, n. sp.

PLATE LXXXV, FIGS. 3, 4, 12.

Shell straight, regularly and gradually enlarging from the apex. Transverse section circular. Apical angle about 4°. Initial extremity unknown.

Chamber of habitation cylindrical, well developed, having a length about three times the diameter of the tube at the last septum, and without any marked constriction or expansion toward the aperture. Air-chambers regular, more frequent toward the grand chamber, having a depth of five mm. where the diameter of the tube is nine mm., and of eight mm. where the diameter is twenty mm. The ventral side is indicated in the cast, by a low longitudinal carina along the walls of the air-chambers.

Septa apparently smooth and thin, with the margins sometimes slightly thickened; having a concavity equal to an arc of about 110°. Sutures straight, and somewhat oblique in a dorso-ventral direction.

Siphuncle large, excentric, less than one-third the diameter of the tube from the ventral walls; having a diameter of two mm. where the tube measures twenty mm. in diameter, and diminishing but slightly toward the apex. Its elements have not been observed in its passage through the air-chambers.

Test and surface-markings not preserved on any of the specimens examined.

Internal mould smooth, with the exception of the ventral carina.

This species is distinguished from *O. exile* by the ventral carina on the cast of the interior, the comparatively deeper air-chambers, and the more excentric position of the siphuncle. It closely approaches *O. emaceratum* in several fea-

tures, but the septa are a little more frequent, and none of the specimens referred to that species have shown any indication of the ventral carina on the cast of the interior.

Formation and locality. In the shales of the Hamilton group at Monteith's Point, Canandaigua lake, N. Y.

Orthoceras emaceratum.

PLATES XXXIX, FIG. 4; LXXXV, FIG. 16.

Orthoceras emaceratum, Hall. Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 170, pl. 8, fig. 7. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 39, fig. 4. 1876.

Shell straight, slender, gradually enlarging from the apex. Transverse section subcircular. Apical angle $4\frac{1}{2}°$. Initial point unknown.

Chamber of habitation not observed. Air-chambers regular, gradually increasing in depth toward the grand chamber, varying from six to nine mm. in the length of eighty mm.

Septa and siphuncle unknown. Sutures straight and horizontal.

The test has not been preserved, but some specimens show traces of transverse striæ.

The internal mould is smooth, with the sutures but little impressed.

One fragment, embracing twenty air-chambers, has a length of 125 mm., with a diameter at the smaller extremity of ten mm. Another portion of a larger individual has twelve chambers in the length of ninety mm.

All the specimens of this species are from the soft shales in the western part of the State. They are usually much flattened and broken from compression, and the test has been destroyed. The distinguishing characters are the depth of the chambers, compared with the diameter of the tube, and the small apical angle. In its general aspect and association it is similar to *O. aulax;* but the marked surface ornaments on the latter species, which are also shown on the internal mould, are characteristic.

Formation and locality. In the soft shales of the Hamilton group, in Genesee and Erie counties, N. Y.

Orthoceras aulax, n. sp.

PLATE LXXXIV, FIG. 18.

This species is indicated from a fragment of the chamber of habitation and several of the attached air-chambers, which retains characteristic and distinctive surface-markings. The tube is slender, and the enlargement very gradual. Air-chambers, septa and siphuncle unknown. Surface marked by regular, numerous, low, rounded transverse ridges, about twelve in the space of ten mm. The interspaces, or furrows, are regularly concave, and have a width equal to the ridges. Portions of the surface also show that it was traversed by fine, sharp, longitudinal striæ, crossing the ridges. Length of the fragment, eighty mm.

The specimen is from the soft shales, and is much compressed. It occurs with *O. emaceratum*, from which it is distinguished by its surface ornamentation.

Formation and locality. From the shales of the Hamilton group at Hamburg, Erie county, N. Y.

Orthoceras scintilla, n. sp.

PLATES LXXXIV, FIGS. 19-21; CXIII, FIGS. 6-12.

Shell minute, slender, regularly and gradually enlarging from the apex. Transverse section circular. Apical angle about 3°. Initial extremity unknown.

Chamber of habitation not observed. Air-chambers increasing in depth from the apex toward the outer chamber; having, at that point, a depth equal to the diameter of the tube, or from one to two mm.

Septa thin, moderately concave, smooth, with the exception of a large circular areola around the insertion of the siphuncle. Sutures straight and horizontal. The areola is always well defined, constituting the base of the cone around the siphuncle in the anterior portion of each air-chamber.

Siphuncle large, central, cylindrical, indenting the septa, having a diameter of about one-third the diameter of the tube. Toward the outer chamber

the siphuncle is gradually modified by a conical expansion of its tube, or by a circumposed organic deposit. The base of the cone is sometimes excentric with regard to the siphuncle, making a predominance of the expansion or deposit on one side, as shown in figs. 8–11, pl. 113.

Test and surface-markings unknown.

Internal mould smooth, showing some traces of a transversely striate surface. Suture line but slightly impressed on well-preserved specimens.

One specimen has a length of twenty-seven mm., with diameters of 1.5 and .75 mm. at the two extremities respectively, and embraces twenty air-chambers. Several fragments have been observed, belonging to larger individuals, but the dimensions given represent the usual size.

This minute and delicate species is remarkable for its small size, the great depth of the air-chambers, the characters of the siphuncle, and the appearances around the siphuncle at the anterior portion of each air-chamber. Specimens are not uncommon in the soft shales along the east shore of Cayuga lake.

Formation and locality. In the soft, black shales of the Hamilton group, at Norton's Landing, Cayuga lake, N. Y.

SECTION *d.*— *Forms having the cone fluted.*

ORTHOCERAS ŒDIPUS, n. sp.

PLATES XXXVII, FIG. 6; LXXXII, FIG. 17.

This species is indicated from several fragments possessing characters distinctive from *O. profundum* and *O. Ægea.* The shell is large, straight, regularly and rather rapidly enlarging. Transverse section circular.

Chamber of habitation well developed. Air-chambers increasing in depth with the diameter of the tube. Where the tube measures twenty-five mm. in diameter the depth of the air-chambers is about six mm.

Septa smooth, thin, having a concavity equal to an arc of 97°. Sutures straight and horizontal.

Siphuncle excentric, distant from the margins of the septa eleven and fourteen mm., as measured along the dorso-ventral diameter. Its diameter is

two mm. where the tube has a diameter of twenty-five mm. In the cavities of the air-chambers its elements have not been observed.

The test has a thickness of nearly one mm. over the chamber of habitation. Surface marked by regular longitudinal ridges, with a single intermediate smaller ridge between, crossed by fine, sharp, crenulating, concentric striæ.

The internal mould usually preserves the longitudinal furrows and ridges without the concentric striæ, but they are less prominent than on the exterior surface of the test.

One fragment, consisting of the chamber of habitation and several attached air-chambers, has a length of 135 mm., with a diameter of nearly fifty mm. at the larger extremity. Other smaller fragments have been observed which do not furnish any additional data as to the dimensions of the shell.

This species is distinguished from *O. profundum* of the Upper Helderberg group, by the finer concentric striæ and the intermediate smaller longitudinal ridges between the prominent ones; and from *O. Ægea* by the absence of the low annulations of the tube and the numerous and irregular longitudinal ridges and striæ of that species.

Formation and localities. In the shales of the Hamilton group, at York, Geneseo, Avon and other localities in the western portion of the State.

Orthoceras Ægea.

PLATE LXXXII, FIGS. 7-13.

Orthoceras Ægea, Hall. Descriptions of New Species of Fossils, etc., p. 52. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 80. 1862.

Shell straight, regularly and somewhat rapidly enlarging. Transverse section very broadly elliptical. Apical angle about 10°. Initial extremity unknown.

The extent of the chamber of habitation has not been observed. Air-chambers regular, having a depth of about seven mm.

Septa smooth, with a concavity equal to an arc of 114°. Sutures straight and horizontal.

Siphuncle subcentral. In its passage through the air-chambers the elements have not been observed.

Test thin, rarely preserved. Tube ornamented by regular, low undulations, which are often elevated into distinct annulations toward the apex; becoming obsolescent on the outer part of the chambered portion of the tube, and often not at all perceptible over the chamber of habitation. The annulations have a distance of about eight mm. where the tube has a diameter of thirty mm. Surface marked by numerous strong, irregular, longitudinal ridges, with lesser intermediate ridges and fine striæ, crossed by sharp, crenulating, concentric striæ.

The internal mould usually preserves the longitudinal ridges, and sometimes the impressions of the concentric striæ; but these markings are much more subdued than on the exterior of the test.

A fragment, showing ten annulations, has a length of fifty-eight mm., with diameters of twenty-one and twelve mm. respectively, at the two extremities. A larger portion of another individual has a diameter of thirty-eight mm.

This species is distinguished by the annulations and undulations of the tube and the surface-markings, in which it differs from *O. Œdipus* and *O. profundum*, of the Upper Helderberg group, and from *O. Creon*, of the Schoharie grit.

Formation and localities. In the Hamilton group, at Geneseo, Livingston county; Pratt's Falls, Onondaga county; and in the calcareous beds of the group in Madison county, N. Y.

Section *d.*—*Annulated forms.*

Orthoceras crotalum.

PLATES XLII, FIGS. 1-9, 11, 12; LXXXII, FIGS. 1-6; CXIII, FIG. 13.

Orthoceras crotalum, Hall. Descriptions of New Species of Fossils, etc., p. 50. 1861.
" " " Fifteenth Rep. State Cab. Nat. Hist., p. 78. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda. Explanation of pl. 42. 1876.

Shell straight, regularly and rapidly enlarging from the apex, and becoming cylindrical toward the aperture. Transverse section subcircular. Apical angle about 9°. Initial extremity obtuse, having a diameter of about 1.5

mm., marked by a cruciform cicatrice, which is formed by two unequal pairs of oval furrows, extending to a central node and forming the umbilicus.

Chamber of habitation small, cylindrical; length about two and a half times the diameter at the last septum. Aperture entire, without special contraction or expansion. Air-chambers regular, numerous, more frequent than the annulations, with a depth of about three mm.

Septa smooth, thin. Their concavity is unknown, on account of the great degree of compression to which most of the specimens have been subjected. Sutures straight and horizontal, and bearing no uniform relation to the frequency or curvature of the annulations.

Siphuncle subcentral, moniliform, slightly indenting the septa. Its diameter at the septa is about two mm., where the tube has a diameter of seventeen mm.

Test very thin, rarely preserved. Tube ornamented with prominent annulations, which become more frequent and less marked toward the apex. On the chamber of habitation the annulations are very sharp and elevated, often curved and oblique. The tube, for a distance of twenty mm. or more back of the aperture, is cylindrical and without annulations, but is marked by lamellose lines of growth. Surface marked by fine, regular, sharp, continuous longitudinal striæ, crossed by finer, crowded, irregular striæ. There are about fifteen to twenty of the longitudinal striæ in the space of two mm.

The internal mould is essentially smooth, with the exception of the prominent annulations, and sometimes shows lamellose-striate markings.

A fragment, having a diameter at the larger extremity of sixteen mm., and a length of eighty-five mm., has sixteen annulations. The apical portion of another individual, with a diameter of ten mm. at the larger extremity, shows twenty-five annulations in the length of fifty-five mm. A fragment of a larger individual has only six annulations in the same space.

This species is distinguished from *O. Thoas*, of the Schoharie grit and Upper Helderberg limestones, by the character of the surface-markings and the rapidly enlarging tube; and from *O. nuntium* by its more prominent and less frequent

annulations. It is more nearly related to *O. cælamen*, but is distinguished by its continuous, sharp, longitudinal striæ and more elevated annulations.

This is the most abundant and extensively distributed species in the Hamilton group. Specimens are common in the soft shales, in the coarser beds and in the calcareous layers throughout the greater portion of the State. The specimens in the softer shales are often much broken and flattened from compression, but the test and surface characters are usually well preserved. From these have been obtained several good examples of the initial extremity of the shell, which is not well preserved in any other species described in this volume.

Formation and localities. In the soft shales of the Hamilton group; on the shore of Seneca lake; at Ludlowville, on Cayuga lake; and in the coarser shales at Cazenovia, Hamilton and numerous other localities in New York.

Orthoceras cælamen, n. sp.

PLATES XLII, FIG. 10; XLIII, FIG. 15; LXXXII, FIG. 16; CXIII FIGS. 22, 23.

Orthoceras nuntium and *Orthoceras crotalum*, Hall (in part). Illustrations of Devonian Fossils: Cephalopoda. Explanation of plates 42, 43. 1876.

Shell straight, regularly and gradually enlarging to the aperture. Transverse section circular. Apical angle about 5°. Initial extremity unknown.

The extent of the chamber of habitation has not been observed. Air-chambers regular, having a depth of two mm. where the tube has a diameter of nine mm.

Septa with a concavity equal to the depth of the air-chambers; ornamented with a small, slightly-elevated areola, and fine, radiating, vascular markings, which extend from the insertion of the siphuncle to the margins. Sutures straight and horizontal, more frequent than the annulations of the tube.

Siphuncle large, slightly excentric, having a diameter of 1.75 mm., where the tube has a diameter of nine mm. Its elements in the interseptal spaces have not been observed.

Test thin, having a thickness of about .25 mm. Tube ornamented with regular, sharp annulations, which increase in frequency from the chamber of habitation to the apex. Where the tube has a diameter of sixteen mm. the

annulations are distant from each other five mm. At a diameter of ten mm. the annulations are distant about 2.5 mm. Surface marked by numerous fine, evenly-rounded, interrupted, longitudinal striæ; crossed by finer, irregular, transverse striæ, and lamellose lines of growth. The longitudinal striæ are interrupted by the margins of the lamellose lines of growth, and often run in lines oblique to the axis of the tube.

The internal mould shows the annulations somewhat rounded, and preserves the transverse, lamellose striæ.

A large fragment has twelve annulations in the length of sixty-five mm. A smaller fragment has eleven annulations, with a length of twenty-seven mm., and diameters of nine and ten mm. respectively, at the two extremities.

This species is characterized by its surface ornamentation and the frequency of its annulations, in which it is distinguished from *O. crotalum* and *O. nuntium*. The annulations are less frequent and less abrupt than in *O. lima*. From *O. crotalum* it further differs in the small apical angle, and less prominent and more rounded annulations. The surface-markings resemble those in *O. lima*, but the number and character of the annulations is quite distinctive.

Formation and localities. From the shales of the Hamilton group, at Muttonville, Ontario county, and Moravia, Cayuga county, N. Y.

Orthoceras nuntium.

PLATES XLIII, FIGS. 4–10, 13, 14; LXXXII, FIGS. 14, 15.

Orthoceras nuntium, Hall. Descriptions of New Species of Fossils, etc., p. 51. 1861.
" " " Fifteenth Rep. State Cab. Nat. Hist., p. 79, pl. 8, figs. 3, 4. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda. Explan. of pl. 43. 1876.

Shell straight, regularly and rapidly enlarging from the apex. Transverse section subcircular. Apical angle about 9°. Initial extremity unknown.

Chamber of habitation not fully observed. Air-chambers regular, numerous, having a depth of two mm. where the tube has a diameter of ten mm., and are of about the same frequency as the annulations.

Septa smooth, with a concavity equal to more than the depth of the adjacent air-chambers. Sutures straight and horizontal; essentially corresponding to the annulations.

Siphuncle subcentral, moniliform, slightly expanding; having a diameter of 1.5 mm. at the septa, where the tube has a diameter of ten mm.

Test very thin, rarely preserved. Its thickness is .2 mm. where the tube has a diameter of fifteen mm. Tube ornamented with regular, numerous, horizontal annulations. Surface marked by regular, fine, thread-like, longitudinal striæ, which are crossed by finer, less prominent lines of growth. The longitudinal striæ are usually continuous, but are occasionally interrupted by the lines of growth, of which there are about twelve in the space of two mm.

On the internal mould the striæ are usually impressed, but they appear as if rounded and continuous, and do not present the sharp, thread-like character as on the exterior.

A large fragment has a length of 140 mm., and shows forty-two annulations. Portions of smaller individuals show from four to six annulations in the length of ten mm., varying with the diameter of the tube.

This species is distinguished from *O. crotalum* by its more frequent and less prominent annulations, and by the somewhat coarser longitudinal striæ. It differs from *O. cælamen* in not having the longitudinal striæ rounded and often interrupted by lamellose lines of growth; and from *O. Idmon* and *O. Thestor* by its much less frequent annulations and different surface characters.

The sections illustrated on plate 82, figs. 14, 15, are of specimens which occur in the calcareous layers of the Hamilton group at Pratt's Falls, Onondaga county, in association with undoubted *O. nuntium.* These specimens show the expanded character of the siphuncle and other internal features, which have not been fully observed in other individuals of the species.

Several fragments have been obtained from collections made in the Upper Helderberg limestones in Canada West, which possess the general form and surface characters of this species. The material, which is too meagre for satis-

factory determination, has been referred to on page 265, under the notice of the distribution of species in the Upper Helderberg limestones.

Formation and localities. In the calcareous shales of the Hamilton group, at Geneseo, Livingston county; on the shores of Seneca lake; and in the coarser shales east of Cayuga lake, New York.

Orthoceras Sicinus, n. sp.

PLATE XXXVIII, FIGS. 1, 2.

Orthoceras subulatum, Hall (in part). Illustrations of Devonian Fossils: Cephalopoda. Explanation of plate 38, figs. 1, 2. 1876.

Shell straight, regularly enlarging. Transverse section subcircular. Apical angle 8° in a specimen slightly compressed. Initial extremity unknown.

Chamber of habitation, air-chambers, septa and siphuncle not observed; owing to the test covering the entire surface of the tube, and the apical portion being compressed.

Test thin. Tube ornamented by regular low, rounded annulations, or transverse undulations, of which there are about seven in the length of ten mm. Surface reticulated with fine sharp, transverse and longitudinal striæ of similar character.

The specimen figured has a length of sixty mm. with diameters of fifteen and seven mm. at the two extremities, and shows about thirty-five annulations.

This species is distinguished by the low annulations of the tube, and reticulate surface. In its general appearance it somewhat resembles *O. subulatum*, and occurs in the same association; but that species has a smooth, or fine transversely striate surface. A closer resemblance is found with *O. textum;* but the annulations are not present in that species, and the reticulations of the surface are finer and more irregular. It is distinguished from the other annulated forms, here described, by its surface characters and the low, rounded, sometimes obsolescent annulations.

Formation and locality. In the carbonaceous beds of the Marcellus shales at Schoharie, N. Y.

Orthoceras Thestor, n. sp.

PLATE LXXXII, FIG. 18.

Shell straight, regularly and gradually enlarging. Transverse section circular. The characters of the chamber of habitation, air-chambers, septa and siphuncle are unknown.

Tube ornamented with very numerous, sharp annulations. The annulations are straight and horizontal, and about twelve in the space of ten mm. Surface marked by regular, fine, longitudinal striæ, crossed in the furrows between the annulations by sharp, transverse striæ. The longitudinal striæ, of which there are ten in the space of two mm., are continuous over the annulations, crenulating their summits.

This species is distinguished by the extreme frequency and regularity of the annulations, in which it differs from the other annulated forms. The surface characters are also different from those in *O. lima*. In *O. Idmon* the annulations are more abruptly elevated and less frequent; being as seven to twelve in the two species, with the intermediate furrows flattened.

Formation and locality. From the carbonaceous beds of the Marcellus shales of the Hamilton group at Schoharie, N. Y.

Orthoceras Idmon, n. sp.

PLATE XLIII, FIGS. 11, 12.

Shell straight, regularly enlarging. Transverse section, chamber of habitation, septa and siphuncle not observed.

The air-chambers are regular, as frequent as the annulations, or having a depth of 1.5 mm. Sutures straight and horizontal.

Test thin. Tube ornamented by numerous, regular, abruptly elevated annulations, with flattened interspaces; of which there are seven in the space of ten mm. Surface marked by regular, fine, continuous, longitudinal striæ, with concentric lines of growth in the furrows.

The specimen figured has a length of forty mm., and preserves twenty-five annulations in this space.

In its surface-markings this species closely resembles *O. nuntium* and *O. crotalum*, but the annulations are much more abrupt and frequent. In its rate of enlargement and general appearance it is very similar to *O. lima.* The annulations are nearly as frequent, being slightly more numerous in that species; but the surface characters are very distinct. This form was doubtfully identified with young individuals of *O. perelegans*, SALTER,* from the Silurian of England —a species which is characterized by fine transverse striæ, without longitudinal lines and with the annulations subacute. *O. solitarium*, BARRANDE, from the Silurian of Bohemia, presents surface ornaments which cannot be distinguished from this species, but is otherwise very different; that one having narrow, sharp furrows, with rounded, curving annulations. *O. Ibex*, SOWERBY, from the same horizon as *O. perelegans*, is very similar, with the addition of distinct, longitudinal striæ. The form here described is removed from the last two species by the more rapidly expanding cone, abrupt annulations, and the flat, interannular spaces.

Formation and locality. In the shales of the Hamilton group at Moscow, N. Y.

ORTHOCERAS LIMA, n. sp.

PLATE CXIII, FIGS. 24, 25.

SHELL straight, very gradually enlarging. The chamber of habitation, septa and siphuncle are unknown.

Air-chambers regular, having a depth equal to the distance between the annulations, or from 1 to 1.5 mm. Suture lines straight and horizontal in the furrows between the annulations.

Test not preserved. Tube ornamented by very numerous, regular, sharp annulations, with the intermediate furrows regularly concave. There are from eight to ten annulations in the length of ten mm. Surface-markings, as preserved on the internal mould, are very fine, longitudinal striæ, interrupted by lines of growth between the annulations.

* *Orthoceras perelegans*, SALTER. Memoirs of the Geological Survey of Great Britain: vol. ii, part i, p. 354, pl. 13, figs. 2–4. 1848.

The specimen figured and described has a length of forty-three mm., and shows thirty-four annulations.

This species is distinguished from *O. Idmon* by the characters of its surface and the concave, interannular furrows. The surface-markings are very similar to those of *O. cælamen*, but somewhat finer, and the frequency and prominence of the annulations are very different. The annulations are sharper and more abrupt than in *O. Thestor*, and it has not the continuous, longitudinal, elevated striæ of that species.

Formation and locality. In the coarse shales of the Hamilton group at Cazenovia, N. Y.

Orthoceras, sp. indet.

PLATE LXXXIII, FIG. 13.

A large fragment, of obscure specific characters, has been observed among collections made from the calcareous beds of the Hamilton group at West Williams, Ontario, Canada. In its form and proportions it bears considerable resemblance to *O. Bebryx*, but is too imperfect for satisfactory reference. The specimen is a weathered cast of the interior of the chamber of habitation and the last air-chamber. The last septum and portions of the walls of the grand chamber are covered with numerous individuals of a species of Spirorbis, which do not appear to have penetrated to the preceding septum.

ORTHOCERATA OF THE PORTAGE GROUP.

The Portage group, as recognized in Central and Western New York, consists of a series of finely laminated, black and olive shales, and argillaceous sandstones, with a few interrupted intercalations of semi-calcareous bands. This series of beds directly succeeds the Genesee slate, which may be regarded as the termination of the Hamilton group, or as beds of passage connecting it with the Portage. This group has yielded few forms of Orthoceratites. In those portions where the shaly deposit has assumed a semi-calcareous character, there has been an increase of animal life, and the fauna is characterized by a large proportion of Goniatites and an increased number of Orthoceratites, indicating more favorable conditions for their development. Owing to the limited collec-

tions which have been made from this group, and without especial reference to any particular class of fossils, it is very probable that future collections will furnish a larger number of Orthocerata. The species here described seem to possess few characters in common with the forms of this genus in other groups.

Orthoceras Atreus, n. sp.

PLATES LXXXVIII, FIG. 1; LXXXIX, FIGS. 10, 11.

Shell large, straight, robust, very regularly and gradually enlarging to the chamber of habitation. Transverse section circular. Apical angle about 6°. Initial extremity unknown.

Chamber of habitation subcylindrical, well developed; length about three times the diameter of the tube at the last septum. Tube with a very broad and gentle constriction anterior to the middle of the outer chamber, and an indication of a contraction at the aperture.

Air-chambers regular, deep, having a depth of fourteen mm. where the tube has a diameter of fifty-five mm. The external walls are smooth in the cast, with a slight longitudinal carina indicating the ventral side.

Septa smooth, so far as observed, with a concavity equal to an arc of 120°. Sutures straight and horizontal.

The siphuncle, as determined from a small fragment referred to this species with some doubt, is large and excentric, having a diameter at the septa of five mm., where the tube has a diameter of fifty mm., and distant from the nearest margin of the septa about one-third the diameter of the tube. It is expanded in the interseptal spaces, as indicated in a longitudinal section.

The test is not preserved. The internal mould shows evidences of a transversely lamellose-striate surface.

A fragment, embracing a large portion of the chamber of habitation and nine air-chambers, has a length of 300 mm., of which 160 mm. pertain to the chamber of habitation. A smaller fragment, referred to this species and preserving its normal form and proportions, contains nine air-chambers and has a length of 115 mm.

This species resembles *O. Thyestes*, with which it is associated, and is distinguished from that species by its more gradually enlarging tube, cylindrical chamber of habitation, and much deeper air-chambers. In the size of the shell and distance between the septa this species belongs to a group of large forms, including *O. Thyestes*, *O. Eriense*, *O. Zeus* and *O. Pelops;* but the position of the siphuncle and the concavity of the septa is very different.

Formation and localities. In the calcareous layers of the Portage group at Penn Yan, Yates county, and in the shales of the group at Rogers' Bridge, on the Genesee River, below Portageville, N. Y.

Orthoceras Thyestes, n. sp.

PLATE LXXXVIII, FIG. 2.

Shell large, straight, robust, regularly and rapidly enlarging to the chamber of habitation. Transverse section not observed on account of the compressed condition of the specimen described. Apical angle about 11°. Initial extremity unknown.

Chamber of habitation not satisfactorily observed. A portion having a length of 100 mm. shows a gradual contraction toward the aperture, which in an entire individual may prove to be merely a constriction of the tube, at a distance from the anterior termination. Air-chambers regular, increasing in frequency from the outer chamber to the apex, varying in depth from twelve to five mm. on a portion of the tube having a length of 220 mm.

Septa and siphuncle not observed. Sutures straight and horizontal. Test and surface-markings unknown.

Internal mould essentially smooth, with the sutures slightly impressed.

The specimen figured, consisting of a portion of the chamber of habitation and twenty-four air-chambers, has a length of 310 mm.

This species is associated with *O. Atreus*, and distinguished by its rapidly enlarging tube, and much shallower air-chambers.

Formation and locality. From the soft shales of the Portage group near Watkins, at the southern end of Seneca Lake.

Orthoceras pacator, n. sp.

PLATE LXXXIX, FIGS. 1-6.

Shell straight, regularly and gradually enlarging to the chamber of habitation. Transverse section circular. Apical angle about 6°. Initial extremity unknown.

Chamber of habitation well developed, having a length of nearly three times the diameter of the tube at the last septum, regularly enlarging to a point near the aperture, where the tube is abruptly constricted, and expanding thence to the aperture. Air-chambers numerous, of regular depth from the apex over the greater portion of the tube, but becoming more frequent and irregular toward the outer chamber. Their depth varies gradually from two to four mm. in the length of eighty mm. At the base of the grand chamber there are usually several very shallow air-chambers, which occasionally show great inequality in the depth of adjacent chambers.

Septa smooth, thin, with a concavity equal to an arc of about 103°. Sutures straight and horizontal in specimens not disturbed by compression.

Siphuncle excentric, distant from the nearest point on the septal margins about one-fourth the diameter of the tube, having a diameter at the septa of two mm. where the tube has a diameter of twenty-one mm. The elements have not been observed in its passage through the air-chambers.

The test has a thickness of .75 mm. Surface marked by fine, irregular, lamellose lines of growth.

The internal mould presents a very smooth surface, and, in the specimens from the soft shales, the sutures are indicated by a mere line.

A fragment retaining its normal form has a length of seventy-five mm., of which forty-five mm. pertains to the chamber of habitation. A compressed chambered fragment, with a length of eighty-five mm., shows twenty-eight air-chambers.

This species somewhat resembles *O. subulatum* and *O. constrictum*, of the Hamilton group; but it differs conspicuously in its excentric siphuncle and the character of the constriction on the chamber of habitation. Other species,

approaching this in the position of the siphuncle, have much more distant septa, as *O. exile* and *O. Telamon.*

The specimens from the soft shales are usually very much flattened from compression. Those in the calcareous layers preserve their normal proportions, with fragments of the test, and are filled and replaced by iron pyrites, which has obscured several features of the septa and siphuncle.

Formation and localities. From the shales of the Portage group, in the vicinity of Ithaca, and in the calcareous layers of the group at Mount Morris, N. Y.

ORTHOCERATA OF THE CHEMUNG GROUP.

The lower shales and calcareous beds of the group furnish very few distinctive forms, and these have but a limited horizontal distribution. The central portion of the group has afforded few specimens, and these are usually in such unsatisfactory condition that they cannot be distinctly characterized. The upper members, generally consisting of arenaceous strata, give evidences of a more extensive development and distribution of these forms, but the beds have not yet been critically examined.

The Orthoceratites of the Scholarie grit and Upper Helderberg limestones may be characterized by the predominance of large and robust species. The Hamilton group is distinguished by the excess of slender and annulated forms, The Chemung group, so far as observed, in its remarkable annulated form, and several short, ventricose, rapidly enlarging species, presents transitional features from the robust to the slender forms, and between the smooth and annulated species. A more extended account of the species occurring in this group will be presented in a future supplementary notice of the genus.

Orthoceras cochleatum, n. sp.

PLATE CXIII, FIG. 19.

Shell straight, regularly and rapidly enlarging to the chamber of habitation. Transverse section circular. Apical angle 15°. Initial extremity acute.

Chamber of habitation slightly gibbous, having a length equal to more than once and a half the diameter of the tube at the last septum. The tube

along the last air-chamber is rapidly expanded, becoming cylindrical throughout the greater length of the grand chamber, and contracted at the aperture. Aperture oblique to the axis of the tube. Air-chambers regular, having a depth of 3.5 mm. Those near the outer chamber are somewhat shallower, but the change in depth towards the apex is very slight.

Septa thin. The other characters of the septa and those of the siphuncle have not been observed. Sutures curved and oblique to the axis, at an angle of about 70° along one side of the tube.

Test not preserved. The surface-markings upon the internal mould are curved, transverse, lamellose striæ.

The specimen figured, which is nearly entire, has a length of 113 mm., of which thirty-three mm. pertain to the grand chamber, with a diameter at the aperture of twenty-three mm., and embraces twenty-eight air-chambers.

This species is distinguished by its rapidly enlarging tube, and the curvature and obliquity of the septa. It somewhat resembles *O. Leander*, but the tube is more rapidly enlarging, the air-chambers shallower, and the sutures are oblique. The regular curvature and obliquity of the sutures give the specimen a spiral appearance, which is very characteristic.

Formation and locality. In sandstones of the Chemung group, at Warren, Pa.

Orthoceras Leander, n. sp.

PLATE XC, FIGS. 6-8.

Shell straight, regularly and rapidly enlarging from the apex to a point near the aperture. Transverse section subcircular. Apical angle 11½°. Initial extremity unknown.

Chamber of habitation, with a length of twice the diameter of the tube at the last septum; regularly expanding to the aperture, where the tube is slightly contracted. Air-chambers showing a slight variation in depth in different individuals, varying from three to five mm. The last air-chamber is shallower than the preceding, but the variation towards the apex is very slight.

Septa smooth, thin, moderately concave. Sutures straight and horizontal.

Siphuncle subcentral, moniliform.

Test not preserved. The internal cast shows some traces of a lamellose-striate surface.

Internal mould smooth, with the sutures slightly impressed.

An individual, nearly entire, has a length of 107 mm., with a diameter of twenty-five mm. near the aperture, and contains the chamber of habitation and nineteen air-chambers.

This species, in general proportions, resembles *O. cochleatum*, and is distinguished by its smaller apical angle, somewhat deeper air-chambers, and its straight and horizontal septal sutures.

Formation and localities. From sandstones of the Chemung group, south of Ithaca, N. Y., and at Warren, Pa.

Orthoceras fulgidum, n. sp.

PLATE XC, FIGS. 2, 3.

Shell straight, slender, regularly enlarging to the aperture. Transverse section subcircular. Apical angle 6°. Initial extremity unknown.

Chamber of habitation small, regularly expanding with the general contour of the tube, having a length of once and a half the diameter at the last septum. Aperture slightly contracted, with the margin acute. Air-chambers regular; depth equal to three mm., and showing but little variation in a length of twenty-five mm.

Septa smooth, thin, with a concavity equal to the depth of the air-chambers. Sutures straight and horizontal.

Siphuncle small, subcentral; its remaining characters have not been observed.

The test has a thickness of .5 mm. Surface marked by fine, rounded striæ of growth. Internal mould smooth.

A fragment, preserving the chamber of habitation nearly entire and twelve air-chambers, has a length of forty-five mm., with a diameter of six and ten mm., respectively, at the two extremities.

There is a close resemblance between this species and the succeeding (*O. Demus*); but a marked difference is observed in the position of the siphuncle, and the air-chambers in the latter are comparatively shallower.

Formation and locality. In the calcareous beds of the Chemung group, near Ithaca, N. Y.

Orthoceras Demus, n. sp.

PLATE XC, FIGS. 1, 4, 5.

Shell straight, regularly enlarging. Transverse section circular. Apical angle 6°. Initial extremity unknown.

Chamber of habitation not observed. Air-chambers regular, increasing in frequency toward the apex, having a depth of from two to three mm.; varying to this degree in the length of forty-five mm.

Septa smooth, thin, having a concavity greater than the depth of the air-chambers. Sutures straight and horizontal.

Siphuncle small, excentric, and at the septa is distant from the nearest point on the margin about one-third the diameter of the tube. The other elements have not been observed.

Test not preserved, surface-markings unknown. The internal mould is essentially smooth.

A chambered fragment, with a length of fifty-seven mm., and diameters of twelve and eight mm. at the two extremities, shows twenty-eight air-chambers. A smaller fragment of another example has twenty-three air-chambers in the length of thirty-two mm.

This species is associated, in some localities, with *O. fulgidum;* and may be distinguished by its excentric siphuncle and somewhat shallower air-chambers.

Formation and localities. In the calcareous beds and shales of the Chemung group, at Ithaca, and in the arenaceous shales at Philipsburgh, N. Y.

Orthoceras anguis, n. sp.

PLATE LXXXIX, FIG. 9.

Shell straight, slender, regularly and gradually enlarging. Transverse section unknown. The apical angle in a specimen much compressed is 5½°.

Chamber of habitation, septa and siphuncle not observed. Air-chambers regular, having a depth of four mm. near the chamber of habitation, where the diameter of the tube is more than twenty mm. Sutures straight and horizontal.

Test not preserved. Surface marked by regular transverse, lamellose, subimbricating striæ, which become more crowded toward the apex, and of which there are nine in the space of five mm., where the tube has a diameter of about ten mm. Near the chamber of habitation the transverse lines become elevated into irregular ridges, with very fine intermediate striæ. The internal mould retains the impression of the transverse markings.

This species is distinguished from the associated forms by the marked characters of the surface ornamentation. *O. aulax* of the Hamilton, possessing similar general characters, has the striæ more rounded and distant.

Formation and locality. From the shales of the Chemung group, Cascadilla creek, Ithaca, N. Y.

Orthoceras palmatum, n. sp.

PLATE XC, FIGS. 9, 10.

Shell straight, regularly and gradually enlarging. Transverse section subcircular or very broadly elliptical. Apical angle about 7°. Initial extremity unknown.

Chamber of habitation not observed. Air-chambers regular, with a depth of nine mm. where the tube has a diameter of thirty mm.

Septa having a concavity equal to the depth of the chambers, with a distinct areola around the insertion of the siphuncle, and a broad flabellate or palmate expansion, extending to the ventral margin, which is indicated by a longitu-

dinal carina along the internal mould of the chamber walls. Sutures straight and horizontal.

Siphuncle small, subcentral, moniliform, with a diameter at the septa of two mm., where the tube measures thirty mm.

Test and surface-markings not preserved. The internal mould is smooth, with the exception of the ventral carina along the walls of the air-chambers.

The specimen figured, and the only one observed, has a length of thirty-five mm., with a diameter of about thirty mm., and preserves four air-chambers.

This species is distinguished by the remarkable ornamentation of the septa, and has no allied form in this horizon. *O. pravum*, from the Schoharie grit, shows an ornamentation on the septa from an organic deposit, or markings on the mantle of the mollusk; but in this species it is quite different, and the other characters are very unlike.

Formation and locality. In the semicalcareous beds of the upper member of the Chemung group, in Southern New York.

Orthoceras bipartitum, n. sp.

PLATE CXIII, FIGS. 20, 21.

Shell straight, regularly and gradually enlarging to the outer chamber. Transverse section subcircular. Apical angle about 5°. Initial extremity unknown.

A small portion of the chamber of habitation has been observed, which possesses no unusual features beyond the ornamentation of the tube. Air-chambers regular, numerous, increasing in frequency toward the apex, varying in depth from one to four mm. in the length of thirty mm., measured from near the chamber of habitation.

Septa thin, smooth, slightly concave. Sutures straight and horizontal.

Siphuncle excentric, with a diameter of 1.5 mm. where the tube measures nine mm., and distant from the nearest septal margin one-fourth of the diameter of the tube. Its elements have only been observed at the septa.

Test not preserved. The cast, near the apex, is smooth. Toward the chamber of habitation the surface is raised into low, rounded undulations,

which, upon the outer chamber, become elevated into strong, prominent annulations. Surface marked by fine, irregular lines of growth and longitudinal striæ, of which there are three in the space of one mm.

A fragment with a length of forty mm. shows five distinct annulations at the larger extremity, and about twenty air-chambers throughout the length Fifteen air-chambers occupy the smaller half of the fragment, which is without annulations. A fragment of a larger individual shows ten air-chambers in the length of fifteen mm., and three annulations in the same space along the larger adjacent, non-septate portion of the tube.

This species is remarkable for the frequency of the air-chambers, the very excentric position of the siphuncle, and the strongly annulated chamber of habitation, with an absence of this ornamentation over the greater part of the septate portion. These characters distinguish it from all the other species here described.

Formation and locality. In sandstones belonging to the Upper Chemung, at Warren, Pa.

Orthoceras pertextum, n. sp.

PLATE XC, FIGS. 16, 17.

Shell straight, gradually enlarging. The other characters, except those of the ornamentation of the tube and the surface-markings, have not been observed, owing to its fragmentary mode of occurrence.

Tube ornamented by regular, prominent annulations with concave interspaces, about five in the length of twenty mm. Surface crenulated by fine transverse striæ, which are crossed by equally fine, regular, longitudinal striæ.

A fragment with twelve annulations has a length of sixty-five mm., and a diameter in its compressed condition of about twenty-five mm.

This species is distinguished by its surface-markings, from any of the other annulated forms, described in this volume.

Formation and locality. From shales of the Chemung group, near Ithaca, N. Y.

BACTRITES, Sandberger. 1841.

The genus Bactrites was founded by Dr. Guido Sandberger in 1841, and its principal characters indicated by him in *Leonh. und Bronn's Jahrb.*, p. 240.

In 1850 Drs. G. and F. Sandberger reproduced the definition of the genus, with descriptions and figures of three species: *B. carinatus*, *B. gracilis*, and *B. subconicus*, in their great work, *Die Versteinerungen des Rheinischen Schichtensystems in Nassau;* p. 124, pl. 11, 12, 17.

Since its first publication the genus has been recognized by other naturalists in several countries of Europe, among whom are Prof. F. A. Rœmer, Dr. Giebel, Dr. Ferd. Rœmer, M. J. Barrande, Prof. Gustave Laube and others.

Until the present time no notice of this genus has been published in America. The number of species described from all the palæozoic countries is very limited, compared with the other allied genera. Only thirteen species have been recognized. Two of these are from the Silurian of Bohemia and Russia. Eleven species have been described from the Devonian of the Rhenish Provinces and the Harz. In Bohemia, where Cephalopodous life reached its maximum development, only one species has been indicated; and this is very limited in its vertical distribution. Two forms have also been recognized in the Triassic.

The species here described is from the Marcellus shales, at the base of the Hamilton group, and has only been observed among collections from a single locality. As a whole, the genus seems to be essentially a Devonian form, and very local and irregular in its vertical and geographical distribution.

On account of the slight "dorsal lobe" of the suture lines, over the insertion of the siphuncle in the septa, these forms have been considered as belonging with the Goniatitidæ. In well preserved specimens, where the septal margins are nearly entire, this bending of the sutures is very slight; and is not a proper sinus in the septa, but is apparently a sinus in the chamber walls, made by the exposure of the siphuncular tube. Many Gyroceras and Trochoceras show a similar sinus in the septal sutures, where the siphuncle is submarginal. The genus Orthoceras, as now constituted, admits of so great a range of variation

in the form and characters of the siphuncle, as well as in the other elements of the shell, as to render the removal of the genus BACTRITES to the Goniatitidæ undesirable. It seems to possess transitional features between the families of Goniatitidæ and Orthoceratidæ; and I prefer to arrange it, for the present at least, with the latter.

BACTRITES CLAVUS, n. sp.

PLATES LXXXIV, FIG. 15; CXIII, FIGS. 1-5.

SHELL slender, straight, regularly and gradually enlarging to the aperture. Transverse section elliptical. Dorso-ventral diameter the longer, having a ratio of 2 to 3 with the lateral diameter. Tube subcarinate on the dorsal (?) side. Apical angle a little more than 1°. Initial extremity unknown.

Chamber of habitation well developed, having a length of more than six times the dorso-ventral diameter at the last septum, regularly enlarging to the aperture. Air-chambers regular, with a depth of three mm., or equal to the lateral diameter of the tube, from which they do not vary perceptibly in the length of sixty mm.

Septa thin, smooth, moderately concave along the lateral diameter, and with a concavity equal to an arc of 140° in a dorso-ventral direction. The sutures form a broad retral curve over the lateral faces of the tube, extending forward over both the ventral and dorsal sides. Immediately over the insertion of the siphuncle they curve more or less abruptly backward, forming the "dorsal lobe," which corresponds to a similar feature in GONIATITES, and probably marks the ventral side of the shell. The sutures meet in an obtuse angle at the carina along the dorsal (?) side.

Siphuncle small, submarginal, indenting the septa, having a diameter of one-half of one mm. Its elements in the interseptal spaces are unknown.

Test and surface ornaments not preserved on any of the specimens.

Internal mould smooth, with the sutures but slightly impressed.

An individual, preserving a portion of the chamber of habitation and twenty-three air-chambers, has a length of ninety-five mm.; with dorso-ven-

tral diameters of 6.5 and 4.5 mm. at the two extremities. Other fragments have been observed, indicating but slight variations from these dimensions.

This species closely resembles *B. carinatus*, MÜNSTER, as described and figured by the Drs. SANDBERGER in *Verstein. des Rhein. Syst. in Nassau*, except that it is larger, the carination on the dorsum(?) is less marked, and none of the specimens have exhibited the curved, transverse undulations on the chamber of habitation as shown in that species. The interiors of the specimens forming the basis of the present description, are filled with iron pyrites, and the shell has been dissolved and replaced by the same material.

This fossil occurring in the Marcellus shale, which is regarded as a subordinate member of the Hamilton group, is associated with an assemblage of species few of which extend beyond the horizon of this shale, and its included "Goniatite limestone." The principal fossils in this association are *Euomphalus planodiscus*, *Orthoceras Marcellense*, *O. fustis*, *O. subulatum*, *Gomphoceras Fischeri*, *G. solidum*, *G. Conradi*, *Gyroceras transversum*, *Nautilus* (*Discites*) *Marcellensis*, *N. oriens*, *Goniatites Vanuxemi*, *G. discoideus*, *G. plebeiformis*, *Proetus Haldemani*, and several species and genera of Pteropoda and Brachiopoda. With the exception of *Orthoceras subulatum*, *Gomphoceras Fischeri*, and *Goniatites discoideus*, these species are restricted to this limited vertical range, and constitute a remarkable fauna, considering the position of the shales between the two prominent formations—the Upper Helderberg limestones and the Hamilton group proper.

Formation and locality. In the carbonaceous shales of the Marcellus member of the Hamilton group, at Schoharie, N. Y.

GOMPHOCERAS, Sowerby. 1839.

The genus Gomphoceras was not recognized in any American publication until 1857, when Mr. Billings described *G. obesum*, from the Utica group, and *G. subgracilis*, from the Upper Silurian (*Geol. Surv. of Canada: Rep. Progress*).

In 1860 Mr. Hall described *G. Conradi*, *G. Fischeri* and *G. oviforme*, from the Hamilton group (*Thirteenth Rep. State Cab. Nat. Hist.*).

In 1861 Mr. Hall described *G. eximium*, from the Upper Helderberg limestone (*Fourteenth Rep. State Cab. Nat. Hist.*), and *G. beta*, from the Schoharie grit (*Descriptions of New Species of Fossils*, p. 44).

In 1862 Mr. Hall republished the description of *G. beta*, from the Schoharie grit (*Fifteenth Rep. State Cab. Nat. Hist.*, p. 72).

In 1866 Mr. Winchell described *G. omicron*, from the Hamilton group of Michigan (*Rep. Lower Peninsula, Mich.*).

Meek and Worthen described *G. turbiniforme*, from the Hamilton group (*Proc. Acad. Nat. Sci. Phila.*).

In 1867 Mr. Hall described *G. septoris*, from the Niagara group of Wisconsin, and *G. scrinium*, from the same horizon in Illinois (*Twentieth Rep. State Cab. Nat. Hist.*).

In 1875 Hall and Whitfield described *G. eos*, from the Hudson-river group (*Geol. Surv. of Ohio: Pal.*, vol. 2).

In 1876 Mr. Hall illustrated *Cyrtoceras clavatum* [=*Gomphoceras*], from the Schoharie grit, and *Cyrtoceras gibbosum* [=*Gomphoceras oviforme*], from the Hamilton group (*Illus. of Devon. Foss.*).

From the geological distribution of the species, as indicated in the above historical sketch, it is shown that the greater number belong to formations above those of recognized Silurian age. The additional species described in the present volume will considerably increase this proportion. The confusion now existing among the heretofore described forms, from an uncertain generic reference, renders any attempt at a digest of the whole impossible without a revision and examination of all the species recorded under

GOMPHOCERAS, CYRTOCERAS, GYROCERAS and NAUTILUS, including several minor genera or subgenera. The distinctions between the genera, as now recognized, do not furnish consistent or satisfactory results when applied to the species here described. A generic definition, with illustrations of the species here described and not figured, will be given in a future supplementary notice.

The comparative distribution of the species of this genus, in the formations, is nearly parallel to the distribution of the species of ORTHOCERAS, with the exception of a greatly increased number of the former in the limestones of the Upper Helderberg group, especially in its western extension. The species in the Schoharie grit are in general comparatively slender. The Upper Helderberg limestones are characterized by several very large gibbous forms; those of the Hamilton, Portage and Chemung groups are marked by a large proportion of short, ovoid forms, and the occurrence of several large fusiform species.

In comparison with the species of Bohemia, as illustrated and described by M. BARRANDE, in *Syst. Sil. du centre de la Bohême*, the American forms of the genus offer a decided and constant difference. The large and small apertures of the Bohemian species are comparatively smaller, and generally widely separated, being connected by a narrow channel. The species described in this volume are characterized by a transverse suboval, trilobate aperture, which is essentially one. The large aperture constitutes the two larger lobes, and the confluent small aperture forms the smaller lobe.

Several of the American forms here referred to the genus GOMPHOCERAS possess features of the aperture intermediate between this genus and MESOCERAS, as constituted by M. BARRANDE. The characteristics of the latter are mainly based upon a single transverse, elliptical aperture, with an undefined sinus in the striæ and margins, corresponding to the small aperture and ventral side of the shell. In the majority of the species here described the large aperture is transverse, and forms the principal feature of the entire aperture, showing a regular gradation in the different forms, from a slight sinus or bend in the ventral margin, to a distinct but confluent aperture, corresponding to the small aperture. See *G. oviforme*, *G. Conradi*, *G. clavatum*, *G. mitra*, *G. Fischeri* and *G. absens*.

List of the species of GOMPHOCERAS described in this volume:

EXOGASTRIC.

GOMPHOCERAS, Sowerby.			
abruptum,	HALL	Hamilton group	Large, robust forms.
Ajax,	"	Portage group	
cammarus,	"	Upper Helderberg group,	
eximium,	"	Upper Helderberg group,	
Fischeri,	"	Hamilton group	
gomphus,	"	Upper Helderberg group,	
impar,	"	Upper Helderberg group,	
lunatum,	"	Hamilton group	
manes,	"	Hamilton group	
mitra,	"	Upper Helderberg group,	
(?) *planum*,	"	Hamilton group	
poculum,	"	Hamilton group	
potens,	"	Chemung group	
rude,	"	Schoharie grit	
solidum,	"	Hamilton group	
absens,	"	Upper Helderberg group,	Slender forms.
fax,	"	Schoharie grit	
Illænus,	"	Schoharie grit	
raphanus,	"	Hamilton group	
beta,	"	Schoharie grit	Short, ventricose forms.
oviforme,	"	Hamilton group	
pingue,	"	Hamilton group	
tumidum,	"	Chemung group	

ENDOGASTRIC.

GOMPHOCERAS, Sowerby.			
clavatum,	HALL	Schoharie grit	Slender, curved forms.
(?) *cruciferum*,	"	Schoharie grit	
Conradi,	"	Hamilton group	

Gomphoceras fax, n. sp.

PLATE—SUPPLEMENT.

Shell slender, slightly arcuate; curvature exogastric. Transverse section broadly elliptical; lateral diameter the longer. Point of greatest gibbosity near the middle of the chamber of habitation. Tube regularly and gradually enlarging from the apex to the point of greatest transverse section, and rapidly contracting to the aperture. Apical angle, in compressed specimens, about 18°. Apex acute.

Chamber of habitation large, with a length equal to the greatest lateral diameter. Crenulated zone narrow, marked by fine, transverse furrows, of which traces are remaining over each of the chamber walls of the internal mould.

Aperture small, suboval, slightly extended on the ventral side forming the small aperture. Large aperture, having its longer diameter equal to two-thirds the lateral diameter of the chamber of habitation.

Air-chambers regular, numerous, with a depth of from two to five mm. Septa smooth, so far as observed. Sutures straight and horizontal.

Siphuncle small, close to the ventral side, not observed in the cavities of the air-chambers.

Test not preserved. The internal mould preserves traces of strong lamellose striæ near the aperture.

A compressed fragment, consisting of the chamber of habitation and about eighteen attached air-chambers, has a length of eighty mm. A smaller individual, preserving the chamber of habitation entire, and twelve air-chambers, has a length of sixty-seven mm., of which twenty-three mm. pertain to the chamber of habitation.

This species resembles, and is associated with, *G. Illænus*, but is distinguished by its much smaller aperture, which also differs conspicuously in general outline. The fragment referred to *G. Illænus* indicates a considerably greater curvature of the tube than is shown in this species. It is further removed from *G. clavatum* and *G. beta* by the relative position of the greatest transverse diameter,

the apical angle, and depth of the air-chambers. The air-chambers in *G. rude* have a much greater depth, and the crenulated band has a marked character, not shown in this species. The specimens are in the same condition of preservation as the associated Orthoceratites, with the minute specific characters much obscured by compression and the process of weathering.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

Gomphoceras Illænus, n. sp.

PLATE—SUPPLEMENT.

Shell curved, arcuate(?); curvature exogastric. Transverse section broadly elliptical, lateral diameter the longer. Greatest transverse diameter near the middle of the chamber of habitation.

Chamber of habitation with a length equal to its greatest lateral diameter. Dorsal and lateral sides nearly straight. Ventral side sloping rapidly to the aperture from the point of greatest gibbosity. Crenulations forming a narrow fossa at the base of the chamber of habitation of two mm. in width, and crossed by small, irregular furrows.

Aperture large, trilobate, elongate; width equal to the greatest diameter of the tube. The small aperture formed by a deep and rounded curve in the margin of the shell. The large aperture, narrow, becoming nearly tubular at the ends, and projecting beyond the lateral margins of the shell.

The depth of the air-chambers has not been observed. Septa smooth, moderately concave. Sutures straight and horizontal.

Siphuncle not observed.

Test not preserved. The surface-markings, as shown on a portion of the internal mould, were sharp, lamellose, transverse striæ.

The specimen described consists of the chamber of habitation nearly entire, but slightly compressed, and has a length of forty-five mm., with an equal transverse diameter.

This species differs from *G. fax* in the size and character of the aperture, and apparently greater curvature of the shell. The characters of the aperture, and the point of greatest transverse section, also distinguish this species from the remaining associated forms.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

GOMPHOCERAS CLAVATUM.

PLATES XLVI, FIGS. 14, 15; XCIII, FIGS. 2, 3.

Cyrtoceras clavatum, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 47, figs. 12, 13. 1876.

SHELL curved; curvature endogastric. Considering the slope of the dorsal and ventral sides of the chamber of habitation, the curvature seems to be the reverse of that indicated by the chambered portion of the tube, which is clearly concave along the ventral side. Tube regularly and gradually enlarging from the apex to the base of the chamber of habitation, and contracting rapidly to the aperture. Transverse section broadly oval, slightly flattened on the dorsal side. Apical angle about 22°. Apex acute.

The chamber of habitation has a length equal to the greatest ventro-dorsal diameter of the tube. The tube is constricted at the aperture. The dorsal and lateral faces slope gradually toward the large aperture: the ventral side has a greater convexity, and slopes very rapidly to the margin of the small aperture. The crenulations have not been observed.

Aperture suboval, small, having a diameter equal to about two-thirds the greatest lateral diameter of the tube. The small aperture is merely a slight bend or sinus in the margin from the large aperture, which is elliptical, and constitutes the principal feature of the entire aperture.

Air-chambers regularly increasing in frequency from the apex to the outer chamber, and varying in depth from 2.5 to 4 mm. in the length of thirty mm. Occasionally the last one or more of the air-chambers are shallower than the preceding. Septa with a concavity equal to the depth of the air-chambers. Sutures bending toward the aperture over the ventral and dorsal sides.

Siphuncle near the concavo-ventral side, having a diameter at the septa of two mm., where the tube has a diameter of twenty-five mm. Its other characters not observed.

Test and surface-markings unknown.

A small individual, nearly entire, has a length of sixty mm., with a greatest lateral diameter of twenty-three mm., and preserves the chamber of habitation and about fifteen air-chambers. Other larger examples have been observed, but in a fragmentary condition.

This species, in its peculiar curvature and size, resembles *G. Conradi*, of the Hamilton group; but the point of greatest transverse section is different, the aperture smaller, and the tube more rapidly contracting toward the aperture. It is distinguished from *G. fax* by the position of the point of greatest transverse section, the endogastric curvature and apical angle.

Formation and locality. Schoharie grit, Helderberg mountains, Albany county, N. Y.

GOMPHOCERAS ABSENS.

PLATE XLVI, FIGS. 8, 9, AND SUPPLEMENT.

Cyrtoceras absens, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 47, figs. 7, 8. 1876.

SHELL small, arcuate, exogastric. Transverse section elliptical; lateral diameter the longer. The ratio of the ventro-dorsal diameter to the lateral diameter is about as 3 to 4. Point of greatest gibbosity on the chamber of habitation, near the last septum. Apical angle about 20°.

Chamber of habitation bursiform, having a length equal to the greatest lateral diameter of the tube. Dorsal side nearly straight, sometimes slightly concave. Ventral side convex, and sloping rapidly to near the aperture, where there is a sudden constriction of the tube, which is cylindrical from this point to the aperture. Crenulated zone very narrow, but marked by broad, shallow, transverse furrows.

Aperture oval, with a width nearly equal to the length of the grand chamber. The small aperture is formed by a very small and shallow bend, or

sinus, in the margins of the large aperture. The length of the large aperture is equal to three times the length of the sinus forming the small aperture.

Air-chambers regular, having a depth of three mm. Septa smooth, and of moderate concavity. Sutures straight and horizontal.

Siphuncle small, moniliform near the ventral side; sometimes exposed in the process of weathering.

Test and surface-markings unknown.

The largest chamber of habitation observed has a length of twenty-five mm., and a lateral diameter at the last septum of twenty-seven mm. A fragment of the septate portion has a length of sixteen mm., and embraces six air-chambers.

This species is distinguished by its size, the curvature of the tube, and the characters of the chamber of habitation. The amount of the constriction at the aperture varies considerably in different individuals, and also the slope of the dorsal and ventral sides. It is distinguished from *G. beta* in its greater curvature and more slender form. A fragment of the chambered portion was originally considered as belonging to CYRTOCERAS, but the discovery of numerous chambers of habitation of a species of GOMPHOCERAS, conforming to the requirements of the septate fragment, has induced its reference to the latter genus The specimens from the Upper Helderberg limestones, at Clarence Hollow, show slight variations from those found in the Schoharie grit, but the differences are not of varietal or specific importance.

Formation and localities. In the Schoharie grit, at Schoharie, and in the limestones of the Upper Helderberg group, at Clarence Hollow, Erie county, N. Y.

Gomphoceras beta.

PLATE XLVI, FIGS. 4, 5.

Gomphoceras beta, Hall. Descriptions of New Species of Fossils, p. 44. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 72, pl. 7, fig. 1. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 47, figs. 5, 6. 1876.

Shell small, gibbous, nearly straight; exogastric. Ventral side more convex than the dorsal. Transverse section elliptical. Longitudinal section suboval, with the greatest transverse diameter through the second or third septum back of the grand chamber. Tube rapidly enlarging from the apex to the point of greatest transverse section, and contracting rapidly to the aperture. Apical angle, in a compressed specimen, about 47°. Apex acute.

Chamber of habitation large, with a length equal to the diameter of the tube at the last septum, or more than one-third the entire length of the shell. The ventral side is the more convex, and slopes more rapidly to the aperture than the dorsal side. Crenulations distinct, traces of them showing on the cast of the walls of the air-chambers.

Aperture small; its other characters have not been satisfactorily observed.

Air-chambers regular, comparatively deep, having a depth of more than three mm., and showing but a slight decrease toward the apex.

Septa smooth, thin, with a concavity equal to the depth of the air-chambers. Sutures horizontal, slightly curving, impressed upon the cast.

Siphuncle moniliform, very near the ventrum, sometimes exposed in the process of weathering.

Test and surface-markings unknown.

One example shows the chamber of habitation with seven air chambers, and has a length of thirty-six mm. When entire, it probably had a length of about forty-five mm.

This species is distinguished from the associated forms by its short gibbous shell, rapidly tapering toward both extremities. It is less globose than *G. oviforme*, of the Hamilton group, and the point of greatest transverse section is different.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

Gomphoceras rude, n. sp.

PLATE XCIII, FIG. I.

Shell gibbous, curved; curvature exogastric. Point of greatest transverse section near the last septum.

Chamber of habitation large, having a length greater than the diameter of the tube at the last septum. Crenulated band cancellated by five imbricating, lamellose striæ, crossed by numerous small furrows. The width of the zone is about ten mm., and there are six furrows in the space of seven mm.

Aperture, septa and surface-markings unknown.

Air-chambers deep, shallower near the chamber of habitation; varying in depth from twelve to six mm., in the length of three chambers over the ventrum. The air-chambers are considerably shallower on the dorsal side, owing to the curvature of the tube. Sutures horizontal, making a slight sinus, which is convex toward the aperture, over the siphuncle.

Siphuncle near the ventral side exposed in the process of weathering; but its elements have not been fully observed.

The specimen figured has a length of ninety-five mm., about half of which belongs to the chamber of habitation,—five air-chambers occupying nearly fifty mm. of the length.

This species is distinguished by the character of the crenulations and the great depth of the air-chambers. The specimen described is much compressed and distorted, and imperfectly preserved, but the characters above indicated are very marked.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

GOMPHOCERAS? CRUCIFERUM, n. sp.

PLATE XCIII, FIG. 4.

A specimen preserving a single septum with the walls of one air chamber has been observed, which possesses an ornamentation unlike anything previously noticed. It is placed in GOMPHOCERAS on account of its association with other species, and the amount of the curvature of the tube indicated by the slope and direction of the chamber walls.

Transverse section very broadly ovate, with the ventro-dorsal and the lateral diameters nearly equal,—the narrower end toward the side containing the siphuncle, which is apparently nearer the concave side of the tube, making the curvature endogastric.

Septa moderately concave. The septum shows an elevated, cruciform ornamentation, with the intersection of the arms at the insertion of the siphuncle, where there is a small areolar marking. The longer arm of the cross is lanceolate, and extends toward the convexo-ventral margin, having a length somewhat less than one-half the dorso-ventral diameter. It is surrounded by indistinct concentric striæ. The three shorter arms form a triangular, trilobate expansion, with an ovoid elevation, surrounded by a furrow on the central lobe.

Siphuncle small on the concave side of the tube, having a diameter of two mm. where the dorso-ventral diameter is forty-five mm., and distant from the nearest margin of the septa about one-third the diameter of the tube.

This species is distinguished by the remarkable ornamentation of the septa, which is sufficient to separate it from any allied form. The evident curvature of the tube and the transverse section remove this species from ORTHOCERAS, in which genus there are several species showing an ornamentation of the septa. In *O. pravum* the aspect of this feature is similar, but the details are very different.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

GOMPHOCERAS EXIMIUM.

PLATE XLIV, FIGS. 1, 2, AND SUPPLEMENT.

Gomphoceras eximium, HALL. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 109. 1861.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 44, figs. 1, 2. 1876.

SHELL large, straight, very gibbous; exogastric. Transverse section subcircular or very broadly oval. Longitudinal section subelliptical, with the point of greatest gibbosity at the last septum. Tube enlarging very rapidly from the apex, with the sides straight or somewhat concave for some distance, and becoming convex over the last six air-chambers and the chamber of habitation. Apical angle about 50°.

Chamber of habitation large, having a length nearly equal to the diameter of the tube at the last septum. The dorsal, ventral and lateral faces slope rapidly to the aperture. Crenulations indistinct, with some traces of fine transverse striæ.

The tube is slightly expanded at the aperture, but the particular features have not been observed.

Air-chambers regular, increasing in frequency from the apex toward the outer chamber, varying in depth from five to ten mm. in a length of about 100 mm.; the last three or four somewhat shallower than the preceding. Septa smooth, thin; concavity equal to the depth of two air-chambers. Sutures straight and horizontal.

Siphuncle nummuloid, distant from the ventral side twice its diameter between the septa, which is equal to fourteen mm. where the tube has a diameter of 100 mm., and equal to twice the depth of the air-chamber, or twice its diameter at the septa. The surface of the constricted portions of the siphuncular tube, at the septa, is radiated and surrounded by a distinct ridge.

Test and surface-markings unknown.

The largest individual observed, consisting of a portion of the chamber of habitation and thirteen air-chambers, has a length of 185 mm., with a diameter at the point of greatest transverse section of 115 mm. The portion of the grand chamber remaining has a length of seventy mm. A smaller

example, preserving a large portion of the chamber of habitation, with a length of ninety mm., and eleven air-chambers, occupying 100 mm., has a diameter of 100 mm.

This species is larger and more gibbous than any similar form here described. It somewhat resembles *G. mitra*, but the position of the siphuncle and the constricted aperture of that species is a very distinguishing feature. In *G. cammarus* the slope of the dorsal and ventral sides is characteristic.

Formation and localities. In the limestones of the Upper Helderberg group, at Black Rock, near Buffalo, N. Y.; and at Columbus, O.

Gomphoceras mitra, n. sp.

PLATE—SUPPLEMENT.

Shell large, straight, gibbous; exogastric. Transverse section very broadly oval or subcircular. Longitudinal section subfusiform. The point of greatest transverse section is posterior to the chamber of habitation, at about the sixth septum. Tube regularly and rapidly enlarging to the point of greatest gibbosity, and sloping irregularly, with constrictions, and slight expansions, to the aperture. The regular enlargement from the apex gives to the chambered portion of the shell a very characteristic, conical form. Apical angle 50°. Apex acute.

Chamber of habitation small; length less than two-thirds its greatest diameter at the base, or less than the length of the large aperture. The tube at the base of the grand chamber, including several shallow air-chambers, is slightly constricted. From this point the sides are convex, and slope rapidly toward the aperture for a distance equal to about half the length of the grand chamber, where the tube is again suddenly and deeply constricted, and the sides slope gradually to the aperture. Crenulations not observed.

Aperture semi-oval; width equal to twice the transverse diameter, or three-fourths the greatest transverse diameter of the tube. The small aperture is formed by a very broad, shallow bend or sinus from the large aperture.

The large aperture is elliptical, with the longer diameter nearly three times the length of the transverse diameter.

Air-chambers regular, numerous, having a depth of eight mm. There is but a slight variation in the depth from the apex to near the grand chamber, where several of the air-chambers are shallower than the preceding. Septa smooth and thin, with a concavity greater than the depth of the air-chambers. Sutures straight and horizontal.

Siphuncle submarginal, moniliform, exposed in the process of weathering; expanding between the septa to a diameter equal to the depth of the chambers, or twice its diameter at the septa.

Test and surface-markings unknown.

The internal mould of specimens, preserved in a coarse limestone, is essentially smooth, without traces of the surface-markings or crenulations, but showing the sutures considerably impressed from the process of weathering.

A large individual, nearly entire, preserves the chamber of habitation with about twenty-three air-chambers, and has a length of 220 mm. The greatest transverse diameter of the specimen is 110 mm., and the aperture has a width of eighty-four mm.

This species is distinguished by its general form, the characters of the chamber of habitation, and the aperture. It somewhat resembles *G. impar* in the features of the grand chamber; but that species is less gibbous, the septa much more frequent, and the point of greatest transverse section is on the outer chamber. In *G. eximium* the shell is more gibbous, the air-chambers deeper, and the siphuncle larger and internal.

Formation and locality. In the Upper Helderberg limestone, at Lexington, Scott county, Ind.

Gomphoceras impar, n. sp.

PLATE—SUPPLEMENT.

Shell straight, exogastric. Transverse section broadly oval. Point of greatest transverse section near the base of the chamber of habitation. Tube regularly enlarging to the last septum, where it is slightly constricted. Apical angle about 30°.

Chamber of habitation large, with a length equal to the greatest ventro-dorsal diameter. The dorsal side slopes somewhat more abruptly toward the aperture than the ventral side. The tube gradually enlarges back of the aperture, and suddenly expands to the point of the greatest transverse section. The crenulated band in the cast forms a deep, narrow fossa at the base of the grand chamber, and is crossed by furrows, of which there are about four in the space of twelve mm.

Aperture sub-oval, having a length equal to the greatest ventro-dorsal diameter, or about twice its transverse diameter. The small aperture is indicated by a sinus in the margins of the large aperture.

Air-chambers numerous, regularly increasing in depth from the apex to near the base of the outer chamber, varying in depth from four to six mm. in the length of seventy mm. The last two air-chambers are shallower than the preceding. Septa not observed. Sutures straight and horizontal.

Siphuncle, test and surface-markings unknown.

The specimen described has a length of 135 mm., of which sixty mm. pertain to the chamber of habitation, and preserves nearly seventeen air-chambers; being incomplete at the apex.

This species is distinguished by its apical angle, the characters of the grand chamber, and the frequency of the air-chambers. In the form of the chamber of habitation it resembles *G. mitra*, but the point of greatest transverse section is different, and the air-chambers much shallower.

Formation and locality. In the Upper Helderberg limestone, at Columbus, O.

Gomphoceras cammarus, n. sp.

PLATE—SUPPLEMENT.

Shell large, exogastric. The chamber of habitation and five attached air-chambers do not show evidences of any decided curvature in the shell. Transverse section broadly oval; lateral diameter the longer. In a longitudinal section the dorsal side is nearly straight, and the ventral side very convex. Point of greatest gibbosity posterior to the outer chamber, at about the fourth septum. Apical angle unknown.

Chamber of habitation small, with a length equal to about three-fourths of the lateral diameter at the last septum. Dorsal side nearly straight; ventral side convex, and sloping rapidly to the aperture. Lateral faces convex, regularly sloping to the aperture, which is slightly expanded at the lateral margins. The crenulations form a broad, coarsely furrowed band at the base of the grand chamber, having a width of eleven mm., and showing about three transverse furrows in the same space.

Aperture longitudinally semi-oval, having a length equal to that of the grand chamber. Transverse or ventro-dorsal diameter nearly two-thirds that of the lateral. The small aperture is indicated by a deep, broad bend in the margins of the large aperture. Large aperture elliptical, with a ventro-dorsal diameter equal to one-half the lateral diameter.

Air-chambers regular, having a depth of nine mm. where the tube has a diameter of ninety mm. The last air-chamber has a depth of one-half the adjacent one, and both are shallower than the preceding chamber. Septa smooth, so far as observed, and deeply concave. Sutures straight and horizontal.

Siphuncle unknown.

The test on the chamber of habitation is strong, having a thickness of two mm. Surface marked by regular, fine, lamellose lines of growth.

The internal mould of the specimen, as preserved in a fine, compact, cherty limestone, has the greater part of the test and septa dissolved, giving to the air-chambers an imbricating appearance. The crenulated band is distinct

at the base of the chamber of habitation, but no traces of the furrows are observed over the walls of the air-chambers.

A fragment, preserving the chamber of habitation and five attached air-chambers, has a length of 105 mm. The chamber of habitation shows a length of sixty-five mm., with a lateral diameter at the base of nearly ninety mm., and a ventro-dorsal diameter of seventy-three mm.

This species is distinguished by the characters of the chamber of habitation and form of the dorsal and ventral sides, in which it differs from *G. eximium*, *G. mitra* and *G. impar*. From *G. gomphus* it is distinguished by the point of greatest transverse section, the curvature of the dorsal and ventral sides, its smaller aperture, the absence of the low undulations of the tube, and its smooth chamber walls in the cast. The specimen described is imperfect, but preserves several of the minor specific features not observed in specimens from the coarser limestones.

Formation and locality. In the cherty beds of the Corniferous limestones, at Lexington, Scott county, Ind.

Gomphoceras gomphus, n. sp.

PLATE—SUPPLEMENT.

Shell large, straight, exogastric. Transverse section oval; lateral diameter the longer. Plane of greatest transverse section through the chamber of habitation, distant from the last septum one-third the length of the chamber. Ventral and dorsal sides convex, with the curvature of the ventral side somewhat greater than the dorsal. Tube gradually enlarging to the point of greatest gibbosity, and contracting slightly toward the aperture. Apical angle about 23°.

Chamber of habitation large; length equal to the greatest diameter of the tube, or about one-third the apparent length of the entire shell; slightly expanded at the aperture. The sides are convex, and slope gradually toward the aperture. The crenulated zone in the cast forms a broad, gentle constriction at the base of the chamber of habitation, and consists of shallow,

transverse furrows, of which there are four in the space of fourteen mm. The crenulations are retained over the internal mould of the chamber walls.

Aperture large, sub-oval, having a width equal to that of the grand chamber. The small aperture is formed by a slight bend in the margins of the large aperture. Ventro-dorsal diameter of the latter about two-thirds that of its lateral diameter.

Air-chambers regularly increasing in depth from the apex toward the chamber of habitation, varying in depth from five to nine mm. in the length of seventy-five mm. The last two chambers somewhat shallower than the preceding ones. Septa smooth, thin, deeply concave; their concavity greater than the depth of two air-chambers. Sutures curved forward over the lateral faces of the tube, but not oblique to the axis in their general direction.

Siphuncle small, moniliform, with a diameter in the cavities of the air-chambers of nearly four mm., where the tube has a ventro-dorsal diameter of thirty-eight mm.; distant from the ventral side about one-fourth the ventro-dorsal diameter.

Test and surface-markings unknown. The septate portion of the tube in the cast is marked by several obscure, transverse undulations of the shell, with a variable frequency and prominence.

The internal mould preserves the furrows of the crenulated band, continued over the walls of the air-chambers. Sutures but little impressed.

The specimen described, consisting of the chamber of habitation and fifteen attached air-chambers, has a length of 180 mm., and its greatest lateral diameter is nearly eighty mm.

This species is distinguished from the other species in the Upper Helderberg limestones by the position of the point of greatest gibbosity, apical angle, the size and characters of the chamber of habitation, and the position and dimensions of the siphuncle. It is considerably larger than the species described from the Schoharie grit. A slight resemblance is found with *G. lunatum*, of the Hamilton group; but that species has a marked arcuate tube, with a larger and submarginal siphuncle. *G. potens*, from the Chemung group, is similar in the

external form of the chambered portion, but the air-chambers are much deeper. From *G. Fischeri*, of the Hamilton group, this species differs in its point of greatest gibbosity, more rapidly contracting chamber of habitation, shallower air-chambers, and transverse section.

Formation and locality. In limestones of the Upper Helderberg group, at Delhi, Delaware county, O.

Gomphoceras Fischeri.

PLATE XLV, FIGS. 5, 6.

Gomphoceras (Apioceras) Fischeri, Hall. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 106. 1860.
" *Fischeri*, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 45. figs. 5, 6. 1876.

Shell large, fusiform, slightly curved; curvature exogastric. Transverse section circular. Tube regularly enlarging from near the apex to the point of greatest transverse section, which is posterior to the chamber of habitation, at the third or fourth septum; thence more gradually contracting to the aperture. Apical angle about 30°. Apex attenuate, and more curved than the remaining portion of the tube.

Chamber of habitation large; length a little less than the greatest transverse diameter; dorsal side nearly straight; ventral side sloping regularly to the aperture. The crenulated band, as shown in the cast, narrow, marked by strong ridges and intermediate furrows, which are carried over the walls of one or two of the last air-chambers, and may be obscurely traced over the internal mould of the entire chambered portion.

Aperture large, oval. Small aperture marked by a broad, gentle bend in the margin on the ventral side.

Air-chambers regular, gradually increasing in frequency toward the apex, varying in depth from four to eight mm. in the length of ninety mm.; the last one or two, at the base of the chamber of habitation, shallower than the preceding. Septa smooth and thin, so far as observed, and showing a considerable degree of concavity. Sutures straight and horizontal. The internal mould of the walls of the air-chambers is marked by a longitudinal carina along the line of the siphuncle and under the sinus in the surface-striæ.

Siphuncle ventral, internal; its characters have not been fully observed.

Test strong, having a thickness of two mm. over the chamber of habitation and larger part of the chambered portion. Surface marked by fine, irregular, lamellose lines of growth, and fine, regular, longitudinal striæ. The surface of the nacreous layer, as shown by the exfoliation of the epidermal layer, is preserved as imbricating, lamellose lines, with obscure longitudinal striæ. The ventral side is indicated by a broad, decided sinus in the surface-striæ.

The internal mould is characterized by the smooth chamber of habitation, the crenulated zone and the longitudinal carina, with traces of the crenulations extending over the walls of the air-chambers.

An individual, nearly entire, has a length of 180 mm., of which sixty mm. pertain to the chamber of habitation. It preserves about twenty-five air-chambers, and has a diameter of sixty-eight mm. at the point of greatest transverse section. Another larger individual, imperfect at the apex, and of the same proportions, has a length of 190 mm.

This species is distinguished by its long, fusiform shape, the position of the point of greatest transverse section, and its large aperture. It is not so rapidly expanding and gibbous as *G. eximium*, and is of smaller size. A specimen found in the drift in Michigan, and probably coming from the calcareous beds of the Hamilton group, in the northern part of the lower peninsula, cannot be distinguished from the species as occurring in the Goniatite limestone of the Marcellus shale. It is associated in New York with *G. solidum*, but in that species the chambered portion is conical and rapidly enlarging, and the point of greatest gibbosity is on the chamber of habitation, from which the slope of the sides to the aperture is sudden and rapid. In the Goniatite limestone the specimens are associated with *Goniatites Vanuxemi* and *Orthoceras Marcellense.*

Formation and localities. In the Goniatite limestone, at Manlius, Onondaga county, N. Y.; and in the glacial drift, at Ann Arbor, Mich.

Gomphoceras solidum, n. sp.

PLATE XCIII, FIG. 9.

Shell large, straight, biconical. Transverse section circular; longitudinal section sub-rhomboidal. The plane of greatest transverse section is through the chamber of habitation, distant from the last septum about one-fourth the length of the chamber. Tube expanding regularly to the point of greatest gibbosity, and rapidly and abruptly contracting to the aperture. Apical angle about 35°.

Chamber of habitation large; length somewhat less than the diameter of the tube at the last septum. The sides slope regularly and rapidly to the aperture. Crenulated band broad, marked by indistinct furrows and striæ, which are carried over the cast of the chamber walls.

Aperture large; not satisfactorily observed.

Air-chambers regular, having a depth of six mm., and showing no appreciable variation in the length of sixty mm. Septa and siphuncle not observed. Sutures straight and horizontal.

Test and surface-markings unknown.

The internal mould shows the general form of the shell, with the regular and frequent air-chambers.

The specimen figured, preserving the chamber of habitation and eleven air-chambers, has a length of 148 mm., and a diameter at the point of greatest gibbosity of ninety mm.

This species resembles *G. Fischeri*, with which it is associated, but is distinguished by its general form, the rapid contraction of the chamber of habitation, the point of greatest gibbosity, the character of the crenulations, and the depth of the air-chambers. In *G. abruptum* the apical angle is apparently much greater, and the comparative volumes of the septate portion and the chamber of habitation very different.

Formation and locality. In the Goniatite limestone of the Marcellus shale, at Manlius, N. Y.

Gomphoceras abruptum, n. sp.

PLATE XCIV, FIG. 1.

A compressed fragment, consisting of a portion of the grand chamber and the air-chambers, shows the following characters, some of which may be greatly obscured by its imperfect preservation:

Point of greatest transverse section at the base of the chamber of habitation, from which the tube rapidly contracts to the apex, giving to its septate portion a short, conical appearance.

Chamber of habitation large, with the sides sloping gradually to the aperture, and a gentle constriction around the middle.

The surface of the internal mould shows lamellose lines of growth.

The fragment has a length of 100 mm., and a greatest transverse diameter of seventy mm.

This species is distinguished from *G. solidum* by its short, conical, apical portion, and its more gradually contracting chamber of habitation, with the constriction of the tube near the middle of the chamber. The specimen is covered with a tubular, branching, parasitic Bryozoan, as shown in the figure given on plate 94.

Formation and locality. In the shales of the Hamilton group, near Cazenovia, N. Y.

Gomphoceras manes, n. sp.

PLATE—SUPPLEMENT.

Shell large, straight, fusiform. Point of greatest gibbosity at the base of the chamber of habitation, or on the last septum. Tube regularly and gradually enlarging to the point of greatest transverse diameter, and gradually contracting to the aperture.

Chamber of habitation large, with the sides sloping very gradually to the aperture.

Aperture large; margins entire. A slight bend in the margin probably indicates the small aperture or the ventral side.

Air-chambers regular, having a depth of about eleven mm. The sutures, in a compressed specimen, make a retral curve or sinus over one side of the tube.

Surface nearly smooth, showing faint striæ of growth.

The specimen described, which is much compressed, embraces the chamber of habitation, with about ten air-chambers, and has a length of 160 mm., and its greatest transverse diameter is eighty-five mm. About sixty-five mm. of the length pertain to the chamber of habitation. The transverse diameter was probably originally much less than it now measures, as the tube has been greatly disturbed by compression.

In its general form this species resembles *G. Fischeri*, but the point of greatest transverse diameter is different, and the tube tapers much more gradually toward the aperture and to the apex.

This species is the only one yet noticed as occurring in the Genesee slate; and from its association and other characters its occurrence furnishes several additional facts as to the fauna of this small division of the Hamilton group, which is a bed of passage from the main formation to the shales of the Portage group above. The specimen described, as preserved in the black carbonaceous shale, is extremely compressed, and shows little more than the general outline, the margins of the aperture, and the suture lines marking the depth of the air-chambers. It is associated with the widely distributed *Styliola fissurella* and other small forms of Pteropoda and Gasteropoda.

Formation and locality. In the dark carbonaceous beds of the Genesee slate, south of Alden, Erie county, N. Y.

Gomphoceras poculum, n. sp.

PLATE XCIII, FIGS. 7, 8.

Shell large, straight. Point of greatest transverse diameter at the base of the chamber of habitation. Tube rapidly expanding, with the sides convex. Apical angle, in a compressed specimen, about 40°.

The base of the chamber of habitation only, has been observed, and pos-

sesses no distinctive features. Crenulated band having a width equal to the distance between the septa, and marked by broad, shallow furrows, which are continued over the cast of the walls of the air-chambers.

Aperture unknown.

Air-chambers regular, with a depth of about seven mm., the last one being somewhat shallower than the preceding. Septa smooth and deeply concave, so far as noticed. Sutures straight and horizontal, but little impressed upon the internal mould.

Siphuncle submarginal, moniliform, exposed in the process of weathering; expanding in the cavities of the air-chambers to twice its diameter at the septa, being nearly equal to the depth of the air-chambers.

Test and surface-markings unknown.

Internal mould essentially smooth, with the exception of the crenulations, which are continued over the walls of the chambers.

The specimen described, embracing a small portion of the grand chamber and eight attached air-chambers, has a length of ninety mm., of which twenty-eight mm. pertain to the outer chamber.

This species is distinguished by its short, rapidly enlarging tube, the characters of the crenulations, and the position and elements of the siphuncle. The example figured, as preserved in the shales, is considerably compressed, but the characters of the internal mould, the siphuncle and crenulations are distinctly retained.

Formation and locality. In the shales of the Hamilton group, near Cazenovia, N. Y.

Gomphoceras lunatum, n. sp.

PLATE XCV, FIGS. 10-13.

Shell large, regularly arcuate, exogastric. Transverse section broadly oval; lateral diameter the longer, and in the ratio of 4 to 3 to the ventro-dorsal diameter. Longitudinal section lunate, with the point of greatest transverse section posterior to the middle of the chamber of habitation. Tube regularly

enlarging, with the dorsal side concave, and the ventral and lateral faces convex. Apical angle about 25°. The apical portion is rather more attenuate than the succeeding part of the tube, on account of the sides of the tube being concave for a short distance.

Chamber of habitation large, gibbous, having a length equal to the ventro-dorsal diameter of the tube at the last septum, or apparently nearly one-fourth of the entire length of the shell. Dorsal side nearly straight, and parallel to the longitudinal axis. Ventral side very convex, and sloping rapidly to the aperture. Crenulated zone not distinctly marked, but indicated by irregular, obscure furrows, which are continued over the cast of the walls of the air-chambers.

Aperture slightly expanded, large, oval, having a width of more than the greatest ventro-dorsal diameter of the tube. Small aperture present, but not fully observed.

Air-chambers regularly increasing in depth from the apex to the grand chamber, varying from six to eight mm. in the length of fifty-five mm. The chambers are somewhat shallower on the dorsal side, owing to the curvature of the tube. Septa thin, smooth, having a concavity greater than the depth of the air-chambers. Sutures straight and horizontal.

Siphuncle moniliform, near to the ventral side, abruptly expanding in the cavities of the air-chambers to a diameter equal to twice its diameter at the septa, or equal to the depth of the chambers, which is about one-sixth the diameter of the tube. The abrupt expansion of the siphuncular tube produces a small areola on the septa, on account of its contact with the surface. Near the apex the distance from the centre of the siphuncle to the chamber walls is four mm. Toward the outer chamber it gradually becomes more distant from the septal margins, and at the last septum is nine mm. from the exterior walls of the tube.

The test has a thickness of about 1.5 mm. on the chamber of habitation. The surface of the nacreous layer is marked by very fine, longitudinal striæ and irregular, concentric lines. The surface of the epidermal layer shows fine, lamellose lines of growth, and indistinct longitudinal striæ. Both layers

retain the sinus in the striæ marking the ventral side. On the inner surface the sinus is very sharp and abrupt. The exterior striæ are bent in a rounded, but distinct sinus, which is much broader than on the interior.

The internal mould is essentially smooth, showing a slight, longitudinal furrow on the ventrum over the siphuncle, and traces of the crenulations, as continued over the walls of the air-chambers.

The specimen described is nearly entire, preserving the chamber of habitation and twenty-two air-chambers, and has a length of about 160 mm., with a greatest lateral diameter of sixty mm.

This species is distinguished by the curvature of the tube, the characters of the chamber of habitation, and the surface ornaments. It somewhat resembles *G. Fischeri*, but the curvature is much greater, and the point of greatest transverse diameter different. In several of its characters it agrees with *G. cammarus*, but is distinguished by its smaller size, the position of the point of greatest gibbosity, and less marked crenulations. This species shows a greater amount of arcuation of the tube than is exhibited in any of the forms of this genus here noticed. As preserved in the calcareous and pyritiferous septaria occurring in the soft shales, the specimen retains its form and structural details in a very satisfactory condition. It belongs to an assemblage of species in the Hamilton group, characterized by their robust form and large size, and includes *G. Fischeri*, *G. solidum*, *G. abruptum*, *G. manes*, *G. poculum* and *G. lunatum*. The species following, belonging to this formation, are for the most part small, slender and ovoid forms.

Formation and locality. In the shales of the Hamilton group, at Hamburg, Erie county, N. Y.

Gomphoceras oviforme.

PLATES XLV, FIGS. 1-4; XLVI, FIGS. 6, 7; XCIV, FIGS. 6, 7.

Gomphoceras (Apioceras) oviforme, Hall. Thirteenth Rep N. Y. State Cab. Nat. Hist., p. 105. 1860.
" *oviforme*, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 45, figs. 1, 2. 1876.
Cyrtoceras? gibbosum, " Illustrations of Devonian Fossils: Cephalopoda, pl. 47, figs. 3, 4. 1876.

Shell small, ovoid, or subglobose, gibbous, straight, exogastric. Transverse section very broadly oval to subcircular. Longitudinal section regularly ovate, sometimes attenuate at the apex. Plane of greatest transverse section at the last septum. Tube rapidly enlarging from the apex, with the sides concave for a short distance, and becoming convex over the greater portion of the tube. Apical angle about 60°. Apex, when present, attenuate, acute. Some of the specimens show a subsequent truncation of the apex: the transverse striæ lose their character, and the test is pitted or roughened. This offers an explanation of the adhering matrix around the apex of many of the specimens.

Chamber of habitation comparatively large, having a length of from nearly one-half to one-third the entire length of the shell, or about two-thirds the greatest transverse diameter. Dorsal side more convex than the ventral, and rapidly sloping to the aperture. The crenulated band forms a very narrow fossa around the base of the chamber of habitation; and shows flat, shallow furrows continued over the grand chamber, and obscurely over the walls of the air-chambers.

Aperture large, trilobate, width equal to three-fourths the greatest transverse diameter of the tube, or one-fourth more than the length of the entire aperture. Minor aperture small, semi-circular, with a diameter of one-fifth the major diameter of the large aperture. Large aperture elliptical, and with its longer diameter equal to twice the length of the shorter diameter. In the small specimens the whole aperture is comparatively smaller, and marked by a variable constriction of the tube near the margin on the chamber of habitation.

Air-chambers regular near the chamber of habitation, except the last,

which is shallower than the preceding. The preceding four or five chambers have a depth of five mm. each: beyond these the tube contracts very rapidly to the apex, and their depth has not been observed. In the shorter and more globose individuals the chambers have a depth of three mm., and the tube contracts abruptly from the second or third chamber posterior to the chamber of habitation. Septa thin and smooth, so far as observed; moderately concave. Sutures straight and horizontal.

Siphuncle near the ventral side, with a diameter of two mm at the last septum.

Test strong, having a thickness of 1.5 mm. over the chamber of habitation. Surface marked by fine, irregular, lamellose lines of growth. The surface and structure of the inner or nacreous layer is characterized by indistinct lines of growth, crossed by fine, longitudinal striæ. At nearly regular intervals of six to nine striæ, one of the lines is larger and stronger than the intermediate striæ, giving the tube a furrowed appearance. The sinus in the lines of growth over the ventral side corresponds in size and position to the small aperture, but is not quite so abrupt.

Internal mould smooth, with the suture-lines well marked.

The largest individual observed has a length of fifty-eight mm., of which twenty-five mm. pertain to the chamber of habitation, at the base of which it has its greatest transverse diameter of forty mm. Five air-chambers are shown before the truncation of the tube commences, which has obscured the preceding chambers. Many of the specimens, having a transverse diameter nearly as large as in the preceding, contract very rapidly from a point immediately at the base of the grand chamber, giving them a gibbous or subglobose form.

This species is distinguished by its ovoid form and the characters of the aperture. It somewhat resembles *G. pingue* and *G. raphanus*. It differs from *G. pingue* in the more rapidly expanded septate portion, and the position of the plane of greatest transverse section. *G. raphanus* has a more slender tube, and is less gibbous on the chamber of habitation.

This form is especially interesting as furnishing the only positive evidence of

a truncation of the apex among the species here described. The absorption or cicatrizing of the apical portion of the tube evidently occurred after the individuals had reached a mature development. The small examples all show the attenuate apex, which, in the larger specimens, is rounded, and preserves a distinctive difference in the external markings of the test. The specimen previously indicated as *C. gibbosum* is a small, gibbous individual, with the exterior layer of the test partially exfoliated, and should evidently be included in the present species. Other specimens have been observed, which present the transitions in form to the large subcylindrical specimen represented in fig. 2, pl. 45.

Formation and localities. In the Goniatite limestone of the Marcellus shale, at Schoharie, and near Manlius, N. Y.

Gomphoceras pingue, n. sp.

PLATES XCIV, FIG. 9; XCV, FIG. 6.

Shell small, gibbous, slightly arcuate. Transverse section very broadly oval or subcircular. Point of greatest gibbosity posterior to the middle of the chamber of habitation. Apical angle about 30°.

Chamber of habitation gibbous, with the sides convex, and sloping gradually to the aperture. Crenulated band not well defined, but the markings are preserved over the cast of the walls of the air-chambers as broad, shallow, longitudinal furrows.

Aperture unknown.

Air-chambers regular, having a depth of about four mm. Septa smooth, moderately concave. Sutures, in uncompressed specimens, straight and horizontal. Siphuncle not observed.

Test and surface-markings unknown. Internal mould smooth, with the exception of the crenulations over the walls of the air-chambers. Sutures but slightly impressed.

A fragment embracing a portion of the chamber of habitation, with five attached air-chambers, has a length of fifty mm., of which about thirty mm. pertain to the grand chamber, which has a greatest transverse diameter of forty mm.

This species resembles *G. oviforme*, but is distinguished by its curved tube, apparently larger aperture, the position of the plane of greatest transverse section, and the rapid slope of the sides of the chamber of habitation to the comparatively small aperture. The same differences distinguish the *G. raphanus*.

Formation and locality. In the shales of the Hamilton group near Cazenovia, Madison county, N. Y.

Gomphoceras raphanus, n. sp.

PLATE XCIV, FIGS. 2-5, 10.

Shell small, straight, slender, exogastric. Transverse section subcircular or very broadly oval. Longitudinal section fusiform. Plane of greatest transverse section at the base of the chamber of habitation. Apical angle about 28°. Apex acute.

Chamber of habitation small; length less than the diameter of the tube at the base. Sides convex, and sloping rapidly to the aperture. Crenulated zone narrow, and marked by obscure furrows, which are carried over the walls of the air-chambers.

Aperture, as observed in a specimen much flattened from compression, large, having a width equal to that of the grand chamber, or to twice the length of the entire aperture. The minor aperture is marked by a small, semicircular sinus from the ventral margin of the large aperture.

Air-chambers regular, showing but slight variation from near the outer chamber to the apex, and having a depth of from four to five mm.; the last one or more, at the base of the chamber of habitation, usually shallower than the preceding.

Septa smooth, thin, slightly concave, the concavity not amounting to the depth of one air-chamber. A small areola around the siphuncle indicates its abrupt expansion in the cavities of the air-chambers. Sutures straight and horizontal.

Siphuncle near the ventral side, small, nummuloid, with a diameter at the septa of less than one-half the diameter at the expanded portions.

Test thin, having a thickness of .35 mm. Surface marked by fine, concentric lines of growth, crossed by indistinct, longitudinal ridges.

A specimen, preserving a portion of the chamber of habitation, with twelve air-chambers, has a length of fifty-five mm., of which twenty mm. pertain to the outer chamber.

This species somewhat resembles *G. tumidum*, but may be distinguished by the position of the plane of greatest transverse section, and the less tapering apical portion of the tube. In general form and size it is related to *G. Conradi*, but in the latter species the endogastric curvature, the point of greatest gibbosity, and the crenulations at the base of the chamber of habitation are very distinctive. The specimens, as occurring in the soft carbonaceous shales and in the coarser beds, present slight differences, which appear to be due principally to the mode and condition of preservation.

Formation and localities. In the shales of the Hamilton group, at Pratt's Falls, Onondaga county, and Cazenovia, Madison county, N. Y.

Gomphoceras Conradi.

PLATE XLVI, FIGS. 1-3.

Gomphoceras (Apioceras) Conradi. Hall. Thirteenth Rep. N. Y. State Cab. Nat Hist., p. 106. 1860.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., pl. 8, fig. 8. 1862.
Cyrtoceras Conradi. Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 47, figs. 1, 2, 11. 1876.

Shell small, clavate, nearly straight, curvature of the dorsal side rather more than the ventral, making the curvature endogastric. From the slope of the sides of the chamber of habitation, the indication is that of an exogastric curvature. Transverse section broadly oval, slightly flattened on the dorsal side. Tube enlarging gradually from the apex to a point nearly on the centre of the chamber of habitation, thence contracting gradually to the aperture. Apical angle about 20°. Apex acute.

The length of the chamber of habitation is nearly equal to the lateral diameter of the tube at the last septum. Ventral side more convex than the dorsal; both sides slope gradually to the aperture, and show a flattened area extending from the base midway to the aperture. Tube marked by a slight

but sudden constriction, distant from the aperture about one-third the length of the grand chamber. Crenulated zone forming a narrow, deep fossa at the base of the outer chamber, marked by sharp furrows, which are continued more obscurely over the posterior half of the chamber, becoming more crowded and extended on the flattened portions of the dorsal and ventral sides.

Aperture large, trilobate, with one lobe considerably smaller than the other two; length equal to five-sixths of the width. Small aperture constituting the lesser lobe, longitudinally semi-oval, having a length of one-third the greater diameter of the large aperture. Large aperture elliptical, lateral diameter twice the length of the ventro-dorsal diameter.

Air-chambers regular, having a depth of three mm., with the last one somewhat shallower. Septa smooth, with a concavity nearly equal to the depth of two chambers. Sutures straight and horizontal.

Siphuncle small, near the ventral side, having a diameter of one mm. at the septa, where the tube measures fifteen mm. in a ventro-dorsal direction; not observed in the cavities of the air-chambers.

The test has a thickness of .75 mm. Surface marked by lamellose lines of growth and fine, rounded, longitudinal striæ.

The length of the chamber of habitation, in the largest fragment observed, is twenty-two mm., with a lateral diameter at the base of twenty mm. A small individual, nearly entire, has a length of thirty-two mm., of which fourteen mm. pertain to the chamber of habitation.

This species bears considerable resemblance to *G. clavatum* of the Schoharie grit, in the curvature of the tube, the position of the siphuncle, the characters of the chamber of habitation, and the depth of the air-chambers, but is distinguished by its larger aperture, smaller size, and the position of the plane of greatest transverse section. In the size of the shell this species is included in a group of small forms, to which belong *G. beta*, *G. absens* and *G. clavatum*. Two of these are endogastric in curvature, and two exogastric.

Formation and localities. In the Goniatite limestone of the Marcellus shale, near Schoharie, and at Manlius, N. Y.

Gomphoceras Ajax, n. sp.

PLATE XCIV, FIG. 8.

This species is recognized from a large fragment, consisting of a portion of the chamber of habitation, with several attached air-chambers, possessing the following characters:

Transverse section broadly oval. Point of greatest gibbosity near the base of the chamber of habitation. The curvature of the tube, as indicated, is exogastric.

Chamber of habitation large, with the sides sloping gradually to the aperture. Crenulated zone narrow, and marked by indistinct furrows and fine, rounded striæ, which are continued over the cast of the walls of the air-chambers.

Air-chambers regular, having a depth of about eight mm. Septa thin, smooth, with a concavity equal to the depth of the chambers. Sutures straight, slightly oblique.

Siphuncle near the ventral side, apparently submarginal, marked by a distinct longitudinal ridge along the internal mould of the chamber walls.

The fragment has a length of about eighty mm., of which fifty mm. pertain to the chamber of habitation. The greatest lateral diameter is eighty-five mm., and the greatest ventro-dorsal diameter is sixty-eight mm.

This species is distinguished from *G. Fischeri* by the position of the plane of greatest transverse section, and more gradual contraction of the tube toward the aperture. It more nearly resembles *G. lunatum*, but differs in the position of the siphuncle and the oblique, septal sutures. So far as known, this species is the only one from the Portage group. It differs conspicuously from *G. potens*, of the Chemung, by its much shallower air-chambers.

Formation and locality. In the shales of the Portage group, at Penn Yan, Yates county, N. Y.

Gomphoceras tumidum, n. sp.

PLATES XCIII, FIG. 6; XCV, FIGS. 2, 3, 4, 5, 7.

Shell subglobose, attenuate at the apex. Point of greatest transverse section on the chamber of habitation, posterior to the middle. Tube expanding gradually at the apex, with the sides concave, becoming convex and rapidly inflating over the chamber of habitation.

Chamber of habitation large, ventricose, with the sides convex, and sloping rapidly to the aperture.

Air-chambers regular, increasing in depth from the apex, varying from two to three mm. in the length of thirty mm. Sutures straight and horizontal.

Surface marked by fine striæ of growth.

Internal mould smooth, with the sutures slightly impressed.

A much compressed specimen, consisting of the chamber of habitation and about sixteen attached air-chambers, has a length of seventy mm., of which twenty-five mm. pertain to the grand chamber. The greatest transverse diameter, in its compressed condition, is forty-five mm.

This species is distinguished from *G. oviforme* in the position of the plane of greatest transverse section, the absence of marked crenulations, and the inflated appearance of the greater portion of the tube, with its attenuate apex.

Formation and localities. In the shales of the Chemung group, near Ithaca, and in the calcareous beds of the upper members of the group, at New Albion, Cattaraugus county, N. Y.

Gomphoceras potens, n. sp.

PLATE—SUPPLEMENT.

Shell large, clavate, robust, exogastric. Dorsal side nearly straight. Ventral side convex. Transverse section broadly oval. Tube regularly and gradually enlarging from the apex. Apical angle 27°.

Chamber of habitation, aperture, test and surface-markings unknown.

Air-chambers deep, regularly increasing in depth toward the outer cham-

ber, varying from ten to fifteen mm. in the length of ninety-five mm. The walls of the cast are smooth and flat, with the exception of an indistinct, longitudinal carina, marking the position of the siphuncle and the ventral side. Septa smooth, deeply concave. Sutures straight and horizontal, but little impressed on the internal mould.

Siphuncle moniliform. Its exact position and characters have not been determined, owing to the compression of the apical portion.

Internal mould essentially smooth.

The specimen described is a large fragment of the chambered portion, embracing about ten air-chambers, and has a length of 120 mm., with a lateral diameter at the larger extremity of eighty mm.

This species is distinguished by its size, apical angle, and the great depth of the air-chambers, which features remove it from any of the species described in this volume. In *G. eximium* of the Upper Helderberg group the air-chambers have a corresponding depth, but the shell is much more gibbous and rapidly enlarging from the apex.

Formation and locality. In the sandstones of the Waverly group, at Medina, Medina county, O.

Gomphoceras (?) planum, n. sp.

PLATE LVII, FIG. 2.

Shell large, straight, exogastric. Transverse section elliptical,—the diameters in the ration of three to four. Tube regularly and rapidly enlarging. Apical angle about 30°.

Air-chambers regular, having a depth of 6 mm. Sepa smooth, with a slight concavity. Sutures straight and horizontal.

Siphuncle small, near the ventral side, having a diameter of two and one-half mm. at the septa, where the tube has a lateral diameter of forty mm. A small areola around its insertion in the septa indicates the expansion of the tube in the cavities of the air-chambers.

Internal mould smooth.

The specimen figured has a length of forty-seven mm. and embraces eight air-chambers.

This species is distinguished by its transverse section, apical angle, and the smooth internal mould. It is described from a fragment of the chambered portion, and is referred to this genus on account of the large apical angle, and the elliptical transverse section.

Formation and locality. In the shales of the Hamilton group, on the shore of Seneca lake, N. Y.

In the genus GOMPHOCERAS, as in ORTHOCERAS, the actual number of species described from the Chemung group bears a small proportion to the number of forms indicated by numerous fragments, which are too incomplete and imperfect to admit of specific distinction. The upper members of this group are characterized by a very distinct fauna, compared with that of the lower beds, and are intimately connected with the succeeding formations. In the Waverly group several forms have been observed belonging to this genus, together with ORTHOCERAS; but the present collections from this group are too meager to furnish satisfactory results. The collections from the Upper Chemung are also, comparatively, very limited. A complete knowledge of the Cephalopodous life of the Upper Devonian system, and of the beds of transition to the higher formations, can only be obtained by the study of larger collections than have yet been made; and any generalizations at this time would be premature.

CYRTOCERAS, Goldfuss. 1832.

A glance at the following historical sketch will show the proportion of the species which have already undergone changes in generic reference, and the inclusion of forms in the genus Cyrtoceras possessing the most unlike characters. This has arisen from the recognition of genera which have as yet no recognized defined limits beyond the individual opinions of the various authors. Another source of constant confusion is the poverty of the material, which, so long as it continues, must render a satisfactory determination and arrangement of all the species impossible.

One cause for the uncertain and unsatisfactory reference of species, in this country, during former years, has been the want of books for reference, and of collections for comparison. Every author has been compelled to rely upon such information as lay within his reach; and this was often of the most incomplete and fragmentary character. There existed, also, a preconceived opinion, from earlier teachings, that the genus Nautilus did not exist in Palæozoic formations; and owing to this impression, such forms as *Cyrtoceras maximus*, Conrad, and *Gyroceras Burlingtonensis*, Owen, were referred to these genera, while they have all the characteristics of genuine Nautilus, to which they are now referred. From a similar misapprehension, or preconceived opinion, the generic term Lituites has been applied to forms not very dissimilar from those just named, and which have all the features of true Nautilus; while others, arranged under the same generic term, belong to the genus Gyroceras, as generally accepted.

The species here described, and indicated below, are placed provisionally and with some degree of reservation under this genus. At the present time, and with the information at hand, no satisfactory generic separation can be made. In the following arrangement, those species preceding *C. eugenium*, viz., *C. metula*, *C. formosum*, *C. densum*, *C. Hector*, *C. liratum*, *C. alternatum* and *C. morsum*, form a heterogeneous group without natural interrelations, and without any special connection with the species following.

HISTORICAL SKETCH.

The genus CYRTOCERAS was first recognized in America by Mr. T. A. CONRAD, who, in 1838, described *Cyrtoceras maximus* [=*Nautilus maximus*], from the Hamilton group (*Geolog. Surv. of N. Y.: Pal. Dept., Annual Report*).

In 1840 [1844] Dr. D. D. OWEN described *C. conicum*, from the upper Magnesian limestone =Galena limestone (*Report on the Geological Explorations of Parts of Iowa, Wisconsin, and Illinois*).

Mr. CONRAD described *C. trivolvis* [=*Gyroceras trivolve*] and *C. Matheri* [=*Gyroceras Matheri*], from the Upper Helderberg group (*Geolog. Surv. of N. Y.: Pal. Dept., Annual Report*).

In 1842 Mr. E. EMMONS published *C. filosum* and *Orthoceras Trentonensis* [=*Cyrtoceras Trentonense*], from the Trenton limestone (*Geolog. Surv. of N. Y.: Rep. Second Dist.*).

In 1843 Mr. CONRAD described *C. marginale* (not *C. marginale*, PHILLIPS), (*Proc. Acad. Nat. Sci. Phila.*, vol. 1).

Mr. LARDNER VANUXEM described *C. undulatum* [=*Gyroceras undulatum*], from the Upper Helderberg limestone (*Geolog. Surv. of N. Y.: Rep. Third Dist.*).

In 1847 JAMES HALL described *C. annulatum* (not *C. annulatum*, GOLDFUSS, 1832) [=*C. subannulatum*, D'ORB., 1850], *C. macrostomum* and *C. multicameratum*, from the Black-river and Trenton groups; and *C. arcuatum* (not *C. arcuatum*, STEININGER, 1830) [=*C. subarcuatum*, D'ORB., 1850], *C. camurum*, *C. constrictostriatum* and *C. lamellosum* (not *C. lamellosum*, D'ARCH. and DE VERN, 1842) [=*C. Hallanum*, D'ORB., 1850], from the Trenton group (*Palæontology of New York*, vol. 1).

In 1852 J. HALL described *C. arcticameratum*, from the Guelph group, and *C. cancellatum* (not *C. cancellatum*, RŒMER, 1844) [=*C. subcancellatum*, HALL, 1877], from the Niagara group (*Palæontology of New York*, vol. 2).

In 1857 Mr. E. BILLINGS described *C. falx*, *C. regulare* and *C. simplex*, from the Black-river and Trenton groups; *C. sinuatum*, from the Black-river group; and *C. subturbinatum*, from the Chazy and Black-river groups (*Geolog. Survey of Canada: Report of Progress*).

In 1858 Prof. G. C. SWALLOW described *C. dorsatum*, from the Permian system (*Trans. St. Louis Acad. Sci.*, vol. 1).

In 1859 Mr. J. W. Salter described *C. Billingsi*, from the Chazy and Black-river groups (*Canadian Organic Remains*, Decade 1).

Mr. Billings described *C. Maccoyi*, from the Chazy group (*Canadian Naturalist and Geologist*, vol. 4).

J. Hall described *C. subrectum*, from the Lower Helderberg group (*Palæontology of New York*, vol. 3).

In 1860 Messrs. F. B. Meek and H. A. Worthen described *C. curtum* and *C. dilatatum*, from the upper Coal Measures (*Proc. Acad. Nat. Sci. Phila.*).

Mr. Billings described *C. exiguum*, from the Trenton group (*Canadian Naturalist and Geologist*, vol. 5).

Mr. J. H. McChesney described *C. giganteum* [=*Nautilus cancellatus*, McC., 1861], from the Niagara group (*New Palæozoic Fossils*).

In 1861 J. Hall described *C. eugium* and *C. Neleus*, from the Chazy and Black-river groups; *C. loculosum*, from the Niagara group; *C. Whitneyi*, from the Hudson-river group; and *C. Dardanus*, *C. Fosteri* and *C. Orcas* (subsequently referred to *Oncoceras*=*Cyrtoceras?*), from the Niagara group of Wisconsin (*Geolog. Survey of Wisconsin: Report of Progress*).

In 1862 J. Hall described *C. corniculum* (not *C. corniculum*, Barrande, 1848) [=*C. tenuistriatum*, Hall, 1877], from the Trenton group (*Rep. Geolog. Surv. of Wis.*, vol. 1); *C. eugenium*, *C. Jason*, *C. metula* and *C. morsum*, from the Upper Helderberg group; and *C. liratum*, from the Hamilton group (*Fifteenth Rep. N. Y. State Cab. Nat. Hist.*).

Mr. Billings described *C. Lysander*, from the Hudson-river group, and *C. Orodes*, from the Guelph group (*Palæozoic Fossils*, vol. 1).

Mr. A. Winchell described *C. unicorne*, from the Chemung group (*Proc. Acad. Nat. Sci. Phila.*).

In 1865 Mr. Billings described *C. Alethes*, *C. Aristides*, *C. Dictys*, *C. Metellus*, *C. Missisquoi* and *C. Syphax*, from the Quebec group; *C. Huronense* and *C. Isidorus*, from the Black-river and Trenton groups; *C. Juvenalis*, from the Trenton group; *C. Orestes*, from the Niagara group; and *C. Postumius*, from the Hudson-river group (*Palæozoic Fossils*, vol. 1).

Messrs. A. Winchell and O. Marcy described *Lituites Hercules*, from the

Niagara group (*Mem. Bost. Soc. Nat. Hist.*, vol. 1). [Referred to *Cyrtoceras:* S. A. Miller, *Catalogue of Palæozoic Fossils*, 1877.]

Mr. Winchell described *C. Rockfordense*, from the Kinderhook group (*Proc. Acad. Nat. Sci. Phila.*).

In 1866 Mr. Billings described *C. Clitus*, *C. Corydon* and *C. fragile*, from the Anticosti and Niagara groups (*Cat. Silur. Foss. Anticosti*).

Messrs. Meek and Worthen described *C. sacculus* [=*Gomphoceras sacculum*], from the Hamilton group (*Proc. Acad. Nat. Sci. Phila.*).

In 1867 J. Hall described *C. amplicorne*, *C. brevicorne*, *C. laterale*, *C. Lucillus*, *C. pusillum* and *C. rigidum*, from the Niagara group of Wisconsin (*Twentieth Rep. N. Y. State Cab. Nat. Hist.*).

In 1869 Mr. J. M. Safford described *C. Bondi* and *C. Massiense*, from the Nashville group, and *C. Stonense*, from the Trenton group (*Geology of Tennessee*).

M. J. Barrande described *C. surgens*, from the Quebec group of Canada (*Syst. Silur. du centre de la Bohême*).

In 1871 Mr. Meek described *C. Ohioense*, from the Corniferous group (*Proc. Acad. Nat. Sci. Phila.*).

In 1874 Mr. S. A. Miller described *C. Vallandighami*, from the Hudson-river group (*Cin. Quart. Journ. Sci.*).

In 1875 Mr. Worthen described *C. Carrollense*, from the Galena group (*Geolog. Surv. of Illinois*, vol. 6).

Messrs. Hall and Whitfield described *C. Hertzeri* and *C. Myrice*, from the Niagara group of Ohio (*Geolog. Surv. of Ohio: Pal.*, vol. 2).

Mr. Billings described *C. Ligarius*, from the Hudson-river group (*Palæozoic Fossils*, vol. 2).

Mr. S. A. Miller described *C. magister* and *C. ventricosum*, from the Hudson-river group (*Cin. Quart. Journ. Sci.*, vol. 2).

In 1876 J. Hall illustrated *C. absens* [=*Gomphoceras absens*], *C. clavatum* [=*Gomphoceras clavatum*] and *C. Orion* [=*Trochoceras Orion*], from the Upper Helderberg group; *C. undulatum* [=*C. alternatum*] and *C. gibbosum* [=*Gomphoceras oviforme*], from the Hamilton group (*Illus. Devon. Fossils*).

Mr. C. A. White described *C. dictyum*, from the Devonian system (*Proc. Acad. Nat. Sci. Phila.*).

GYROCERAS, De Koninck. 1841.

This genus has been variously constituted and defined by different authors to include forms showing a greater curvature of the tube than in typical forms of Cyrtoceras, and without the contiguity of the volutions, as in the genus Nautilus. With these characters as a basis, it has been made the receptacle of numerous unlike species, agreeing only in the amount of curvature. The original types of the genus have little resemblance to the species described by other authors, and have since been removed to form the type of another distinct genus. The very thorough and complete digest of the allied genera by M. Barrande does not appear to have furnished such information as can be satisfactorily applied to the determination of the relations of the species here described.

HISTORICAL SKETCH.

The first recognition in America of the genus Gyroceras, as defined and established by De Koninck, was in 1844, by Dr. D. D. Owen, in his *Report of a Geological Exploration of Parts of Iowa, Wisconsin and Illinois*;* where he described the species *Gyroceras cornutum*, from the Devonian system of Iowa.

In 1840 Mr. T. A. Conrad described *Phragmoceras spinosum* [=*G. spinosum*], *Cyrtoceras Matheri* and *Cyrtoceras trivolve* [=*Gyroceras*], from the Upper Helderberg group (*Ann. Rep. Geolog. Surv. of N. Y.: Pal. Dept.*).

In 1843 Mr. L. Vanuxem described *Cyrtoceras undulatum*, from the Upper Helderberg group (*Geolog. Surv. of N. Y.: Rep. Fourth Dist.*).

In 1852 Dr. Owen described *G. Burlingtonense* [=*Nautilus*], from the Lower Carboniferous system (*Geolog. Rep. of Wisconsin, Iowa and Minn.*).

In 1853 Dr. Saeman described *G. expansum* [=*Nautilus bucinum*] (*Dunker and von Meyer: Palæontographica*, vol. 1).

In 1857 Mr. E. Billings described *G. Americanus*, from the Upper Silurian system; *G. magnificum* [=*Lituites magnificum*], from the Hudson-river group; and *G. vagans*, from the Black-river group (*Geolog. Surv. of Canada: Rep. of Progr.*).

* Bearing the date of 1840, although revised and first published in 1844.

In 1860 J. HALL described *G. gracile*, from the Goniatite limestone of Indiana; *G. liratum* [=*Nautilus liratum*] and *Cyrtoceras transversum*, from the Goniatite limestone of the Marcellus shale (*Thirteenth Rep. N. Y. State Cab. Nat. Hist.*).

In 1861 J. HALL described *G. Cyclops*, *G. Eryx*, *G. Nereus*, *Cyrtoceras eugenium* and *C. Jason*, from the Upper Helderberg group; and *Gyroceras Nais* [=*Porcellia Nais*], from the Chemung group (*Descriptions of New Species of Fossils*). The same species were republished in the *Fifteenth Rep. N. Y. State Cab. Nat. Hist.* in 1862.

In 1862 Mr. RICHARD OWEN described *G. rhombolineare* [=*Trochoceras*], from the Silurian system of Indiana (*Geological Reconnoisance of Indiana*, page 36).

In 1865 Messrs. WINCHELL and MARCY described *G. Bannisteri* [=*Trochoceras Bannisteri*], from the Niagara group (*Mem. Bost. Soc. Nat. Hist.*).

In 1866 Messrs. MEEK and WORTHEN described *Nautilus* (*Cryptoceras*) *Rockfordensis*, from the Kinderhook group (*Proc. Acad. Nat. Sci. Phila.*). In 1868 the authors referred this species to the genus GYROCERAS? (*Geolog. Surv. Illinois*, vol. 3).

In 1868 Mr. J. W. DAWSON described *G. Hartti*, from the Carboniferous system (*Acadian Geology*).

Mr. F. B. MEEK described *G. Logani*, from the Devonian system (*Trans. Chicago Acad. Sci.*).

MEEK and WORTHEN described *G? constrictum*, from the Hamilton group (*Geolog. Survey of Illinois*, vol. 3).

In 1871 Mr. MEEK described *G. inelegans* [=*Nautilus*] and *G. Ohioensis* [=*Nautilus*], from the Upper Helderberg group (*Proc. Acad. Nat. Sci. Phila.*).

In 1876 J. HALL described *G. paucinodum* and *G. validum*, from the Upper Helderberg group, and *G. subliratum* [=*Nautilus subliratum*], from the Hamilton group (*Illustrations of Devonian Fossils*).

In 1879 J. HALL described *G. abruptum*, from the Niagara group of Indiana (*Trans. Alb. Inst.*, vol. 10).

The historical notices and remarks on these genera are introduced here to facilitate a comparison, and to avoid separating species which must unavoidably appear in the consideration of either genus. The well-defined species

previously considered as undoubted CYRTOCERAS, beginning with *C. alternatum*, *C. eugenium* and *C citum*, together with *Gyroceras Nereus*, *G. trivolve*, *G. laciniosum*, *G. Matheri*, *G. paucinodum* and *G. undulatum*, constitute a series of similar forms with a regular gradation of form and curvature, from a nearly straight tube to one with several closely coiled volutions. A second group of stouter forms, beginning with *Cyrtoceras Jason*, and ending with *Gyroceras Cyclops*, present a similar gradation of curvature. That the genus GYROCERAS or CYRTOCERAS must include such forms as *Cyrtoceras* (*Gyroceras*) *eugenium* and the following species, is evident from the close relations existing between them, and the regular gradations of form and curvature, reaching the maximum in *Gyroceras undulatum* and *G. Cyclops*. Any generic separation of these forms, based on the amount of curvature of the tube, overlooks the features which constitute the more prominent characters, and unite the species in a single natural group.

In the Silurian formations the reference of the species to CYRTOCERAS is easily made; but when the forms considered as GYROCERAS are gradually developed in the Devonian formations, the limits of the genera are not clearly defined. If the latter genus is to be recognized in this country, it must certainly include such forms as *Gyroceras Cyclops* and *G. undulatum*, which are not generically removed from *Cyrtoceras Jason* and *C. eugenium*.

In the notice which is intended to supplement this volume an attempt will be made to furnish some satisfactory generic distinctions, and to arrange the species with regard to their natural dependence and interrelations.

CYRTOCERAS (GOMPHOCERAS) METULA.

PLATES XLVII, FIGS. 1, 2; CXIV, FIG. 11.

Cyrtoceras metula, HALL. Descriptions of New Species of Fossils, etc., p. 44. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 72, pl. 9, fig. 7. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 46, figs 1, 2. 1876.

SHELL slender, arcuate, exogastric. Transverse section elliptical, with the diameters in the ratio of three to four. Longitudinal section sublunate. Plane of greatest transverse section near the middle of the chamber of habi-

tation. Tube regularly and gradually enlarging from the apex. Apical angle of the lateral faces about 20°. Apex acute.

Chamber of habitation large, gibbous, having a length greater than the greatest transverse diameter. The sides are convex, and slope gradually to the aperture. Crenulated zone not well defined, but marked by shallow furrows, of which there are three in the space of four mm., and are continued over the cast of the walls of the air-chambers. Aperture not fully observed.

Air-chambers regularly increasing in depth from the apex, varying from one to six mm. in the length of seventy-five mm. Septa smooth, thin, having a concavity equal to the depth of the air-chambers. Sutures horizontal, curving slightly forward over the ventral side, and in the opposite direction on the concave dorsal side.

Siphuncle moniliform, ventral, submarginal; having a diameter between the septa of four mm., where the lateral diameter of the tube is thirty mm.; often exposed in the process of weathering.

Test and surface-markings unknown.

Internal mould essentially smooth, with the exception of the inconspicuous furrows of the crenulations. Sutures slightly impressed.

An individual nearly entire, embracing the chamber of habitation with twenty-seven air-chambers, has a length of 110 mm., of which thirty-five mm. pertain to the chamber of habitation. Its greatest ventro-dorsal diameter is thirty mm.

This species is distinguished by the curvature of the tube, the transverse section, the apical angle, and the curvature of the septal sutures.

Formation and localities. In the limestones of the Upper Helderberg group, at Clarence Hollow, Erie county; Littleville, Livingston county, N. Y.; and in the same horizon in Ontario, Canada West.

Cyrtoceras (Gomphoceras?) formosum, n. sp.

PLATE XCV, FIGS. 8, 9.

Shell arcuate, exogastric. Point of greatest transverse section apparently near the middle of the chamber of habitation.

Chamber of habitation large, with the sides sloping very gradually to the aperture.

Aperture comparatively large; its characters have not been fully observed

Air-chambers, septa and siphuncle unknown.

Tube ornamented with regular, shallow, transverse furrows, four in the space of twelve mm., with minutely undulating lines of growth between the ridges, crossed by regular, continuous, sharp, crenulating striæ, of which there are six in the space of seven mm. Near the aperture the transverse furrows disappear, and the surface shows coarse, lamellose lines of growth. The peculiar surface ornamentation here described gives the tube a very characteristic, cancellated appearance. The furrows and lines of growth make a decided sinus on the ventral side.

The fragment figured, belonging to the chamber of habitation, is much compressed, and has a length of nearly eighty mm.

This species is characterized by the remarkable surface ornamentation, which bears no similarity to any of the other forms described in this volume. It is doubtfully referred to the genus Gomphoceras on account of its gibbous chamber of habitation and the evident curvature of the tube, while the ornamentation is similar to several species of Cyrtoceras from the Silurian system.

Formation and locality. In the shales of the Hamilton group, at Dresden, near Penn Yan, Yates county, N. Y.

Cyrtoceras densum, n. sp.

PLATE LXXXV, FIGS. 17-19.

Shell very slightly curved; curvature greater toward the apex; exogastric. Transverse section broadly oval; lateral diameter the longer. Tube regularly and gradually enlarging. Apical angle about 12°.

Air-chambers regular, numerous, gradually increasing in depth toward the chamber of habitation, having a depth of four mm. where the tube has a diameter of thirty mm., and of seven mm. where the tube measures fifty mm.

Septa smooth, thin, with a concavity equal to an arc of about 102°, or equal to the depth of the chambers. A small areola around the insertion of the siphuncle marks its expansion in the cavities of the air-chambers. Sutures straight and horizontal.

Siphuncle large, nummuloid, near the ventral side, having a diameter between the septa of nearly twice the depth of the air-chambers, or more than one-fifth the diameter of the tube.

Internal mould smooth, with the sutures but slightly impressed.

One large fragment, with a lateral diameter at the smaller extremity of forty-three mm., and embracing twelve air-chambers, has a length of seventy-five mm. Smaller fragments have been observed, preserving these proportions.

This species is related to *C. Hector*, and may be distinguished by its rigid suture-lines, which in that species are curved. The relations of these species to the genus Orthoceras are not evident from the specimens examined, and they cannot be grouped with any of the species of that genus here described. The large, excentric siphuncle and rapidly enlarging tube, showing a slight curvature, more nearly assimulate them with species which have been considered as Cyrtoceras.

Formation and locality. In the calcareous beds of the Hamilton group, at Cumberland, Md.

Cyrtoceras Hector, n. sp.

PLATE XC, FIGS. 11-15.

Shell apparently nearly straight, regularly enlarging to the aperture. Transverse section broadly oval. Apical angle about 14°.

Chamber of habitation small, having a length equal to the dorso-ventral diameter of the tube at the base. Sides expanding regularly with the general contour of the tube, and contracting slightly at the aperture.

Air-chambers regular, having a depth of about five mm. One specimen shows several very shallow air-chambers near the grand chamber.

Septa smooth and thin, moderately concave. Sutures considerably curved and oblique.

Surface marked by fine striæ of growth, with a few coarser, lamellose lines at the margin of the aperture.

One fragment, showing the extent of the grand chamber, and embracing seven air-chambers, has a length of forty-three mm., of which twenty-five mm. pertain to the outer chamber. Another fragment shows eight air-chambers in the length of thirty-three mm.

This species is distinguished from *C. densum* of the Hamilton group by its smaller size and curving septal sutures.

Formation and localities. In the sandstones of the Upper Chemung, south of Olean, N. Y., and in the same horizon at Warren, Pa.

Cyrtoceras liratum.

PLATE XCV, FIG. 1.

Aploceras (Cyrtoceras) liratum, Hall. Descriptions of New Species of Fossils, etc., p. 44. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 72. 1862.

Shell arcuate, regularly and rapidly enlarging. Transverse section circular. Apical angle about 28°.

A portion of the chamber of habitation has been observed, possessing no marked characters. Air-chambers regular, having a depth of four mm. Sutures straight and horizontal.

From some indications on the specimen described, the curvature appears to be exogastric, and the siphuncle ventral or on the convex side.

Test not preserved. Tube ornamented with regular longitudinal furrows, six in the space of six mm. where the tube has a diameter of twenty-four mm.

The specimen figured, and the only one yet observed, has a length of thirty mm., with diameters of twenty-six and thirteen mm. respectively at the two extremities.

This species is unlike any of the Devonian forms yet noticed, and it is not sufficiently defined to admit of a satisfactory generic reference.

Formation and locality. In the Goniatite limestone of the Marcellus shale, at Manlius, N. Y.

CYRTOCERAS ALTERNATUM, n. sp.

PLATE XLVI, FIGS. 12, 13.

Cyrtoceras undulatum, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 47, figs. 9, 10. 1876.
Not *Gyroceras undulatum*, VANUXEM Geolog. Surv. N. Y.: Rep. Third Dist., pp. 139, 140, fig. 2. 1842.

SHELL slender, slightly curved, exogastric. Transverse section very broadly oval or subcircular. Tube regularly enlarging from the apex to the aperture, with the exception of the nodes and constrictions, which form the ornamentation of the surface. Apical angle about 8°.

Chamber of habitation having a length more than one-third greater than the lateral diameter of the tube at the last septum. Aperture apparently entire, with a slight sinus in the margin on the ventral side.

Air-chambers regular, gradually increasing in depth toward the chamber of habitation, varying from four to six mm. in the length of seventy-five mm. Septa smooth, moderately concave. Sutures straight and horizontal.

Siphuncle small, cylindrical, close to the ventral side, exposed in the process of weathering; having a diameter of 2.5 mm. where the tube measures twenty-seven mm.

Test strong, having a thickness of two mm. on the chamber of habitation. The septate portion of the tube is ornamented with regular, rounded annulations or undulations, occurring at about every second air-chamber. Each annulation is marked by about twelve rounded nodes, and these are arranged

in regular, longitudinal lines along the tube. The chamber of habitation is usually marked by a double constriction near the middle, with an intermediate ridge. The ventral side of the cast shows a longitudinal, flattened area, extending the entire length of the tube, and having a width equal to the depth of the air-chambers. On the internal mould of the dorsal side there is a low longitudinal carina, which is, however, not a conspicuous feature. The surface shows lamellose lines of growth, which are raised into transverse ridges or expansions at the summits of the annulations of the internal mould. The striæ make a broad, retral sinus over the ventral side.

The internal mould is very characteristic on account of the ornamentation of the tube and the features of the ventral and dorsal sides. Sutures but slightly impressed.

The greatest diameter of the aperture of one individual is thirty-five mm., and the chamber of habitation, with eighteen attached air-chambers, has a length of 140 mm., of which forty mm. pertain to the grand chamber.

The curvature of the tube, the characters of the siphuncle and the ornamentation distinguish this species from any allied form.

In this connection it is worthy of remark that the CYRTOCERAS and GYROCERAS of the Upper Helderberg are characterized by a similarity in the surface ornamentation, which generally consists of prominent, transverse, foliate expansions of the test. In the Goniatite limestone we meet with the species here described and *G. transversum*, both of which have the tube ornamented with nodes and transverse undulations. A similar variation is also exhibited in the species of the genus NAUTILUS, which are generally without special surface ornamentation; but the forms occurring in the same formation included under the genus DISCITES of McCOY, are intermediate in character to the Devonian and Carboniferous types of NAUTILUS.

These transitional characters of the fauna of the Marcellus shale are more marked in its contained Cephalopoda, which, however, constitute the conspicuous feature of the formation.

Formation and locality. In the Goniatite limestone of the Marcellus shale, at Schoharie, N. Y.

Cyrtoceras morsum.

PLATE XLVII, FIGS. 3. 4.

Cyrtoceras morsum, Hall. Descriptions of New Species of Fossils, etc., p. 43. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 71, pl. 9, fig. 6. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 46, figs 3, 4. 1876.

Shell small, arcuate, making about one-fourth of one volution, exogastric. The depth of the arc of curvature is six mm. in the length of thirty-six mm. Transverse section circular. Tube regularly enlarging from the apex to the aperture. Apical angle about 9°.

The chamber of habitation has a length equal to the diameter of the tube at the aperture. Aperture entire, slightly expanded, with a gentle sinus in the margin on the ventral side.

Air-chambers regular, numerous, increasing in depth from the apex to the outer chamber, varying from one to three mm. in the length of thirty mm. Septa not observed. Sutures straight and horizontal.

Siphuncle near the convex ventral side; its other characters have not been observed.

Test thin, having a thickness of about .25 mm. Surface ornamented with fine, lamellose, undulating lines of growth, and regular transverse ridges, formed by an aggregation of the lines of growth. Sinus of the ornaments on the ventral side small, but abrupt.

A specimen, preserving the chamber of habitation with twenty-six attached air-chambers, has a length of fifty-five mm., of which sixteen mm. pertain to the chamber of habitation. Another specimen has been observed which has nearly the same dimensions as the one given.

This species is distinguished by its size, the transverse section, and the apical angle. It differs from the apical portions of *Gyroceras trivolve* and *G. Matheri* in its lesser curvature. From the apex of *C. eugenium* it is distinguished by its more cylindrical and less rapidly expanding tube, with the sinus in the surface ornaments not so conspicuous.

Formation and localities. In the Schoharie grit at Schoharie, and in the Upper Helderberg limestone at Clarence Hollow, Erie county, N. Y.

CYRTOCERAS—GYROCERAS.

Considering the species in the order here followed, it is evident that one genus must include the whole series. Besides the gradation exhibited in the amount of curvature, there are conspicuous and almost constant features marking nearly all the species, in the characters of the surface ornaments and the position of the siphuncle.

The nomenclature of the species remains essentially as originally published, and will not be altered until a further revision of this subject can be made.

List of the species of CYRTOCERAS–GYROCERAS described in this volume:

CYRTOCERAS–GYROCERAS.

eugenium,	HALL,	Schoharie grit and Upper Helderberg limestone .	Slender forms, showing a gradation from curved to convolute.
æmulum,	"	Schoharie grit and Upper Helderberg limestone .	
citum,	"	Upper Helderberg limestone.	
Nereus,	"	" "	
trivolve,	CONRAD,	" "	
Matheri,	"	" "	
laciniosum,	HALL,	" "	
undulatum,	VANUXEM,	" "	
paucinodum,	HALL,	" "	
Jason,	"	Schoharie grit . .	Robust forms, showing a gradation from curved to convolute.
spinosum,	CONRAD,	" " . . .	
transversum,	HALL,	Hamilton group . .	
validum,	"	Schoharie grit . . .	
Eryx,	"	Hamilton group . .	
Cyclops,	"	Upper Helderberg limestone.	

CYRTOCERAS EUGENIUM.

PLATES XXXVI, FIG. 5; XLVII, FIGS. 5–7; XCVI, FIGS. 1–11; XCVII, FIGS. 10, 11.

Cyrtoceras eugenium,	HALL.		Descriptions of New Species of Fossils, etc., p. 42.	1861.
"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 70, pl. 9, figs. 1–3.	1862.
"	"	"	Illustrations of Devonian Fossils: Cephalopoda, pl. 46, figs. 5–7.	1876.
Orthoceras folialum.		"	Descriptions of New Species of Fossils, etc., p. 42.	1861.
"	"	"	Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 70, pl. 9, figs. 1–3.	1862.

SHELL slender, apical portion curved, making about one-fourth of one volution. Tube nearly straight for a length, measured from the aperture toward the apex, equal to one-half the entire length of the shell. In the larger individuals the length of the straight portion is comparatively greater. Transverse section subcircular, somewhat flattened on the dorsal and ventral sides along the straight portion of the tube. Tube regularly enlarging from the apex to the aperture, becoming slightly gibbous over the anterior half, and contracting very gradually toward the aperture, where it is somewhat expanded. Apical angle about 10°.

Chamber of habitation with a length one-half greater than the ventro-dorsal diameter of the tube at the last septum; slightly contracting toward the aperture, where it more rapidly expands. Crenulations marking the cast of the tube throughout its length, showing as irregular, indistinct, rounded furrows and ridges. Aperture entire, with a deep rounded sinus in the ventral margin, corresponding to the sinus in the ornaments of the test.

Air-chambers regular, having a depth of six mm. near the grand chamber. Toward the apex they are shallower, and show a considerable variation in depth; one specimen presents a variation of from four to six mm. in the length of twenty mm. Septa smooth, thin, having a concavity greater than the depth of the air-chambers, apparently independent of the surface characters. Sutures straight and horizontal, but slightly impressed on the internal mould.

Siphuncle small, submarginal, exposed in the process of weathering, having a diameter of three mm. where the tube measures thirty mm.

Test thin, with a thickness of .75 mm. over the chamber of habitation, and of .25 mm. on the apical portion of the tube. Surface marked by fine, irregular, lamellose lines of growth, crossed by irregular, longitudinal striæ. The ornamentation consists of regular, prominent, sharp, foliate ridges or expansions of the test, slightly inclining toward the aperture, and are more distant along the middle portions of the tube; becoming gradually more numerous and less prominent toward the apex and aperture. On one specimen the distance between two expansions is ten mm., and on another five mm., varying with the age or size of the individuals. Sometimes the elevation of the folds measures nine mm., but it is only on the larger specimens. Sinus very distinct, affecting the surface-markings and transverse costæ; angular near the apex, becoming deeper and rounded toward the aperture.

The internal mould preserves traces of the furrows of the crenulations, the surface-markings and low annulations corresponding to the prominent, transverse expansions of the test. The ventral side of the tube is slightly flattened along the portion covered by the sinus in the striæ and ornaments.

A small example, nearly entire, has a length of 193 mm., with a diameter of thirty-one mm. at the aperture, and shows about forty-five of the transverse costæ. The largest individual observed has a diameter of thirty-five mm. at the aperture.

This species resembles *C. æmulum*, but is characterized by its lesser curvature of the tube, larger apical angle and more distant, regular and prominent transverse folds, forming the ornaments of the test. It is a common and well-marked species, and may be recognized, even from small fragments, by the distance and prominence of the transverse expansions, which resemble those of *G. Matheri*, but are much more frequent. In the Schoharie grit the specimens are mostly very imperfect and fragmentary, but the limestones above furnish well-preserved individuals, which retain their natural form and proportions.

Formation and localities. In the Schoharie grit, in the counties of Schoharie and Albany, and in the limestone of the Upper Helderberg group, at Schoharie, N. Y.

Cyrtoceras æmulum, n. sp.

PLATES XCVII, FIGS. 1-9; XCVIII, FIGS. 3, 4.

Shell slender, curved, making more than one-fourth of one volution. For a considerable distance back of the aperture the tube is but slightly arcuate, and becomes more curved toward the apex. Transverse section broadly oval or subcircular. Tube regularly and very gradually enlarging from the apex to the aperture, and without special contraction or expansion. Apical angle about 6°.

The extent of the chamber of habitation has not been observed. The crenulations show, as obscure longitudinal ridges and striæ, over the internal mould of the walls of the air-chambers. Aperture entire, with a sinus in the ventral margin having a width equal to about twice the depth.

Air-chambers having a depth of seven mm., but showing considerable irregularity in different portions of the tube, and in different individuals. Septa smooth, with a concavity greater than the depth of the air-chambers. Sutures straight and horizontal.

Siphuncle small, close to the ventral side, often exposed in the process of weathering.

Test thin, having a thickness of about .5 mm. on the grand chamber. Surface marked by irregular, lamellose lines of growth. Tube ornamented with somewhat irregular, numerous, sharp, foliate expansions of the test, slightly inclining toward the aperture, and projecting about two mm. above the general surface of the test. The distance between two ridges varies in different specimens from two to three mm. Sinus sharp, deep, affecting the surface striæ and ornaments, together with the annulations of the internal mould.

Internal mould nearly smooth, but preserving traces of the crenulations and the external ornaments and markings of the test. Sutures moderately impressed.

The largest fragment observed has a length of about 185 mm., with a diameter of thirty-two mm. at the aperture, and shows but a very gradual

attenuation toward the apex in this length. Smaller fragments have been noticed, having an apical angle near the apex but little larger than the above.

This species resembles *C. eugenium*, and is distinguished by the greater curvature of the tube, smaller apical angle, less regular and prominent transverse expansions. In *C. citum* the curvature of the tube is somewhat greater, and the transverse folds are finely plicated.

Formation and localities. In the Schoharie grit, at Schoharie, N. Y., and from the crystalline sandstone of the Upper Helderberg group, at Pendleton, Ind.

Cyrtoceras citum, n. sp.

PLATE LI, FIGS. 1-3, AND SUPPLEMENT.

Shell slender, arcuate, making about one-half of one volution, and showing some variation in the amount of curvature in different individuals. Transverse section circular. Tube regularly and gradually enlarging from the apex to the aperture. Apical angle 11°.

The extent of the chamber of habitation has not been fully observed. The crenulations are well preserved over the internal mould of the tube as regular, rounded, longitudinal ridges and intermediate striæ. The ridges are continuous, and form nodes on the transverse annulations of the internal mould. Aperture entire, with the exception of a distinct sinus in the ventral margin, corresponding to the sinus in the ornaments of the test.

The depth of the air-chambers has not been determined. Septa smooth, moderately concave.

Siphuncle close to the ventral side; its elements unknown.

Test thin, having a thickness of .75 mm. Surface marked by lamellose lines of growth. Tube ornamented with regular, numerous, sharp, transverse, foliate, plicate expansions of the test, which have an elevation of three mm. above the general surface. There are about five of these plicæ in the length of ten mm. Toward the apex they become more numerous and less prominent. Sinus well marked.

Internal mould marked by low annulations, which correspond in frequency to the transverse folds of the test, and showing lamellose, concentric lines from the external striæ of growth.

One fragment, comprising about one-fourth of one volution, has a length of 180 mm., with diameters of thirty and eleven mm. respectively at the two extremities.

This species is distinguished from *C. eugenium* and *C. æmulum* by the greater curvature of the tube, larger apical angle, and the more slender plicate expansions of the test. In its ornamentation it more nearly resembles *G. Nereus*, but in that species the tube clearly makes more than an entire volution. The specimens preserved in the softer limestones of the West retain their normal form, and show the characters here mentioned in a very satisfactory degree.

Formation and localities. In the limestones of the Upper Helderberg group; at Schoharie, Caledonia, Leroy, Falkirk, N. Y.; and at Cayuga, Ontario, Can.

Gyroceras Nereus.

PLATE LXI, FIGS. 4-6.

Gyroceras Nereus, Hall. Descriptions of New Species of Fossils, p. 39 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 67, pl. 9, fig. 4. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 49, figs. 1–3. 1876.

Shell subdiscoidal, very openly coiled; spiral rapidly enlarging, making about one volution and a half. Transvere section subcircular. Tube regularly and rapidly enlarging. Apical angle in a compressed specimen 14°.

Chamber of habitation not observed. Some obscure, longitudinal furrows over the internal cast indicate the character of the crenulations. Aperture entire, with a small, semicircular notch on the ventral side, equal to the sinus of the ornaments on the test.

Air-chambers regular, having a depth of about five mm. on the outer volution.

Siphuncle ventral; not fully observed.

The test has a thickness of .75 mm. Surface marked by fine, undulating, lamellose lines of growth. Tube ornamented with numerous, regular, transverse, sharply plicated, undulating, lamellose expansions, at right angles to the general surface of the shell. These expansions of the test have an elevation of about two mm., and are distant from each other about four mm., gradually becoming more numerous toward the apex. The sinus forms a distinct furrow along the ventrum, and produces a semicircular, retral bend in the lines of growth and transverse lamellæ. The lamellæ are not plicated over the sinus. Internal mould essentially smooth.

The disc, in the specimen figured, has a greatest diameter of 150 mm., and the tube has a diameter of fifty mm. at the aperture.

This species is more coiled than *C. citum*, and the lines of growth and transverse folds of the test are more abruptly undulating. In *G. trivolve* the shell has a greater number of volutions, the internal mould is annulated, and the characters of the test and its ornaments, with the ventral sinus, is distinctive. The specimens of this species usually occur in a very compressed condition, but preserving the test, with its ornaments, and showing the number of volutions.

Formation and localities. In the Upper Helderberg limestone, at Waterloo and Auburn, N. Y.

Gyroceras trivolve.

PLATES LII, FIGS. 1-6; LII A, FIGS. 1-7.

Cyrtoceras trivolvis, Conrad. Geolog. Surv. N. Y.: Pal. Dept., Third Ann. Rep., p. 206. 1849.
Gyroceras trivolvis (Conr.) Hall. Descriptions of New Species of Fossils, etc., p. 37. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 65. 1862.
" " " " Illustrations of Devonian Fossils: Cephalopoda, pl. 54, figs. 1-5; and pl. 56, fig. 4. 1876.
Orthocera paradoxica, Sowerby. Eaton: Geological Text Book, p. 29. 1832.

Shell involute, subdiscoidal, openly coiled. Spiral rapidly enlarging, making from one and a half to two volutions. The last half of the outer volution in large individuals shows a tendency to become straight and tangent to the spiral. Transverse section subcircular. Tube regularly and gradually enlarging from the apex. Apical angle about 9°.

The chamber of habitation has a length equal to once and a half the diameter of the tube at the last septum. Crenulations preserved on the internal mould, as low, rounded, longitudinal ridges, with fine intermediate striæ. Aperture straight and horizontal, entire, with a distinct sinus in the ventral margin.

Air-chambers regular, numerous, having a depth of 4.5 mm. Septa smooth, thin, with a concavity greater than the depth of one air-chamber, or equal to an arc of 110°. Sutures straight, and at right angles to the spiral axis.

Siphuncle near the ventral side, not expanding in the cavities of the air-chambers.

The test has a thickness of .75 mm. Surface marked by very fine undulating, lamellose lines of growth, crossed by revolving striæ and obscure furrows. Tube ornamented with numerous transverse, plicate folds, or expansions of the test, having an elevation of about two mm. on the outer volution, and usually corresponding in frequency to the septa. Sinus distinct, having a width of more than twice the depth.

From the strength and regularity of the transverse folds of the test, the internal mould is marked by annulations, which are more prominent on the ventrum. It also shows lamellose lines of growth, and the furrows and striæ of the crenulations.

The largest individual observed has a diameter across the disc of 190 mm., with a diameter to the tube of forty-two mm. at the aperture.

This species is distinguished from *G. Nereus* by the greater number of volutions and the character of the surface ornamentation. In *G. citum* and *G. Matheri* the transverse section is different, and the transverse plications are more elevated and distant.

The individuals of this species are comparatively common, and, as obtained from the limestones, the casts are unusually well preserved. The examination of a large number of specimens shows slight variations in the amount of curvature of the tube, and in the prominence and frequency of the transverse plications of the test.

This is evidently the species recognized by Prof. Eaton, in his *Geological Text-Book*, as the *Orthocera paradoxica* of Sowerby,—the locality cited as Bethlehem caverns, being at Clarksville, in the town of Bethlehem, Albany county.

Formation and localities. In the limestones of the Upper Helderberg group, in the Helderberg mountains, Scholarie, Oneida and Onondaga counties, N. Y.

Gyroceras laciniosum, n. sp.

PLATE LII A, FIG. 8, AND SUPPLEMENT.

Shell discoidal, openly coiled, making not less than one volution and a half. Transverse section elliptical; lateral diameter the longer, the two diameters being in the ratio of four to five. Apical angle about 10°.

Chamber of habitation not observed. Crenulations preserved as low longitudinal ridges on the internal mould. Aperture unknown.

The air-chambers, septa and the characters of the siphuncle have not been observed, on account of the imperfect material.

The test has a thickness of about .5 mm. Surface marked by fine, irregular, undulating, lamellose lines of growth, crossed by broad, shallow, longitudinal furrows, of which there are three in the space of ten mm. Test ornamented with regular, distant, raised, foliate expansions, slightly inclining toward the aperture, and regularly plicated, the plications extending and forming the furrows on the general surface. The transverse plicæ have an elevation of about six mm., decreasing in height toward the apex. The sinus forms an abrupt deflection in the surface-markings and ornamentation.

Internal mould characterized by distinct annulations, corresponding to the transverse expansions of the test.

One incomplete fragment has a diameter, measured across the disc, of sixty mm., and a lateral diameter to the tube, at the larger extremity, of about thirty mm.

This species is distinguished by its transverse section and regularly and deeply plicate expansions of the test. The transverse section is conspicuously different from *G. trivolve*, and the expansions are more elevated and distant. It

more closely resembles *G. Matheri*, but differs in its finer and more regular plications of the expansions, their slighter elevation and apparently more elliptical transverse section.

Formation and locality. In the Upper Helderberg limestone, at Cherry Valley, N. Y.

GYROCERAS MATHERI.

PLATE LV, FIGS. 1-6.

Cyrtoceras Matheri, CONRAD. Geolog. Surv. N. Y.: Pal. Dept., Third Ann. Rep., p. 206. 1840.
Gyroceras Matheri (CONR.), HALL. Descriptions of New Species of Fossils, etc., p. 38. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 66. 1862.
" " " " Illustrations of Devonian Fossils: Cephalopoda, pl. 55, figs. 5, 6, and pl. 56, fig. 3. 1876.

SHELL discoidal; spire open, with the outer portion of the last volution directed outward, tending to become tangent to the spiral. The tube makes about one volution and a half. Transverse section elliptical; lateral diameter the longer, the two diameters being in the ratio of five to seven. Toward the apex and near the aperture the transverse section is subcircular. Apical angle about 10°.

Chamber of habitation slightly contracting toward the aperture; its extent has not been observed. The low, rounded ridges forming the crenulations are continued over the annulations and furrows of the internal mould. Aperture like transverse section, with a sinus corresponding to the sinus of the ornaments.

Air-chambers and siphuncle unknown. Septa smooth, deeply concave.

Test having a thickness of .75 mm. Surface marked by fine, irregular, lamellose lines of growth, crossed by scattered, indistinct, revolving striæ. The ornamentation consists of regular, raised, transverse, foliate, plicate expansions, inclining forward and projecting above the general surface about ten mm. The plications are irregular, and correspond to the frequency of the revolving furrows of the internal mould. The distance between the expansions of the test varies considerably on the same and on different specimens. Measured on the ventral side of the outer volution, the distance between

three of them varies from thirty to forty mm. Sinus abrupt, angular, having a depth of about four mm. on the outer volution, and very marked in the raised expansions.

Internal mould marked by regular, prominent annulations, corresponding in frequency to the external ornaments, and showing the longitudinal ridges and furrows of the crenulations.

The diameter across the disc, in a large specimen, measures 125 mm., and the tube has a diameter of thirty-three mm. at the aperture.

This species is distinguished from *G. laciniosum* by its nearly circular transverse section, and more elevated and less regularly plicated transverse expansions of the test. The annulations of the internal mould are much more prominent and distant than in *G. trivolve*, and the transverse section is different. In *G. undulatum* and *G. paucinodum* the shell is characterized by several closely coiled volutions. The specimens referred to this species show slight, but unimportant variations in the transverse section of the tube and the number of volutions. This latter variation is principally due to the tendency of the outer volution to become straight.

Formation and localities. In the Upper Helderberg limestone, at Schoharie and Catskill, N. Y.

Gyroceras undulatum.

PLATES LIII, FIG. 1-6; LIV, FIG. 5.

Cyrtoceras undulatum, Vanuxem. Geolog. Surv. of N. Y.: Rep. Third Dist., pp. 139, 140, fig. 2. 1842.
Gyroceras undulatum (Vanux.), Hall. Descriptions of New Species of Fossils, etc., p. 38. 1861.
" " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 66. 1862.
" " " " Illustrations of Devonian Fossils: Cephalopoda, plate 56, figs. 1, 2. 1876.

Shell discoid, closely coiled, making from two to three volutions, which are not contiguous. Transverse section broad, subangular transversely ovate; lateral diameter the longer. The tube is somewhat flattened on the ventrum, and angular at the ventro-lateral sides and on the dorsum; regularly and gradually enlarging. Apical angle about 7°.

Chamber of habitation slightly contracting toward the aperture, having a length two-thirds greater than the ventro-dorsal diameter of the tube at the last septum. The crenulations are shown on the internal mould as low, rounded ridges and striæ. Aperture expanded, slightly oblique, opening a little outward.

Air-chambers regular, gradually increasing in depth toward the grand chamber, varying from six to nine mm. in the length of 150 mm., measured on the convex side of the outer volution. There are about two air-chambers between two of the transverse ornaments of the test. Septa smooth, with a concavity equal to the depth of the air-chambers. Sutures straight and at right angles to the spiral axis of the tube.

Siphuncle close to the ventral side. Its elements have not been observed in the cavities of the air-chambers.

The test has a thickness of .5 mm. Surface marked by fine, irregular, lamellose lines of growth, curving in a retral direction over the ventro-lateral faces. On the ventro-lateral angles the lamellose expansions of growth are suddenly bent backward at each alternate septum, and raised into semi-tubular nodes or spines. These processes incline toward the aperture, and are continued as lamellose expansions of the test over the dorsal and lateral faces of the tube, reaching an elevation of ten mm., and extending to the ventral side of the inner adjacent volution. Sinus broad, rounded, deep.

The internal mould preserves the striæ and furrows of the crenulations, and shows transverse, elongate nodes, corresponding to the tubular processes of the test.

The largest specimen observed has a diameter of 120 mm., measured across the disc, and the tube has a diameter of thirty mm. at the aperture. The majority of the specimens have a diameter across the disc of from 110 to 115 mm.

This species is more closely coiled, and has a greater number of volutions than any of the preceding forms. It resembles *G. paucinodum*, and may be distinguished by its slightly more open spiral, broader and less triangular section, and its more frequent and numerous spines on the ventro-lateral angles. These

two species, in the ornamentation of the tube, form a small group, similar to an assemblage of large and robust forms, named in the succeeding descriptions, including *C. Jason*, *G. spinosum* and *G. transversum*.

Formation and localities. In the Upper Helderberg limestone, Oneida and Schoharie counties, and in the Helderberg mountains, Albany county, N. Y.

GYROCERAS PAUCINODUM.

PLATE LIV, FIGS. 1–4.

Gyroceras (Hercoceras?) paucinodus, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 55, figs. 1–4. 1876.

SHELL discoid, closely coiled, making not less than two nearly contiguous volutions. Transverse section triangular, ventral side the longest. The length of the dorso-ventral diameter is about three-fourths of the lateral diameter. Tube regularly and gradually enlarging from the apex to the aperture. Apical angle about 7°.

The extent of the chamber of habitation has not been observed. The crenulations are preserved on the internal mould as fine, rounded striæ. Aperture slightly oblique, opening outward, with a distinct sinus on the ventro-lateral margins, and in the middle of the ventral side.

Air-chambers, septa and siphuncle unknown.

The test has a thickness of about .5 mm. on the outer volution. Surface marked by irregular slightly undulating lines of growth, curving in a retral direction. The ventro-lateral angles are ornamented with a row of nodes or spines, formed by the outward and backward bending of the lamellæ of growth. On the outer volution these nodes are separated by a distance of about twenty-four mm., becoming more frequent toward the apex. Sinus very broad and deep.

The internal mould shows the furrows and striæ of the crenulations, and large rounded nodes on the ventro-lateral angles, corresponding to the external ornaments of the test.

Three specimens have a uniform diameter of 100 mm. each, measured across the disc, with a lateral diameter of forty-three mm. at the aperture.

This species is very nearly related to *G. undulatum*, but may be distinguished by its more closely coiled volutions, triangular section, broad, flat, ventral side, and the more regular and distant nodes along the ventro-lateral angles of the tube. The general form of the shell, with the ornaments of the test, is similar to *Hercoceras mirum*, BARRANDE, from the Silurian of Bohemia; but the apertures in the two species are very unlike.

Formation and localities. In the Upper Helderberg limestones at Cherry Valley, and Schoharie, N. Y.

CYRTOCERAS JASON.

PLATE L, FIGS. 1, 2; AND SUPPLEMENT.

Cyrtoceras Jason, HALL. Descriptions of New Species of Fossils, etc., p. 43. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 71. 1862.
Gyroceras " " Illustrations of Devonian Fossils: Cephalopoda, pl. 52, fig. 2. 1876.

SHELL large, robust, curved, making more than one-fourth of one volution. Transverse section subcircular, somewhat hexagonal, losing the angular character toward the apex of the tube. Tube rapidly enlarging. Apical angle about 15°.

Chamber of habitation large, with a length greater than the diameter of the tube at the aperture. Crenulations preserved on the internal mould as numerous, shallow, longitudinal furrows. Aperture oblique, opening outward from the spiral axis of the tube.

Air-chambers regular, having a depth of from five to ten mm.—a variation which is shown in different specimens. Septa smooth, with a concavity equal to the depth of the air-chambers. Sutures straight, and at right angles to the spiral axis of the tube.

Siphuncle small, ventral, near the surface, sometimes exposed in the process of weathering.

The test has a thickness of .75 mm. Surface marked by irregular, lamellose lines of growth. At intervals of about each alternate septum the lamellose lines of growth are projected into sharp, transverse, foliate expansions, inclining toward the aperture. Along the obtuse angles of the tube these

ridges are bent suddenly backward, forming semi-tubular spines or retral arches, having an elevation of about fifteen mm. Sinus deep, very broad, rounded.

One large fragment, making nearly one-fourth of one volution, has a length of 250 mm., and a diameter of eighty mm. at the aperture. Another smaller specimen has a length of 230 mm., and shows sixty-five mm. of the chamber of habitation, and about twenty air-chambers.

This species is distinguished by its large size and the character of the surface ornaments. From *G. spinosum* it differs in its smaller curvature, transverse section; the lines of growth not undulating between the rows of spines; and in the less regularity in the ornamentation of the test.

Formation and localities. In the Schoharie grit at Schoharie, and in the Helderberg mountains; and in the limestone of the Upper Helderberg group, at Schoharie, N. Y.

GYROCERAS SPINOSUM.

PLATES XLVII, FIG. 8; XLVIII, FIGS. 1-5; XLIX, FIG. 1; XCVIII, FIGS. 1, 2, 5, 6, 7; XCIX, FIGS. 1-8.

Phragmoceras spinosum, CONRAD. Third Ann. Rep. Geolog. Surv. N. Y.: Pal. Dept., p. 206. 1840.
Gyroceras (Cyrtoceras?) spinosum (CONR.), HALL. Descriptions of New Species of Fossils, etc., p. 41. 1861.
" " " " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 69. 1862.
" " " " " Illustrations of Devonian Fossils: Cephalopoda, pl. 46, fig. 8; pl. 50, figs. 1-4; pl. 51, fig. 1; and pl. 52, fig. 1. 1876.

SHELL curved, making more than one volution; coiled in an open spiral. The distance between the outer and the adjacent inner volution is less than the diameter of the tube of the inner volution. Transverse section subcircular; lateral diameter a little the longer. Tube regularly and gradually enlarging from the apex to the aperture. Apical angle about 10°.

The chamber of habitation has a length of one-third more than the diameter of the tube at the last septum. Crenulations showing as fine, revolving striæ and furrows on the internal mould of the air-chambers. Aperture slightly contracted.

Air-chambers regularly increasing in depth from the apex to the grand chamber, varying from two to eight mm. in the length of nearly fifty air-chambers. In larger specimens the chambers have a depth of eleven mm. toward the grand chamber. Septa smooth, having a concavity equal to the depth of the air-chambers. Sutures straight and at right angles to the spiral axis of the tube.

Siphuncle ventral, nummuloid, small in its passage through the septa, and very much and abruptly enlarged in the cavities of the air-chambers, assuming the form of flattened, ovoid expansions between the septa, which have a diameter equal to the depth of two air-chambers.

Test thin, having a thickness of .5 mm. on the outer volution. Surface marked by coarse and fine, undulating, lamellose lines of growth. Tube ornamented with two or four lateral and two ventral revolving rows of semi-tubular spines, formed by a retral arching of the lamellose lines of growth, and having an elevation of from four to ten mm. Generally on the ventrum, and occasionally on the sides, the margins of the laminæ, which at intervals are elevated into spines, are continued along the test, forming low, rounded, revolving ridges, giving the tube a hexagonal form, rounded on the dorsal side. On the ventral side these revolving ridges limit the sinus in the striæ of growth. Sinus deep, rounded, broad, having a width equal to one-fourth the diameter of the tube.

Internal mould essentially smooth, but preserving remains of the surface-markings and the ornaments of the test, with the striæ and furrows of the crenulations.

The largest fragment of this species observed, which is septate throughout, has a diameter of 180 mm., measured across the volutions.

This species is characterized by the regular rows of semi-tubular spines and the undulating lines of growth. The curvature of the tube is much greater than in *C. Jason*, and the ornamentation is more regular and marked than in that species. The internal mould of *G. validum* is very similar, but it has shown no evidences of an ornamentation from expansions of the test or undulations of the tube. The specimens of this species are found in considerable

abundance, but the majority are fragmentary and very imperfect. It is only from the examination of numerous individuals that the characters of the species can be satisfactorily determined.

Formation and localities. In the Schoharie grit, at Schoharie, and in the Helderberg mountains; and from the same horizon in Ulster county, N. Y.

GYROCERAS TRANSVERSUM.

PLATE LVI, FIGS. 1–4.

Cyrtoceras transversum. HALL. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 104. 1860.
Gyroceras " " Illustrations of Devonian Fossils: Cephalopoda, pl. 57, figs. 1–4. 1876.
Comp *Gyroceras constrictum*, MEEK and WORTHEN. Geological Survey of Illinois, p. 446, pl. 12. 1868.

SHELL large, curved, curvature regular. The depth of the curvature amounts to twenty-two mm. in a fragment having a length of 110 mm. Transverse section elliptical; lateral diameter the longer. The ventro-dorsal and transverse diameters are in the ratio of three to four. Tube very gradually enlarging. Apical angle about 6°.

Chamber of habitation small, having a length equal to the lateral diameter of the tube at the last septum, slightly contracting toward the aperture, and again expanding. Crenulated zone narrow, marked by broad, shallow furrows. Aperture entire, with a very deep sinus in the ventral margin.

Air-chambers regular, gradually increasing in depth toward the grand chamber, varying from four, seven, to ten mm. in three specimens, having transverse diameters of twenty-three, sixty, and sixty-seven mm respectively. Septa smooth, slightly concave. Sutures straight, and at right angles to the spiral axis of the tube.

Siphuncle small, cylindrical, having a diameter of two mm. where the tube has a transverse diameter of fifty-three mm.

Test strong, reaching a thickness of three mm. on the chambers of habitation. Surface marked by fine, irregular lamellose, imbricating lines of growth, crossed by numerous rounded, revolving striæ. The ventro-lateral sides of the tube are ornamented, at about every third air-chamber, with large, rounded nodes, which may extend into spines on perfect specimens.

The sinus is deep, and occupies a broad, flattened, revolving band, extending along the ventrum.

The internal mould of the air-chambers is marked by the obscure furrows of the crenulations, and by fine, longitudinal striæ. The ornamentation of the ventro-lateral sides is indicated by large rounded nodes.

One fragment, making nearly one-fourth of one volution, and embracing the chamber of habitation with thirteen attached air-chambers, has a length of 180 mm., of which sixty-five mm. pertain to the grand chamber. The tube of the same specimen has a transverse diameter of seventy mm. at the aperture, and a dorso-ventral diameter of forty-six mm. at the same point. The chamber of habitation of a small individual has a length of twenty-seven mm., with diameters of nineteen and twenty-eight mm. at the aperture.

This species is distinguished from any of the other forms described in this volume by its transverse section, very gradually enlarging tube, the ornamentation of the test, and the character of the internal mould.

Formation and locality. In the Goniatite limestone of the Marcellus shale, near Manlius, N. Y.

GYROCERAS VALIDUM.

PLATES XLIX, FIG. 2; C, FIG. 1.

Gyroceras validum, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 51, fig. 2. 1876.

SHELL large, subdiscoidal, coiled in a free spiral, and making more than one volution and a half. The distance between the chamber of habitation and the adjacent inner volution is nearly twice the diameter of the inner volution. Transverse section subcircular. Tube regularly and gradually enlarging from the apex. Apical angle about 8°.

Chamber of habitation large; its greatest diameter is at a point about two-thirds of the length from the last septum, directed outward, tangent to the spiral axis of the tube. The sides slope gradually from near the middle of the chamber to the aperture, which is slightly expanded.

Air-chambers regular, numerous, gradually increasing in depth toward the grand chamber, varying from three to seven mm. in the length of twenty-eight air-chambers. Septa smooth, moderately concave, with an areola around the insertion of the siphuncle. Sutures straight and at right angles to the spiral axis.

Siphuncle near the ventral side, moniliform; not satisfactorily observed.

Test and surface-markings unknown. Internal mould essentially smooth, with the sutures moderately impressed.

The specimen figured on pl. 100 has a diameter, measured from the aperture across the disc, of 180 mm., and the greatest diameter of the tube is fifty-two mm.

This species is distinguished from *G. spinosum* by the absence of revolving rows of spines or nodes, and a more gradually enlarging tube. It differs from *G. Eryx* in its smaller volutions and more openly coiled spiral.

Formation and localities. In the Schoharie grit, Schoharie and Albany counties, N. Y.

Gyroceras Eryx.

PLATES LVIII, FIG. 1; CIII, FIG. 3.

Gyroceras Eryx, Hall. Descriptions of New Species of Fossils, etc., p. 39. 1861.
" " " Fifteenth Rep. N Y. State Cab. Nat. Hist., p. 67. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 48, fig. 1. 1876.

Shell large, discoid, coiled, making about two nearly contiguous volutions. Transverse section broadly oval; ventro-dorsal diameter the longer. Tube regularly enlarging from the apex to the aperture. Apical angle about 10°.

Chamber of habitation large. Aperture not observed.

Air-chambers numerous, regular, having, on the outer volution, a depth of fifteen mm., measured on the convexo-ventral side, and of six mm. on the concavo-dorsal side. Sutures straight and at right angles to the spiral axis of the tube.

Siphuncle ventral, near the chamber walls, nummuloid, expanding to a diameter equal to the depth of the air-chambers.

Test and surface-markings unknown. Internal mould smooth, with the sutures slightly impressed, and preserving some traces of transverse lines of growth.

The largest individual observed has a diameter, measured across the disc, of 200 mm., with a diameter of the tube at the aperture of seventy mm. A small, septate fragment, comprising about one-half of one volution, has a diameter across the volutions of 110 mm., and preserves about thirty air-chambers.

This species is distinguished by its transverse section, its size, closely coiled volutions, and the absence of any prominent ornamentation on the tube. It somewhat resembles *G. validum* in its smooth internal mould, but the large, closely coiled volutions and transverse section are very different. From *G. Cyclops* it is easily distinguished by the absence of the annulations and crenulations of the internal mould, and is without evidences of any characteristic surface ornamentation.

Formation and locality. In the Magnesian limestone of the age of the Hamilton group, near Milwaukee, Wis.

Gyroceras Cyclops.

PLATES CI; CII; CIII, FIGS. 1, 2; CIV, FIGS. 1, 2.

Gyroceras Cyclops, Hall. Descriptions of New Species of Fossils, etc., p. 40. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 68. 1862.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 53, figs. 1–3. 1876.

Shell large, discoidal, regularly coiled. Spiral open, making about one volution and a half. The volutions are distant about twenty mm.; near the aperture they are almost contiguous on account of the expansion of the tube. Transverse section subcircular, or broadly oval, flattened on the dorsum, and obtusely subangular on the ventral side. Tube regularly enlarging from the apex. Apical angle about 14°.

Chamber of habitation small, expanding and forming a campanulate aperture, which opens outward, oblique to the spiral axis of the tube. This

feature of the direction of the aperture is inferred from the lines of growth and the direction of the ornamentation of the test. The crenulations are preserved as fine, rounded ridges and striæ, along the internal mould of the walls of the air-chambers.

Air-chambers frequent, regular, becoming numerous toward the apex, having a depth of ten mm. near the grand chamber, and of one mm. near the apex. Septa smooth, with a very slight concavity, equal to an arc of about 60°. Sutures straight, and at right angles to the spiral axis.

Siphuncle near the ventral side, small in its passage through the septa; having a diameter of six mm. where the tube has a ventro-dorsal diameter of forty-five mm.

The test has a thickness of about one mm. on the outer volution. Surface marked by irregular, lamellose, undulating lines of growth, which slope in a retral direction, oblique to the spiral axis of the tube. The ornamentation consists of strong, transverse, prominent, plicate, foliate expansions of the test, inclining toward the aperture, and having an elevation of about twenty-seven mm. on the outer volution, growing less prominent and more finely plicated toward the apex. These expansions are quite regularly plicate, and present surface-markings similar to the general surface of the tube. The folds or plications are continued along the tube, forming rounded, revolving ridges. The sinus in the striæ and ornaments of the test is rounded, and has a width equal to twice the depth.

The internal mould is annulated from the strong transverse expansions of the test, and shows the furrows and ridges of the crenulations, with those of the test. Sutures not impressed.

One specimen, nearly entire, constituting about one volution and a half, has a length of 600 mm., with a diameter of seventy-five mm. near the aperture, and measures 210 mm. from the ventral margin of the aperture across the volutions.

This species is distinguished by its size, the curvature of the tube, the apical angle, and the prominence of the ornamentation. The apical portion differs from *G. trivolve* in its more rapidly enlarging tube and marked characters of the

internal mould and surface ornaments. ' In *G. Nereus* the tube is more slender, less involute, and the expansions of the test are more frequent and more decidedly plicated, but much less elevated. The curvature of the tube in *G. Matheri* is distinctive, and the tube is more slender, and with a flattened, transverse section. This form is a remarkably large and well-defined species, and has a horizontal range greater than any of the previously described forms, except, perhaps, *C. æmulum.*

Formation and localities. In the limestones of the Upper Helderberg group, Helderberg mountains, N. Y.; near Columbus, O.; and Kelly's Island, Lake Erie.

In the historical notices and descriptions of species of GYROCERAS and CYRTOCERAS, no mention has been made of the numerous genera and subgenera which have been constituted on various modifications of the typical forms of these genera. The majority of the species of CYRTOCERAS and allied genera have been indicated from the Silurian system. And on the other hand, the greater proportion of the species of GYROCERAS have been described from Devonian and Carboniferous strata. From this fact, it would seem probable that there was sufficient grounds for some generic separation, and that these genera held an equivalent relative position in these grand divisions of palæozoic time.

In the Silurian system the genera ORTHOCERAS and CYRTOCERAS form the leading feature in the cephalopodous fauna, while in the succeeding periods the genus NAUTILUS supersedes ORTHOCERAS, and GYROCERAS appears to be a gradual and natural outgrowth from CYRTOCERAS.

TROCHOCERAS, BARRANDE–HALL.

The genus TROCHOCERAS was proposed by M. BARRANDE and by myself, about the same time, and quite independently of each other, for fossils of identical character and structure. The name was first published by M. BARRANDE—my own appearing only in the second volume of the Palæontology of N. Y., Recognizing these facts, M. BARRANDE has done me the honor to associate my name with his own in his subsequent publications of the genus, and I have adopted the same course.

In 1852 J. HALL described *Trochoceras Gebhardi* and *T. turbinatum*, from the Coralline limestone of the Niagara group (*Palæontology of New York*, vol. 2).

In 1860 Mr. J. H. MCCHESNEY described *T. Desplainense*, from the Niagara group (*New Palæozoic Fossils*).

In 1861 J. HALL described *T. Clio* and *T. eugenium*, from the Schoharie grit (*Fourteenth Rep. N. Y. State Cab. Nat. Hist.*); *T. costatum*, from the Niagara group of Wisconsin (*Geolog. Survey of Wis.: Rep. of Progress*); and *T. discoideum*, from the Schoharie grit (*Desc. New Species Foss.*).

In 1865 Messrs. MEEK and WORTHEN described *T. Bæri* [=*Nautilus*], from the Hudson-river group (*Proc. Acad. Nat. Sci. Phila.*).

Messrs. WINCHELL and MARCY described *Gyroceras Bannisteri* [=*Trochoceras*], from the Niagara group of Illinois.

In 1867 J. HALL described *T. notum*, from the Niagara group of Illinois (*Twentieth Rep. N. Y. State Cab. Nat. Hist.*).

In 1869 M. BARRANDE described *T. incipiens*, from the Quebec group (*Syst. Sil. du centre de la Bohême*).

In 1870 J. HALL described *T. Æneas*, from the Niagara group of Iowa (*Twentieth Rep. N. Y. State Cab. Nat. Hist.:* Revised ed., explanation of pl. 25).

In 1876 J. HALL illustrated *T obliquatum*, *T. Pandion*, *Cyrtoceras Orion* [=*T. Orion*], from the Schoharie grit (*Illustrations of Devonian Fossils*); and *T. Waldronense*, from the Niagara group of Indiana (*Twenty-eighth Rep. N. Y. State Mus. Nat. Hist.*).

This genus is essentially a Silurian form in America and other countries where it has been recognized. All the species here described are from the lowest member of the Devonian system, and have not been observed in the succeeding formations. One-half of the species named in the above historical sketch are from the horizon of the Niagara group; and it would seem probable that the genus here reached its maximum development. M. BARRANDE has indicated forty-five species from the Silurian system of Bohemia, among which are several groups of forms which are similar to a natural grouping of the species here described. Their specific relations will be noticed in the descriptions following.

In the Schoharie grit the forms of TROCHOCERAS seem to represent the genus NAUTILUS, which has not been observed to occur in that horizon. The Hamilton group has furnished a variety of species of the latter genus, but as yet no forms which can be referred to TROCHOCERAS.

List of the species of TROCHOCERAS described in this volume:

TROCHOCERAS, { Barrande. / Hall.

Clio,	HALL . .	Annulated forms.
discoideum,	" .	
Biton,	" . .	
eugenium,	" .	Smooth forms, making more than one volution.
Orion,	" . .	
Barrandei,	" .	
Pandion,	" . .	
obliquatum,	" .	Smooth forms, making less than one volution.
expansum,	" . .	

Trochoceras Clio.

PLATES LIX, FIGS. 1, 2, 3, 4, 5, 9; CXI, FIG. 6.

Trochoceras Clio, Hall. Fourteenth Rep. N. Y. State Cab. Nat. Hist., p. 108. 1861.
Not " " " Fifteenth Rep. N. Y. State Cab Nat. Hist., pl. 9, fig. 8. 1862.
Not " " Hall (in part). Illustrations of Devonian Fossils: Cephalopoda, pl. 59, figs. 3–7. 1876.
Trochoceras discoideum, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 59, figs. 1, 2. 1876.

Shell subdiscoidal, sinistral, making about three volutions, coiled in a helix. Volutions contiguous, supporting each other on the upper dorso-lateral side, which is marked by a revolving furrow, made by the inner, adjacent volution. The spire has an elevation equal to about two-thirds the transverse diameter of the disc. Umbilicus profound, having a diameter of about one-half the diameter of the tube. Transverse section very broadly subovate, lateral diameter the longer. The plane of the lateral diameter is oblique to the vertical axis of the helix, making an angle of nearly 45°, and is directed away from the apex of the spire, while the plane of the ventro-dorsal diameter is inclined to the apex. Tube regularly and gradually enlarging, increasing its diameter about twice for each volution.

Chamber of habitation large, having a length more than twice the diameter of the tube at the last septum, following the curvature of the spire. It comprises about one-third of the outer volution, and has a capacity of less than one-half of the volume of the air-chambers. Aperture slightly contracted, opening downward, oblique to the spiral axis of the tube, and showing a sinus in the ventral margin corresponding to the sinus in the striæ and annulations of the test.

Air-chambers regular, increasing in depth toward the grand chamber, where they have a depth of six mm. in an individual having a diameter of forty-five mm., measured across the disc. Septa smooth, not regularly concave. The concavity is greater in a ventro-dorsal direction, and is about equal to the depth of one air-chamber or an arc of 110°. Sutures straight and at right angles to the spiral axis of the tube, crossing the annulations, which are about twice as frequent.

Siphuncle small, subcentral, having a diameter of one mm. where the tube has a ventro-dorsal diameter of thirteen mm. A small areolar depression on the convex side of the septa indicates a moniliform expansion of the siphon in the cavities of the air-chambers.

Test thin, not well preserved. Surface subreticulate, marked by fine, regular lines of growth, crossed by regular, sharp, more distant, longitudinal striæ, of which there are six to nine in the space of four mm. on the outer volution. Tube ornamented with regular, curved, oblique annulations, crossing the septa, and of about twice their frequency. On the internal mould the annulations are more rounded than on the exterior of the test, and are not continued over the concave dorsal side, being most prominent along the ventrum; becoming more distant and less marked on the chamber of habitation in large individuals. The sinus is indicated by a slight retral bend in the annulations and surface striæ on the convexo-ventral side.

The internal mould shows the annulations subdued, with some traces of the surface-markings. Sutures but slightly impressed.

One specimen, measuring thirty-five mm. across the volutions, has a diameter, near the aperture, of sixteen mm., and an elevation of the helix of about twenty mm. The largest specimen observed has a diameter, across the disc, of nearly eighty-five mm.

This species is distinguished from *T. discoideum* by its more gradually enlarging tube, smaller umbilicus, more elevated spire, and shallower air-chambers; the annulations are more frequent, and have less the character of transverse nodes, than in that species. It somewhat resembles *T. Hærnesi*, Barr., from the Silurian system of Bohemia, in its surface characters and form of the tube; but the position of the siphuncle is different, and in that species the helix is dextral.

This is the most abundant form of this genus in the Schoharie grit, but the specimens are mostly fragmentary, and in a very imperfect condition of preservation.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

Trochoceras discoideum.

PLATE LIX, FIGS. 6-8.

Trochoceras discoideum, Hall. Descriptions of New Species of Fossils, etc., p. 36. 1861.
" " " Fifteenth Rep. N. Y. State Cab Nat. Hist., p. 64. 1862.
Not " " " Illustrations of Devonian Fossils: Cephalopoda, pl. 59, figs. 1, 2. 1876.
Trochoceras Clio, Hall. Fifteenth Rep. N. Y. State Cab. Nat. Hist., pl. 9, fig. 8. 1862.
" " Hall (in part). Illustrations of Devonian Fossils: Cephalopoda, pl. 59, figs. 3–7. 1876.

Shell discoidal, sinistral, making about three contiguous volutions, supporting each other on the upper dorso-lateral side. Spire depressed, sinistral. Umbilicus large, wide, exposing all the volutions. Transverse section subcircular. Tube regularly and gradually enlarging from the apex, more rapidly so in the outer volution.

Chamber of habitation large, curving with the volutions of the helix, occupying more than one-third of the outer volution. Aperture expanded.

Air-chambers regularly increasing in depth toward the grand chamber, equal in frequency to the transverse nodes, varying from four to six mm. on the outer volution of different specimens. These measurements are taken from the lateral face of the tube. Septa smooth, not regularly concave, having a concavity equal to an arc of about 130°. Sutures straight, and at right angles to the spiral axis.

Siphuncle small, central, surrounded, at its insertion in the septa, by a small areola which extends, as a narrow slightly raised expansion, to the ventral margin.

Test not preserved. Surface marked by fine, sharp, concentric striæ, crossed by regular, more distant, sharp, revolving striæ, forming a reticulation of the surface. Tube ornamented with rather prominent, transverse, linear nodes or annulations on the lateral faces, which are not continued over the dorsal and ventral sides. The nodes are of about the same frequency as the septa, and reach their greatest prominence on the ventro-lateral faces of the tube. Sinus not observed.

The internal mould shows the linear, lateral nodes somewhat subdued, and is otherwise essentially smooth. Sutures slightly impressed.

The specimens have a diameter, measured across the disc, of from forty-five to seventy mm. A satisfactory determination of the elevation of the spire cannot be given from the compressed and fragmentary condition of the specimens.

This species is distinguished from *T. Clio* by its more rapidly enlarging tube, larger umbilicus, and the linear, lateral, annular nodes, which are not continuous over the dorsal and ventral sides. In *T. Biton* the tube is more gradually enlarging, and the nodes are less extended, reaching the greatest prominence on the concave dorso-lateral faces.

Formation and localities. In the Schoharie grit, Schoharie and Albany counties, N. Y.

Trochoceras Biton, n. sp.

PLATE CXI, FIG. 7.

Shell discoid. Transverse section very broadly elliptical. Tube regularly and gradually enlarging.

Chamber of habitation large, rapidly expanding toward the aperture, occupying about one-fourth of one volution, and curving regularly with the volutions of the helix.

Air-chambers having a depth of about three mm. near the grand chamber, as measured on the lateral face of the tube.

Test thin. Surface marked by fine striæ of growth, crossed by regular, sharp, revolving striæ, of which there are four in the space of two mm. Tube ornamented with low, rounded, transverse undulations, which are raised into prominent, short, linear nodes on the concave dorso-lateral face. There are three in the length of twenty mm. on the grand chamber. Sinus not observed.

The specimen described is an imperfect fragment, consisting of the chamber of habitation, and two attached air-chambers; having a length of sixty mm., and preserving distinctive characters.

This species differs from *T. discoideum* in the position and smaller size of the linear, annular nodes. The tube is also apparently less rapidly enlarging. It is easily distinguished from similar fragments of *T. Clio* by the absence of the nearly continuous, numerous annulations of that species.

Formation and locality. In the Schoharie grit, at Clarksville, Albany county, N. Y.

Trochoceras eugenium.

PLATE LVIII, FIGS. 3, 4; LXIX, FIGS. 10, 11.

Trochoceras eugenium, Hall.			Fourteenth Rep N. Y. State Cab. Nat. Hist., p. 108. 1861.
"	"	"	Illustrations of Devonian Fossils: Cephalopoda, pl. 59, figs. 8, 9. 1876.
"	*sp.?*	"	Illustrations of Devonian Fossils: Cephalopoda, pl. 48, figs. 3, 4. 1876.

Shell subdiscoidal, dextral, involute, making about one volution and a half, departing but little from a symmetrical coil. The apical portion is contiguous to the basal half of the grand chamber and several air-chambers. Transverse section subcircular, obtusely angular on the concave dorso-lateral margin. The tube rapidly enlarges to a point near the middle of the chamber of habitation, and contracts more rapidly to the aperture. The diameter of the tube is doubled for about every half volution.

Chamber of habitation large, gibbous, having a length equal to twice the greatest diameter, curved, and extending about half its length beyond the point of contiguity with the inner, adjacent volution. A narrow zone of crenulations, consisting of short, distinct furrows, crossed by one or more concentric lines, is continued around the base of the grand chamber, but does not appear on the internal mould of the air-chambers. Aperture contracted, opening direct, or at right angles to the spiral axis of the tube.

Air-chambers regular, increasing in depth from the apex to the grand chamber, varying from five to eight mm., measured on the lateral face of the outer volution. The last one or two chambers, usually somewhat shallower than the preceding. Septa smooth, having a concavity equal to the depth of the air-chambers. Sutures slightly curved and oblique, making a slight retral sinus on the ventral side.

Siphuncle moniliform, close to the convex ventral side, having a diameter at the septa of five mm., where the tube measures about thirty mm.

Test and surface-markings unknown. The internal mould is nearly smooth, preserving some traces of transverse lines of growth. Sutures moderately impressed.

Numerous specimens have an average diameter of 100 mm., measured across the disc, with a greatest diameter of the tube of forty mm.

This species is distinguished from *T. Orion* by its less gibbous form, less twisted and curved chamber of habitation, and more oblique septa.

Formation and localities. In the Schoharie grit, Schoharie, and in the Helderberg mountains.

Trochoceras Orion.

PLATE LVIII, FIG. 2.

Cyrtoceras Orion, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 48, fig. 2. 1876.

Shell large, subdiscoidal, making more than one volution. Spire very depressed, dextral. Umbilicus abrupt, profound, having a diameter less than the transverse diameter of the grand chamber. Transverse section broadly oval; transverse diameter the longer, and oblique to the axis of the spiral. Tube rapidly enlarging to the middle of the chamber of habitation, and thence more rapidly contracting to the aperture.

Chamber of habitation large, subovoid, length twice the ventro-dorsal diameter, sharply curved at the base, and near the aperture directed outward from the spiral, tangent to the curve. It occupies about one-third of the outer volution, and has a capacity of more than twice the volume of the air-chambers. Aperture same as transverse section, with a distinct sinus in the ventral margin on the convex side of the tube.

Air-chambers regular, having a depth of eleven mm. on the convex side of the tube, near the grand chamber. Septa smooth, moderately concave. Sutures oblique, inclining toward the aperture on the upper, lateral face, and toward the apex on the lower or umbilical side of the tube.

Siphuncle near the convex ventral side, having a diameter at the septa of three mm. where the tube measures thirty-five mm.

Test not preserved. Surface marked by fine, sharp striæ of growth, which make a distinct sinus on the ventral side.

Internal mould essentially smooth, with the sutures slightly impressed.

In three specimens the disc has a diameter of about 100 mm. each, and the chamber of habitation has a greatest diameter of fifty mm.

This species closely resembles *T. eugenium*, but differs in its more gibbous form, less oblique sutures, and more curved and twisted chamber of habitation.

A fact worthy of notice in connection with the CYRTOCERAS, GYROCERAS and TROCHOCERAS, of the Schoharie grit, is the much greater proportion of specimens preserving surface characters than in ORTHOCERAS from the same horizon. This would seemingly indicate a much stronger test, with more decided surface characters, than in the latter genus.

Formation and locality. In the Schoharie grit, at Knox, Albany county, N. Y.

TROCHOCERAS BARRANDEI, n. sp.

PLATE CXI, FIGS. 8-10.

SHELL large, nautiloid, gibbous, making about one dextral volution. Spire depressed, not elevated above the upper lateral face of the grand chamber. Transverse section broadly oval or subcircular; lateral diameter apparently the longer. Tube very rapidly enlarging from the apex to the aperture. Apical angle about 22° in a specimen somewhat compressed.

Chamber of habitation large, regularly expanding, with a capacity somewhat less than the volume of the air-chambers, curving in the direction of the spiral axis. Crenulated band marked by obscure furrows, and several revolving lines at the base of the grand chamber.

Air-chambers regular, deep, having a depth of twelve mm., measured on the convex side of the tube, near the outer chamber, becoming gradually more shallow toward the apex. The last one or two chambers, usually somewhat shallower than the preceding. Septa smooth, with a concavity

about equal in depth to the air-chambers. Sutures slightly oblique to the spiral axis.

Siphuncle large, moniliform, expanding in the cavities of the air-chambers to nearly twice its diameter at the septa. The constrictions of the siphuncular tube are marked by strong transverse striæ. Its position on the ventral side is indicated on weathered specimens, where a portion of the tube is usually exposed.

Test and surface-markings unknown. Near the aperture the cast preserves traces of strong lamellose lines of growth. Internal mould essentially smooth, showing the crenulations at the base of the grand chamber, and the suture lines but slightly impressed.

One specimen, consisting of the chamber of habitation, and six attached air-chambers, has a length of ninety mm., of which about thirty mm. pertain to the chamber of habitation, which has a transverse diameter of sixty-five mm., measured near the aperture. A similar fragment, retaining eight air-chambers, has a length of 125 mm., measured on the convex side of the tube.

This species is remarkable for its very gibbous, nautiloid form, large apical angle, and the depth of the air-chambers. It is more involute than any of the succeeding species, although resembling in its nautiloid character *T. expansum*, which is distinguished by a lesser curvature, shallow air-chambers, and form of transverse section. The forms without annulations, which have preceded, including *T. eugenium* and *T. Orion*, are conspicuously different in the contraction of the tube toward the aperture, and its more gradual enlargement from the apex. The characters of the siphuncle are similar to many species of Gomphoceras (see *G. eximium*), and have not been observed in the other species of the genus described in this volume.

Formation and localities. In the Schoharie grit, Schoharie and Albany counties, N. Y.

Trochoceras Pandion.

PLATES LVIII, FIGS. 7–9; CXI, FIG. 3.

Trochoceras Pandion, Hall (in part). Illustrations of Devonian Fossils: Cephalopoda, pl. 48, figs. 7–9. 1876.

Shell large, coiled in an open spiral, departing but little from a plane, making somewhat more than one dextral volution. Transverse section broad, subtriangular, lateral diameter the longer. Tube nearly straight toward the aperture, gradually enlarging from the apex.

Chamber of habitation small, having a length equal to the diameter of the tube at the last septum. Crenulations preserved as obscure furrows over the cast of the walls of the air-chambers. Aperture contracted with a distinct sinus in the ventral margin.

Air-chambers regular, gradually increasing in depth toward the grand chamber, varying from three to five mm. in the length of fifty mm., measured on the upper, lateral face. Near the grand chamber they reach a depth of seven mm., and the last one or more are considerably shallower. Septa smooth, having a concavity equal in depth to one air-chamber. Sutures oblique, inclined toward the aperture on the upper, lateral face of the tube, and curving gently forward on the convexo-ventral side.

Siphuncle moniliform, near the ventral side, often exposed in the process of weathering.

Test and surface-markings unknown. Internal mould smooth, preserving obscure traces of the furrows of the crenulations. Sutures slightly impressed.

One imperfect specimen, preserving about one volution, has a diameter, measured across the volutions, of seventy mm. A fragment, making about one-third of a volution, and consisting of twelve air-chambers, has a length of seventy mm., and a ventro-dorsal diameter at the larger extremity of thirty mm.

This species is distinguished from *T. eugenium* by its more angular transverse section, open spiral, and oblique septa. It more nearly resembles *T. obliquatum*, which is characterized by its lesser curvature, shallower air-chambers, and rapidly enlarging tube.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

Trochoceras obliquatum.

PLATES LVIII, FIG. 5; CXI, FIGS. 1, 2.

Trochoceras obliquatus, Hall (in part). Illustrations of Devon. Fossils: Cephalopoda, pl. 48, figs. 5, 6. 1876.

Shell curved, making about one-half of one volution, which is twisted or bent out of one plane, producing a considerable variation from a symmetrical volution. Transverse section subquadrangular, becoming broadly elliptical or subcircular in some individuals; lateral diameter the longer. Tube regularly and gradually enlarging from the apex. The enlargement between the lateral faces is much more rapid than between the ventral and dorsal sides. Most of the specimens indicate a dextral helix; but in some, where the suture lines are inclined in a contrary direction, the spiral appears to be sinistral.

The chamber of habitation has a length equal to its greatest transverse diameter. Some obscure remains of the furrows of the crenulations are preserved on the cast of the walls of the air-chambers. Aperture unknown.

Air-chambers increasing in depth to the grand chamber, where they measure six mm. on a specimen in which the diameter of the tube at the point is thirty mm. Septa smooth, moderately concave. Sutures oblique, curving slightly downward over the dorsum, extending toward the aperture over the upper lateral face, and oblique on the ventrum.

Siphuncle small, near the ventral side. Test and surface-markings unknown. Internal mould essentially smooth, showing the obscure crenulations over the walls of the air-chambers. Sutures slightly impressed.

One imperfect individual, consisting of the grand chamber, and twenty-five attached air-chambers, has a length of 140 mm., of which forty mm. pertain to the chamber of habitation. A chambered fragment, having a length of 110 mm., preserves twenty-two air-chambers.

This species is distinguished from *T. Pandion* by its more angular transverse section, lesser curvature, and more numerous septa. Some of the phases closely resemble *T. expansum*, especially when compressed in a ventro-dorsal direction; but that species is more symmetrical, with an elliptical, transverse section, and has a nautiloid appearance, which is sometimes slightly imitated by special

conditions of *T. obliquatum*. *T. distortum*, BARRANDE, from the Silurian strata of Bohemia, is an allied form, but differs specifically in its greater curvature, elliptical, transverse section, and shallower air-chambers.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

TROCHOCERAS EXPANSUM, n. sp.

PLATES LVIII, FIG. 6; CXI, FIG. 5.

Trochoceras obliquatus, HALL (in part). Illustrations of Devonian Fossils: Cephalopoda, plate 48, figs. 5, 6. 1876.

SHELL large, nautiloid, gibbous, making about half of one volution, departing but little from one plane. The portion of a volution is curved in a sinistral direction. Transverse section elliptical; ventro-dorsal diameter about two-thirds of the lateral. Tube regularly and rapidly enlarging. Apical angle about 25°, but showing considerable variation, from the compressed nature of the specimens.

Chamber of habitation large, having a length less than the greatest lateral diameter. Aperture not observed.

Air-chambers regular, numerous, very gradually increasing in depth toward the grand chamber, varying from 1.5 to 4 mm. in different individuals. Septa smooth, moderately concave, the concavity amounting to about the depth of one air-chamber. The sutures curve toward the apex, over the dorsal and ventral sides, and toward the aperture on the lateral faces of the tube. Siphuncle small, close to the convex ventral side.

Test and surface-markings unknown. Internal mould smooth, with the sutures impressed.

A small individual, retaining a portion of the chamber of habitation, with six attached air-chambers, has a length of thirty-five mm., measured on the lateral face of the tube. About eighteen mm. of this length pertain to the grand chamber, which is somewhat compressed, and has a lateral diameter at the base of thirty mm. One fragment shows fifteen air-chambers in the length of forty mm., measured on the concavo-dorsal side.

This species is distinguished from *T. obliquatum* by its nautiloid form, lesser

departure from a symmetrical curve, shallower air-chambers, and transverse section. It somewhat resembles *T. Barrandei*, but that species is more gibbous, more incurved at the apex, with a larger apical angle and deeper air-chambers.

Formation and locality. In the Schoharie grit, at Schoharie, N. Y.

Trochoceras? (Gonioceras?) pandum, n. sp.

PLATE CXI, FIG. 4.

Among the extensive collections from the Schoharie grit have been observed several specimens of extremely doubtful relations. The shell was originally nearly straight, angularly elliptical in its transverse section, and rapidly enlarging from the apex.

Air-chambers numerous and very shallow toward the apex, suddenly increasing in depth toward the larger portion of the tube, and showing other irregularities. Near the apex of one specimen there are ten air-chambers, having a uniform depth of two mm. each. The four succeeding chambers measure five, seven, nine and fourteen mm. respectively.

The sutures make a broad retral curve over each face of the tube, and are extended forward, convex to the aperture, over the angles. Siphuncle and surface-markings unknown. Internal mould essentially smooth.

One fragment with a length of fifty-five mm. shows fourteen air-chambers. Another specimen, having about the same dimensions, preserves the same number of air-chambers, but exhibits a greater variation in their depth.

The curvature of the sutures and the acutely elliptical transverse section give this form much the aspect of Gonioceras; but the species of this genus have not shown such variations in the depth of the air-chambers, and none are known above the Lower Silurian. The absence of all distinctive characters beyond general form would probably assimilate it with Orthoceras; but it is unlike anything yet known in that genus. It bears some relation to Trochoceras, and might be associated with *T. expansum* or *T. obliquatum*, from its resemblance to a lateral view of a portion of one volution in these species; but the flat sides of the tube, its sharply angular transverse section, and the extreme variation in the depth of the air-chambers are distinguishing features.

NAUTILUS, Breyn. 1732.

In 1732 Breyn described and restricted the genus Nautilus, which term had been used by Aristotle; by Pierre Belon in 1553 and 1555 to include both Argonauta and Nautilus of later authors; by Aldrovandi in 1606, by Jonston in 1650, by Rumphius in 1711, and by W. Derham in 1726.

In 1825 Mr. J. de C. Sowerby described *Nautilus globatus*, from the Carboniferous limestone of Ireland (*Min. Con.*, p. 129, T. 481). This species has been identified by Meek and Worthen in the upper members of the Lower Carboniferous limestone of Illinois.

In 1838 Mr. T. A. Conrad described *Cyrtoceras maximus* [= *Nautilus maximus*], from the Hamilton group (*Geolog. Surv. of N. Y.: Pal. Dept., Ann. Rep.* 1838).

In 1842 Mr. L. Vanuxem described *Goniatites Marcellensis* [= *Nautilus Marcellensis*], from the Hamilton group (*Geolog. Surv. of N. Y.: Rep. Third Dist.*).

In 1852 Dr. D. D. Owen described *Gyroceras Burlingtonensis* [= *Nautilus Burlingtonensis*], from the Carboniferous—Burlington limestone; and *Discites tuberculatus* [= *Nautilus*], from the Upper Carboniferous limestone (*Geolog. Surv. of Wisconsin, Iowa and Minnesota*).

In 1853 Dr. L. Saemann described *Gyroceras expansum* [= *Nautilus* = *? N. bucinum*] (*Dunker und von Meyer: Palæontographica*).

In 1857 Prof. E. T. Cox described *Nautilus canaliculatus*, *N. decoratus* and *N. ferratus*, from the Coal Measures of Kentucky (*Geolog. Surv. of Kentucky*).

Mr. E. Billings described *N. Hercules*, from the Hudson-river group (*Geolog. Surv. of Canada: Rep. of Prog.*).

In 1858 J. Hall described *N. Clarkanus*, from the Lower Carboniferous system (*Trans. Albany Institute*, vol. 4).

Prof. G. C. Swallow described *N. Missouriensis*, from the Coal Measures, and *N. occidentalis* and *N. Permianus*, from the Permian system (*Trans. St. Louis Acad. Sci.*).

Dr. B. F. Shumard described *N. nodoso-dorsatus* and *N. planovolvis*, from the Coal Measures (*Trans. St. Louis Acad. Sci.*).

Messrs. MEEK and HAYDEN described *N. eccentricus*, from the Permian system (*Trans. Albany Institute*, vol. 4).

In 1859 Mr. BILLINGS described *N. Jason*, *N. natator* and *N. tyrans*, from the Chazy limestone (*Canadian Naturalist and Geologist*).

In 1860 J. HALL described *N. biserialis*, from the Coal Measures of Iowa (*Geolog. Surv. of Iowa*, supplement to vol. 1, pt. 2); *Lituites capax* [=*N. capax*] and *N. occidentalis* (not *N. occidentalis*, SWALLOW, 1858), from the Niagara group (*Geolog. Surv. of Wisconsin: Rep. of Prog.*); *N.* (*Discites*) *ornatus* [=*N. Marcellensis*], *Gyroceras liratum* [=*Nautilus liratus*] and *Gyroceras expansum*, var. SAEM. sp. [=*Nautilus*], from the Hamilton group (*Thirteenth Rep. N. Y. State Cab. Nat. Hist.*).

Messrs. MEEK and WORTHEN described *N. Chesterensis*, *N. spectabilis* and *N. subglobosus* (the latter since referred to *N. globatus*, Sow.), from the Carboniferous limestone; *N.* (*Discus*) *digonus*, from the Kinderhook group; *N.* (*D.*) *planorbiformis* and *N.* (*D.*) *Sangamonensis*, from the Coal Measures (*Proc. Acad. Nat. Sci. Phila.*).

Mr. J. H McCHESNEY described *N. Forbesianus*, *N. Illinoisensis*, *N. quadrangulus* and *N. nodocarinatus*, from the Coal Measures; and *Cyrtoceras giganteum* [=*Nautilus*], from the Niagara group (*New Palæozoic Fossils*).*

Prof. G. C. SWALLOW described *N. Gilpini*, from the Coal Measures, and *N. Lawsi*, from the Hamilton group (*Trans. St. Louis Acad. Sci.*).

In 1861 Mr. McCHESNEY published *Lituites cancellatus* [=*N. cancellatus*], from the Niagara group (compare with *Lituites*=*Nautilus capax*).

Messrs. MEEK and WORTHEN described *Nautilus* (*Trematodiscus*) *trisulcatus*.

In 1862 Mr. A. WINCHELL described *N. ingentior*, *Trematodiscus altidorsalis*, *T. discoidalis*, *T. Meekanus*, *T. planidorsalis*, *T. striatulus*, *T. strigatus* and *T. trigonus*, from the Marshall group (*Amer. Jour. Sci.*, 2d series).

In 1865 Mr. BILLINGS described *N. calciferus*, *N. ferox* and *N. Pomponius*, from the Calciferous group; *N. desertus*, *N. versutus* and *N. insolens*, from the Quebec group (*Palæozoic Fossils*).

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* In a revision of this paper by Mr. F. B. MEEK, in 1869, he makes the following synonomy: *Nautilus occidentalis*, SWALLOW, 1858,=*N. quadrangulus*, McC., 1860,=*N. nodocarinatus*, McC.,=*N. biserialis*, HALL, 1860. It is also to be remarked that these species are closely related to, if not identical with, [*N.*] *Discites tuberculatus*, OWEN, 1852 (not *N. tuberculatus*, SOWERBY, 1821).

Messrs. MEEK and WORTHEN described *N. capax* [=*Solenocheilus* (*Cryptoceras*) *capax*, M. and W., 1870], from the Coal Measures; *Nautilus* (*Endolobus*) *peramplus*, *N.* (*Discites*) *disciformis*, *N.* (*Temnocheilus*) *Niotensis*, *N.* (*Solenocheilus*) *Leidyi*, from the Lower Carboniferous limestones; and *Trochoceras Baeri* [=*Nautilus*], from the Hudson-river group (*Proc. Acad. Nat. Sci. Phila.*).

In 1866 Messrs. MEEK and WORTHEN described *N. Lasallensis*, from the Coal Measures, and *N. Rockfordensis*, from the Kinderhook group (*Proc. Acad. Nat. Sci. Phila.*).

Prof. H. B. GEINITZ described *N. Seebachanus* (=*Pteronautilus*, MEEK), from the Permian system (*Carb. and Dyas in Nebraska*).

In 1868 Prof. J. W. DAWSON described *N. Avonensis*, from the Carboniferous system (*Acadian Geology*).

Messrs. WHITE and ST. JOHN described *N divisus* (not *N. divisus*, MEYER, 1831) and *N. Springeri*, from the Coal Measures (*Trans. Chic. Acad. Sci.*).

In 1869 M. J. BARRANDE described *N. avus*, from the Quebec group (*Syst. Sil. du centre de la Bohême*).

Messrs. MEEK and WORTHEN described *N.* (*Temnocheilus*) *Coxanus*, from the St. Louis limestone (*Proc. Acad. Nat. Sci. Phila.*).

In 1870 Messrs. MEEK and WORTHEN described *N.* (*Solenocheilus*) *collectus*, from the St. Louis limestone; *N.* (*Temnocheilus*) *latus* and *N.* (*T.*) *Winslowi*, from the Coal Measures (*Proc. Acad. Nat. Sci. Phila.*).

In 1871 Mr. F. B. MEEK described *Gyroceratites* (*Trochoceras?*) *Ohioensis*, and *Gyroceratites* (*Nautilus?*) *inelegans* [=*Nautilus*] (*Proc. Acad. Nat. Sci. Phila.*, 1871, and *Geolog. Surv. Ohio: Palæontology*, vol. 1, 1873).

In 1876 J. HALL illustrated *N. Barrandei* (not *N. Barrandei*, VON HAUER), *N. bucinum*, *N. cornulum*, *N. oriens* and *Gyroceras subliratum* [=*Nautilus*], from the Hamilton group (*Illus. of Devon. Foss.: Cephalopoda*).

In 1879 Mr. C. A. WHITE described *N. Danvillensis*, from the Coal Measures of Illinois (*Proc. Acad. Nat. Sci. Phila. for* 1878).

J. HALL described *N. Oceanus*, from the Niagara group of Indiana (*Trans. Alb. Inst.*, vol. 10).

Nautilus liratus.

PLATES LVII, FIG. 3; LX, FIGS. 8, 9.

Gyroceras liratum. Hall. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 104. 1860.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 57, figs. 5, 6; pl. 58, figs. 1, 2; and pl. 60, figs. 8, 9. 1876.

Shell subdiscoid-ovoid, trumpet-shaped, gibbous, becoming ventricose toward the aperture. Volutions about two, or more, barely contiguous and rapidly expanding. Umbilicus wide, exposing all the volutions. Transverse section subcircular or moderately transverse. Tube very rapidly enlarging. Apical angle, as measured between the dorsal and ventral sides, about 16°.

Chamber of habitation large and widely expanded, occupying a great part of the outer volution. Aperture subcircular or somewhat transverse, without any observed sinus in the margin, and opening at right angles to the direction of the tube. Air-chambers somewhat regular, increasing in depth from the apex, and becoming shallower near the grand chamber.

Septa regular, strong, thickened and imbricating at their margins. A fragment of the chambered portion, apparently extending nearly to the base of the grand chamber, shows the distance of the septa to be from six to eight or nine mm. on the convex side, while the distance between the last two, as preserved, measures only five mm. The suture lines are strongly impressed and distinctly imbricating.

Siphuncle central or subcentral.

Test one mm. thick on the side of the volution over the chambered portion, and thinner on the ventral side. The septate portion of the tube is marked by obscure annulations, which are less frequent than the septa, becoming stronger and more conspicuous toward the apex, and obsolete on the grand chamber. It is likewise ornamented by broad, rounded, longitudinal, diverging ridges, which are more strongly marked upon the lateral and concave portions. These carinæ, or plications, which are narrow and closely arranged near the apex, and diverge with the expansion of the shell, become more or less obsolete toward the aperture, especially upon the convex

portions. Near the apex they are distant from each other less than two mm., and diverge until they are at least ten mm. distant toward the aperture. The interspaces are at first curved in the bottom, concave, becoming gradually flattened, as the distance between the ridges increases. The entire surface is marked with fine, thread-like, transverse striæ; and sometimes, in the exfoliated condition, with obscure, revolving striæ, which appear to pertain to the inner or nacreous layers of the shell.

The internal cast is distinctly marked by the suture lines, and by the strong revolving ridges; and obscurely marked by the transverse and revolving striæ. One specimen has a diameter of ninety mm., and includes a portion of the grand chamber, occupying about half a volution. A fragment of the chambered portion, incomplete at the apex, measures 130 mm. on the periphery.

The typical specimen preserves a mammillary deposit upon the surface, apparently connected with the inner laminæ of the shell.

This species is quite distinct from the ordinary forms of NAUTILUS, and there is little external similarity between them. It is referred to NAUTILUS on account of the contiguous volutions, the form of the transverse section, the large, apical angle, the comparative size of the chamber of habitation and the chambered portion of the shell, and the absence of any well-defined sinus, while the siphuncle is subcentral. This species is distinguished from the other forms, except *N. subliratus*, by the presence of strong, revolving carinæ.

In the typical specimen of *N. liratus* there are fourteen revolving ridges over the chambered portion of the shell, a part of which become obsolete upon the ventral side of the grand chamber. In the specimen fig. 3 of plate 57 there are nine strong plications seen on the lateral face of a partially compressed grand chamber.

Formations and localities. In the Goniatite limestone, near Manlius, N. Y.; and in the shales of the Hamilton group, in Madison county.

NAUTILUS SUBLIRATUS.

PLATE LVII, FIGS. 4, 6, 7, and 5?

Gyroceras subliratum, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 58, figs. 1, 2. 1876.

SHELL subglobose or subovoid, ventricose, making more than a single volution. Volutions contiguous, not embracing; umbilicus exposing all the whorls. Transverse section broadly elliptical, usually flattened from compression, and with a gentle sinus on the concave dorsal side. Tube rapidly expanding. Apical angle, as measured from a compressed specimen, about 19°.

Chamber of habitation having a length about twice the diameter at the base, which is two-thirds the apertural diameter. Aperture opening at right angles to the direction of the axis of the tube; the dorsal and dorso-lateral margins plicated. Air-chambers regular, the last one or two shallower than the preceding.

Septa regular, making a slight inflexion over the lateral face of the volution; distant on the convex side of the outer volution from six to eight or nine mm., and less than half that distance on the concave side. Suture lines distinctly marked in the cast. Siphuncle subcentral.

Test not preserved, except some portions of the inner laminæ in a macerated and exsolute condition. Surface on the concave dorsal side, and partially on the lateral faces, marked by strong, gradually diverging, rounded, revolving ridges or plications, with wider, concave interspaces, which are usually absent along the median area, and become gradually obsolete, or abruptly disappear toward the ventral side. Entire surface marked by regular, transverse striæ, and on the lateral and ventral sides by distant, longitudinal striæ.

In a cast of the grand chamber of a specimen in which scarcely any surface-markings remain, there are two broad, shallow, undefined, longitudinal depressions, traversing the entire ventral side of the chamber, while the margin of the aperture shows obscure, undefined sinuosities.

The internal cast is marked by the impressed septal lines, the strong radiating ridges, and the fine transverse and longitudinal striæ, as well as

by obscure or obsolete transverse annulations on the chambered portion. A single specimen shows obscure, wide, flattened longitudinal folds over the convex side of the chambered portion of the volution, but they are not continued over the chamber of habitation. This part of the surface is sometimes very distinctly marked by longitudinal, impressed striæ, which are about the same distance apart as the narrow depressions between the wide, obscure plications.

Another fragment of the chambered portion of a larger shell shows similar but much more distinct plications upon the surface, and is doubtfully referred to the same variety of form.

A single large individual shows obsolescent, longitudinal folds over the surface of the cast of the chamber of habitation. The largest specimen has had a diameter of about ninety-five mm., and a specimen slightly compressed, near the distal termination of the chambered portion, has a transverse diameter of about fifty mm.

This species, or variety of form, is closely related to, if not specifically identical with *N. liratus*. It was originally separated from *N. liratus*, on account of the absence of the radiating costæ upon the centre of the concave dorsal side of the shell, as well as upon the convex portion of the outer chamber. With the present material for study and comparison, it has appeared necessary to recognize the distinction in order to reconcile the marked differences observed in the specimens. It may be remarked, that of those referred to *N. liratus*, one presents a lateral view, and the other is crushed in a lateral direction. All the specimens referred to *N. subliratus*, with one exception, are crushed in a ventro-dorsal direction, and this fact may have some connection with the apparent differences.

This form may be compared with *N. pinguis*, DE KONINCK.

Formation and locality. In the compact shales of the Hamilton group, at Earlville, Madison county, N. Y.

NAUTILUS LIRATUS, var. JUVENIS, n. var.

PLATE LVI, FIGS. 5, 6.

Nautilus liratus, HALL (in part). Illustrations of Devonian Fossils: Cephalopoda, pl. 57, figs. 5, 6. 1876.

SHELL subovoid, discoid. Transverse section elliptical. The ventro-dorsal diameter about three-fifths as great as the transverse diameter. A part of the difference being probably due to moderate compression.

Volutions rapidly expanding from near the base of the great chamber, which is subovoid, with unequal diameters. Number of volutions unknown.

Chamber of habitation deep and wide, having a length, on the convex side, of fifty-five mm., with an equal transverse diameter at the aperture, and a ventro-dorsal diameter of twenty-eight mm. Aperture transverse to the direction of the tube, elliptical in outline. Ventral side entire, without sinus. Air-chambers not satisfactorily determined: there are about four attached to the base of the grand chamber, which are partially crushed and the form distorted.

Septa direct, moderately concave. Suture lines not satisfactorily observed. Siphuncle obscure, apparently small and subcentral.

Test thin, imperfectly preserved on the specimen. Surface, in the partially preserved shell, marked on the concave and lateral faces by slender, sharp, cariniform ridges, of which there are fourteen or fifteen on each side, becoming gradually subdued and obsolete on the convex or ventral side. Ventral side marked by about twenty subdued, rounded, longitudinal striæ, which are arranged at subequal distances on each side of a wider median space. Entire surface marked by fine, even, transverse, thread-like striæ, which traverse the flat or concave interspaces, and arch over the ridges, producing a crenulate aspect. On the ventral side these transverse striæ are more conspicuous than the longitudinal striæ, which do not perceptibly interrupt their course. The surface is farther marked by low, rounded and inconspicuous, transverse undulations, of which about eleven may be counted on the grand chamber. No sinus has been observed in the margin of the

aperture; but there are indications in the striæ of an obscure sinus on each side, half way from the centre to the lateral margins on the ventral face of the shell.

The specimen described has a length of about seventy mm., and includes several imperfectly preserved air-chambers. Of this length, fifty-five mm. pertain to the grand chamber, which is equal to the greatest transverse diameter. The dorso-ventral diameter of twenty-eight mm. is somewhat reduced from the natural proportions by pressure; while the transverse diameter is slightly increased from the same cause.

With only a single imperfect specimen, the determination is quite unsatisfactory; but this form possesses so many characters in common with *N. liratus* that its specific relations may be inferred, the features being those which might be presented in the immature condition of that species.

Formation and locality. In the arenaceous beds of the Hamilton group, in Madison county, N. Y.

Nautilus bucinum.

PLATES LX, FIGS. 1-4; CVI, FIGS. 4-7; CVII, FIGS. 2-5; CIX, FIGS. 1, 2.

Nautilus bucinum, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 60, figs. 1-4. 1876.
Compare *Gyroceras expansum*, Saemann. Dunker and von Meyer's Palæontographica. 1853.
Not *Nautilus expansum*, Sowerby. Min. Conchol., vol. 5, p. 83, tab. 458, fig. 1. 1825.
Gyroceras expansum, var., Hall. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 104. 1860.

Shell subovoid, ventricose, rapidly expanding toward the aperture.

Volutions about one and a half or two, contiguous, not embracing, exposed for their entire length. Umbilicus large, profound. Transverse section broadly elliptical. The dorso-ventral and transverse diameters about as three to four, three to five, and five to seven, measured on different parts of the chambered portion of the shell, some variation being due to pressure. The enlargement of the volutions is very rapid, the transverse diameter increasing to nearly double in less than a single volution preceding the grand chamber.

Chamber of habitation large, rapidly expanding from its base, and becoming very ventricose. Longer than wide. Its capacity about twice as great

as all the chambered portion of the shell. Gently constricted near the aperture. Aperture straight, entire, opening horizontally and transverse to the axis of the shell. Margin slightly curving toward the apex on both the dorsal and ventro-lateral sides. Air-chambers regular, gradually increasing in depth toward the grand chamber. In a fragment of the chambered portion of the tube, measuring about sixty mm. on the curve of the convex side, and having a width of thirty-six mm. in the middle of its length, there are nine air-chambers.

Septa thin, regular, having a concavity of about 110°, and equaling the depth of one and a half air-chambers; closely arranged on the axial margin, and distant six to ten mm. on the ventral side. Sutures distinctly marked, and often deeply impressed from the solution or weathering of the septal margins.

Siphuncle near the concave dorsal side, and about one-fourth or one-third of the dorso-ventral diameter from the surface. Its elements between the septa not observed.

Test thin, having a thickness of about one mm. on the dorsal side, and from .5 to .75 mm. on the convex ventral side. Surface marked by very fine lines of growth, and by regular, more distant, transverse striæ. These are crossed by regular, sharply elevated, revolving striæ, of which there are about four in the space of ten mm. near the aperture, and between these there are finer, irregular striæ. The stronger revolving striæ are not unfrequently very prominent, and assume the character of gentle carinations on the concave side; but they are more subdued upon the convex side. In examples where the shell is partially exfoliated, the inner layer preserves the longitudinal, and to some extent the transverse striæ, in a very subdued condition.

The internal cast is essentially smooth, with the sutures distinctly impressed, and the substance of the filling strongly imbricating. Sometimes there are thin films of the macerated test remaining attached, which partially preserve the surface-markings; and the cast often retains distinct impressions of the revolving striæ of the inner, nacreous layer of the shell.

There is likewise sometimes, a distinct longitudinal carina, marking the surface of the filling of the air-chambers along the centre, on the convex ventral side; and the same feature is shown in the inner laminæ of the shell. In the same position the cast sometimes preserves a gentle sinus on the ventral side of the chamber of habitation.

This species, in the larger individuals, has a diameter of about ninety mm., with a transverse diameter of the tube, near the aperture, of sixty-five mm.

This form is distinguished from *N. liratus* by the absence of the strong, revolving plications, the greater curvature of its volutions and the position of the siphuncle. From *N. cornulum* it differs in the proportionally greater transverse diameter, and the simple contiguity of the volutions. It has a wide vertical and horizontal distribution in the shales of the Hamilton group, occurring also in the Goniatite limestone. It becomes more common in the coarse, arenaceous shales of the lower part of the group in Schoharie, Otsego and Madison counties, especially near Cazenovia. It occurs in the higher, semi-calcareous shales of the group in the central and western part of the State. It also occurs near Cumberland, Md., and the adjacent part of Virginia.

Formations and localities. In the Goniatite limestone, near Manlius; in the Hamilton group, at Schoharie; Cazenovia; on the shores of Cayuga and Canandaigua lakes; near Genesco, Avon and York, in Livingston county, and other localities in Central and Western New York; and at Cumberland, Md.

Nautilus cornulum.

PLATE LX, FIGS. 5, 6.

Nautilus cornulum, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 60, figs. 5, 6.

Shell subdiscoid, ovoid, gibbous. Volutions about two or more, slightly re-entrant, exposing nearly their entire width. Umbilicus profound. Transverse section subcircular, with a distinct sinus on the concave dorsal side, where it embraces the adjacent volution. Tube regularly and rapidly enlarging. Apical angle about 16°.

Chamber of habitation large; length about twice its diameter at the base, slightly contracting at the aperture, its capacity at least twice as great as all the septate portion of the shell. Aperture at right angles with the direction of the tube, slightly curving toward the apex on the convex ventrum. Air-chambers regular, gradually increasing in depth toward the grand chamber, and on the convex side increasing from a depth of six to nine mm. in the distance of nine chambers.

Septa regular, somewhat distant; nine in the space of fifty mm., as measured on the convex side of the outer volution, from the base of the grand chamber. Suture lines not deeply impressed. Siphuncle below the centre, on the concavo-dorsal side.

Test imperfectly preserved in the specimens examined, consisting mainly of the inner, macerated laminæ attached to the cast. The exterior surface has been marked by distinct, somewhat irregular, lamellose striæ of growth, which are crowded in folds toward the margin of the aperture. These have been crossed by fine, somewhat distant and irregular, elevated, radiating or revolving striæ, which, on some parts of the shell, give a regularly cancellated surface.

The interior cast is essentially smooth, preserving remains of the surface-markings, which are chiefly indicated in the transverse striæ. One specimen has a diameter of seventy-two mm., and a transverse diameter of the tube, near the aperture, of forty mm.

This species bears much general resemblance to *N. bucinum*, but is distinguished by its slightly re-entrant or embracing inner volutions, its more nearly circular transverse section, its less rapidly expanding tube, with comparatively more distant septa, and by its surface characters. From *N. liratus*, in all its varieties, it is more decidedly separated by the character of its surface-markings.

Formation and locality. This species is known only in the arenaceous shales of the Hamilton group, near Cazenovia, N. Y.

Nautilus cavus, n. sp.

PLATE CVI, FIGS. 1-3.

Shell subglobose, ventricose. Volutions at least two; the inner ones re-entrant and exposing only the lateral faces. Umbilicus deep. Transverse section subelliptical, somewhat concave, and indented in the middle of the dorsal side by a deep sinus produced by the inner adjacent volution. Transverse diameter nearly twice as great as the dorso-ventral diameter. Tube rapidly expanding. Apical angle about 16°.

Chamber of habitation and aperture unknown. Air-chambers regular, comparatively deep, and increasing in depth with the expansion of the volutions.

Septa regular, distant, increasing in distance from eight to fifteen mm. in the space of less than half a volution. The septa, at their origin on the concave-dorsal side, are distant about two mm., and make an abrupt retral curve in the sinus. A length of eighty mm., measured on the convex curve of the outer volution, preserves seven septa and six air-chambers entire. The suture lines are conspicuously marked on the cast. Siphuncle undetermined.

Test not preserved. The surface has been marked by lamellose lines of growth and regular revolving striæ, as indicated by a small fragment of the macerated test remaining on the cast. A deep sinus marks the concave dorsal side.

The cast of the interior is essentially smooth, except the impressed suture lines, and some remains of the impression of the surface striæ. A narrow raised line is preserved on the convex ventral side of the air-chambers, indicating the ventral carina. Where the test is entirely removed the cast appears smooth; but where the inner laminæ remains the surface is covered by a fine mammillary deposit.

A fragment preserving eight septa has a length of about ninety mm., as measured on the convex curve; its greatest transverse diameter being about fifty-five mm.

This species may be distinguished from *N. cornulum* by its more re-entrant volutions, the form of the transverse section, the more distant septa, and their curvature on the dorsal side. From *N. bucinum* it differs in its re-entrant volutions and deeper air-chambers. From *N. acræus* it may be distinguished by the same characters and by the surface-markings.

Formation and locality. In the shales of the Hamilton group, near Cumberland, Maryland.

Nautilus acræus, n. sp.

PLATE CIX, FIGS. 3-5.

Shell small, obliquely subovoid, ventricose. Volutions not exceeding two, contiguous or slightly re-entrant. Umbilicus very deep. Transverse section elliptical, with a gentle sinus on the concave dorsal side. The dorso-ventral and transverse diameters are about as two to three, the difference increasing in the grand chamber. Tube rapidly enlarging. In a somewhat flattened specimen, the apical angle is about 20°.

Chamber of habitation large, its volume much greater than all the septate portion of the shell; its length twice the lateral diameter at the base. Aperture nearly straight, not oblique to the axis of the shell. Air-chambers of moderate depth; not satisfactorily determined.

Septa having a very moderate degree of concavity. Siphuncle small, subcentral, being a little above the centre on the dorsal side.

Test thin. Surface marked by fine, irregular lines of growth, and by fine, sharp, regular, and closely arranged revolving striæ, about twelve in the space of four mm. on the convex side, and a little more distant on the concave side of the outer volution.

The internal cast preserves impressions of the transverse and revolving striæ. The outer chamber of a small specimen has a length, as measured on the convex side, of a little more than forty mm., while its greatest diameter at the base is eighteen mm., and at the aperture, where it has been more compressed, thirty mm. A larger individual, somewhat more compressed, has a diameter at the base of the grand chamber, of thirty mm.

This species may be distinguished from *N. bucinum* by its smaller size, more closely coiled volutions, and more regular surface-markings, especially in the even and closely arranged revolving striæ. It differs from *N. cornulum* in its more elliptical transverse section, larger apical angle, and by its surface characters. This is the smallest form observed among the species of this genus in the Hamilton group, and it is of rare occurrence in the collections.

Formation and localities. In the coarser, arenaceous shales of the Hamilton group, near Cazenovia, Madison county, N. Y.

NAUTILUS MAXIMUS.

PLATES LXIII, LXIV, AND SUPPLEMENT.

Cyrtoceras maximum, CONRAD. Geolog. Surv. of N. Y.: Pal. Dept., First Ann. Rep., p. 117. 1838.
Nautilus maximus (CONR.), HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 64, fig. 1; pl. 64 A, fig. 1. 1876.

SHELL very large, subdiscoid, gibbous, becoming very ventricose. Volutions about three, contiguous, not re-entrant. Umbilicus wide and deep, exposing all the volutions. Transverse section subcircular, flattened on the concave dorsal side. Tube regularly and gradually enlarging to a point near the aperture. Apical angle about 14°.

Chamber of habitation very large and ventricose, occupying half a volution or more. In the larger individuals it is free from the inner volution for about one-third of its length. Length of the grand chamber more than twice its greatest diameter, gradually contracting toward the aperture from a point about two-thirds of its entire length from the base. Aperture slightly oblique to the axis of the tube, opening upward. Air-chambers numerous, regular and very deep, gradually increasing from the apex, and measuring on the convex side, sometimes more than thirty mm.; the last one shallower than several of those preceding.

Septa regular, distant, very concave, the concavity greater than the depth of the air-chambers; strongly imbricating. The distance between the septa is variable in different specimens, but in the same individual is nearly constant, with a gradually increasing distance. Measurements taken from the convex side of the outer volution of three individuals show four chambers in

the space of 60, 110 and 125 mm. respectively. Siphuncle large, subcentral, slightly expanding between the septa; its elements not fully observed. The ventral side of the shell is indicated by a sharp, narrow, longitudinal, raised line on the outer face of the chambers, on the convex side of the volution.

.Test preserved only in a macerated and exsolute condition. Surface marked by fine and coarser, irregular, lamellose lines of growth, and fine, regular, undulating, elevated, thread-like striæ, parallel to the lines of growth; longitudinally marked by rounded, or sometimes sharper, undulating, revolving striæ, of which there are five or six in the space of five mm. These markings are visible on the cast, or on the macerated inner laminæ of the shell.

The internal cast is strongly marked by the suture lines, which are deeply impressed from the solution and removal of the imbricating margins of the septa; and the filling of these narrow spaces is usually more or less broken, leaving the suture lines irregular. In all the specimens the surface of the cast or of adhering inner portions of the shell is pitted with minute, rounded depressions, or with corresponding elevations, which appear to be of organic origin. This marking pertains to the inner layer of the shell, or to the immediate underlying or interior surface, and bears a close resemblance to the markings of the organic deposit in *Orthoceras luxum*.

The largest known specimen of this species has a diameter of 360 mm.; and the chamber of habitation of the same specimen, measured along the middle of the lateral face, has a length of more than 360 mm., and measured on the periphery, has a length of more than 450 mm.

In nearly all the specimens observed the chamber of habitation is more or less covered with scattered groups of a parasitic Bryozoan, having the form of a low, flat disc, with a central depression. These discs have a diameter of from six to fifteen mm., and the only structure exhibited is a radiate and concentric arrangement of obscure pores or cells. There is also frequently a tubular, branching Bryozoan upon the surface of the cast, which appears to have been attached to the interior of the shell.

This species is closely allied to *N. oriens*, which presents a somewhat different surface-marking, with a closer coiling of the volutions, giving the appearance as if partially embraced by the outer volution. All the forms which have been referred to that species are laterally compressed, which may cause or augment this appearance.

The *N. maximus* differs from *N. magister* in the more circular transverse section, in the less closely coiled volutions, and in the surface-markings, as well as in the position of the siphuncle.

Formation and localities. In the lower, arenaceous shales of the Hamilton group, at Earlville, Solsville and other places in Madison county; and in the higher shales of the group, near Borodino, on Skaneateles lake.

Nautilus oriens.

PLATES LXI; CV, FIG. 2; CVI, FIG. 8.

Nautilus oriens, Hall. Illustrations of Devonian Fossils: Cephalopoda, pl. 61, fig. 1. 1876.
Compare *Nautilus maximus* (Conr.), Hall. Page 418, plates LXIII and LXIV.

Shell large, subovoid, discoid, making about three volutions, which are slightly re-entrant. Umbilicus very wide, exposing all the volutions. Transverse section subcircular. Tube somewhat gradually enlarging in the inner volutions. The apical angle, as taken from a compressed specimen, is about 15°.

Chamber of habitation large, ventricose, rapidly expanding. Aperture opening at right angles to the axis of the tube, with a gentle sinus on each side of the convex ventral face of the shell. Air-chambers regular, deep, increasing in depth with the enlargement of the volutions. The measurement of two specimens give a depth of twenty to twenty-five mm.

Septa regular, distant, having a greater concavity than the depth of the air-chambers, strongly imbricating. As measured on the ventrum of one specimen, they have a distance of twenty-five mm., where the tube has a diameter of seventy-five mm. Suture lines strongly marked on the casts and partial casts of the interior.

Test imperfectly preserved, and its thickness not determined. In the compressed and macerated specimens, partially retaining the shell, or its

impressions upon the cast, the surface is shown to have been marked by fine, lamellose, somewhat undulating striæ of growth, and finer elevated lines, which are interrupted by coarser revolving striæ, and these are especially conspicuous on the dorsal side, on the margins, and within the cavity of the umbilicus, forming low rounded ridges, which are at unequal distances. Similar, but less conspicuous, revolving striæ or low ridges, are often preserved over the ventral face of the shell, while a single specimen preserves the marks of obsolescent, low undulations, as in some specimens of *N. subliratus*. In another specimen, near the aperture, there is a belt more than twenty mm. wide, which is strongly marked by rounded, transverse undulating striæ, the undulations being caused by slender revolving striæ, of which there are six or seven in the space of five mm.

The internal cast is essentially smooth and polished (this feature being due to the nature of the matrix), with the exception of the suture lines, the impressions of the transverse striæ, and the obscure radiating striæ, and obsolescent undulations. The largest individual observed has a diameter of about 200 mm., as measured across the volutions at the base of the grand chamber; the entire individual has been much larger.

This species has its nearest relations with *N. maximus*, and possesses many features in common with that form. With a single exception all the specimens are laterally compressed, and this may conduce to the contraction of the umbilicus and the apparent re-entrant character of the volutions which is observed in comparison. The specimens are preserved in a soft, fissile black shale, and the surface-markings are more distinctly retained upon the cast, or upon the adhering inner laminæ of the shell, than in *N. maximus*, which is usually imbedded in a coarser material. The pitted and mammillary deposit, which everywhere marks the exfoliated specimens of *N. maximus*, is either entirely absent, or scarcely at all observable on the specimens of *N. oriens*.

This form is distinguished from *N. magister* by its comparatively wider umbilicus, the greater exposure of the inner volutions, the nearly circular transverse section, and sinus in the aperture. The surface-markings and the absence of nodes on the ventro-lateral margins are distinctive features.

Formation and localities. The specimens of this form have been principally obtained from the Marcellus shale, at Richmondville, Schoharie county. Some fragments of the same have been found at another locality in the same county.

NAUTILUS MAGISTER, n. sp.

PLATES LXII, CVII, FIGS. 1, 6, 7, 8; CVIII, FIGS. 1, 2.

Nautilus Barrandi, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl 62, fig. 1; pl. 63, fig. 1; pl. 64 A, fig. 2. 1876.

Not *N. Barrandei*, VON HAUER. Haidinger: Naturwissenschaftliche Abhandlungen, 3. Band, pl. 1. 1850.

SHELL large, globose, the transverse and ventro-dorsal diameters being about as eleven to twelve, making about three volutions. Volutions re-entrant, embracing to one-third the diameter of the inner contiguous volution. Umbilicus comparatively narrow and profound. Transverse section elliptical, with a broad rounded sinus on the concave dorsal side. Transverse diameter the longer,—the two diameters being in the ratio of three to four. Tube rapidly enlarging. Apical angle about 18°.

Chamber of habitation large, very ventricose, its capacity greater than the entire septate portion of the shell. The length, as compared with the greatest diameter at the base, is about as nine to seven, and somewhat rapidly expanding to the aperture. Aperture opening at right angles to the axis of the tube, with a gentle sinus in the centre of the convex ventral side. Air-chambers regular, and gradually enlarging toward the chamber of habitation, the last one being shallower than the preceding; having a depth of from eighteen to thirty mm. in the distance of eleven chambers, as exposed on the ventral side of the outer volution.

Septa thin, regular, very concave; concavity greater than the depth of the air-chambers; from three to four in the space of seventy-five mm., measured on the convex side of the outer volution of the shell, the distance on the umbilical margin being from seven to nine or ten mm. in the distance of eight septa. The margins are extremely advanced and highly imbricate on the ventral side. Their convexity in the transverse diameter is equal to 106°, and in the direction of the ventro-dorsal diameter 110°. Some speci-

mens indicate a small, shallow depression, close to the dorsal margin, on the concave faces of the septa.

Siphuncle large, expanding abruptly, and becoming cylindrical between the septa; diameter about one-fifth the dorso-ventral diameter of the tube at the same point; position subcentral, above the middle, or ventral as measured in a direct dorso-ventral direction, at right angles to the axis of the shell; and below the centre, or dorsal, as measured on the convex face of the septa; surrounded by an areola on the septa; section circular. Casts of the interior show a narrow, raised band on the ventral side, having a width of 1.5 mm.

Test partially preserved, having a thickness of 1.5 mm. on the sides of the volution, and .75 mm. on the ventral portion. The surface shows broad, lamellose lines of growth, and obscure, wide radiating striæ, which, on some parts, are wider than the intermediate spaces. The inner laminæ of the shell are marked by very fine, revolving striæ, which are scarcely elevated, but constitute an intimate part of the shell structure. The tube is ornamented with low, rounded, obscure nodes on the dorso-lateral faces, which are about as frequent as the septa. These nodes, in some cases at least, appear to be connected with a more abrupt advance of this part of the shell; and are preserved upon the cast of the interior.

The internal cast presents no unusual features. Owing to the extremely imbricating character of the septa, the thin margins of the chamber fillings are usually broken. Measurements taken from a large, nearly entire chamber of habitation, give a length of 190 mm., with a greatest lateral diameter of 170 mm., and the greatest dorso-ventral diameter of 140 mm. The diameter of the siphuncle between the septa is seventeen mm., and at the septa ten mm. The diameter of the specimen, plate 62 and plate 63, measured across the volutions, is 185 mm.

This species is distinguished by its great size and broad, re-entrant volutions. Comparisons with *N. maximus* have already been made on page 420.

Formation and locality. In some concretionary calcareous layers, in the upper shales of the Hamilton group, on the shore of Lake Erie, in the town of Hamburgh, Erie county, N. Y.

The forms of NAUTILUS described in the preceding pages present a most remarkable similarity in the plan and style of the surface-markings; although, at first view, there seems little similarity between *N. liratus* and *N. maximus*, yet they are of precisely the same order.

In *N. liratus* the surface ornamentation is condensed and excessive. The revolving striæ and plications constitute the prominent features of the surface, while the transverse striæ, in well-preserved specimens, are likewise conspicuous. The absence of the test in most of the specimens renders it impossible to know fully the original aspect; but this may be inferred from the impressions upon the casts of the interior. The specimen given as *N. liratus*, var. *juvenis*, presents a subdued condition of the surface characters, which are more fully developed in the typical specimens of the species. The same character, in a still more subdued condition, marks the surface of *N. bucinum*, *N. cavus*, and, in a lesser degree, that of *N. cornulum*, while it is still preserved in the extremely fine markings on the surface of *N. acræus*.

These surface features, in an extenuate and obsolescent condition, are still observable in the surfaces of *N. oriens*, *N. maximus* and *N. magister*. In specimens of *N. oriens*, which are partial casts of the interior, the entire lateral face is seen to be marked by low, undefined, revolving plications, which are sometimes so obscure as to be seen only by reflected light. A similar character, with wider and scarcely distinguishable low folds or undulations of the surface, is visible on the chamber of habitation, near the aperture. In all cases wherever any portion of the shell is retained, or even in the unweathered casts, the fine, thread-like, transverse striæ are present, differing in no respect from those on the surface of *N. liratus*. In one example where a portion of the outer chamber of *N. oriens*, near the aperture, is preserved in black shale, the transverse striæ are extremely conspicuous, with only narrow revolving striæ perceptible, having precisely the appearance of an extenuate portion of the surface of *N. liratus*, var. *juvenis*. The surface characters of *N. maximus* and of *N. magister* are less distinctly preserved; but in the small, remaining portions of the test, or its imprint upon the cast of the interior, the same style of marking is observed.

NAUTILUS, Subgenus DISCITES, McCOY.

The three following species possess characters which, in many respects, are very unlike the preceding. The general form of the shell and position of the siphuncle, as well as the surface-markings and ornamentation, are quite distinctive. They are all laterally compressed and angular, or subangular, on the umbilical and peripheral margins. The septa make a distinct, more or less deep and angular sinuosity on the dorso-lateral and ventro-lateral angles of the volutions, precisely as in the simpler forms of GONIATITES.

For forms of this character Prof. McCoy proposed the name DISCITES, which however, has been but partially recognized by authors, the species being usually arranged with NAUTILUS proper. It appears to me that possessing so many characters, which are widely different from the typical forms of that genus, they should receive some distinct recognition, at least as a subgeneric type.

NAUTILUS (DISCITES) AMMONIS, n. sp.

PLATE—SUPPLEMENT.

SHELL large, discoid; the greatest thickness of the disc is equal to one-seventh of its diameter, or one-half the dorso-ventral diameter of the outer volution.

Volutions about three, having the dorso-ventral diameter greater than the transverse diameter. Inner volutions re-entrant for about one-seventh of their diameter. Umbilicus very wide, exposing the lateral faces of all the volutions. Tube regularly and very gradually enlarging, the sides of the dorsal and ventral faces diverging at an angle of 10°. Transverse section subangularly elliptical.

Chamber of habitation very large, slightly expanding toward the aperture; occupying more than one-third of the outer volution. Aperture apparently opening a little outward. Air-chambers numerous, regular, gradually increasing in depth toward the base of the grand chamber; about four in the space of forty-five mm.

Septa regular and slightly advancing from the centre of the dorsum to the umbilical angle; thence curving backward, and again forward, they are recurved from the ventro-lateral angle, making a gentle inflexion across the lateral face of the volution, and a more abrupt, retral curve on the ventral face. This direction of the septa corresponds very nearly with their direction in the simpler forms of Goniatites, presenting a low saddle on the ventro-lateral and dorso-lateral angles, and a broad, shallow lateral, and narrower ventral lobe. Convexity of the septa, measured across the dorso-ventral diameter, 112°. Siphuncle small, near the convex ventral side; its elements not fully known.

Test and surface-markings unknown.

The specimen described is an internal cast, measuring across the disc 230 mm.; the dorso-ventral diameter of the outer volution at the base of the air-chamber is sixty-five mm.

This species bears considerable general resemblance to *N.* (*Discites*) *Marcellensis*, but is distinguished by its larger size, re-entrant volutions, form of the transverse section, more gradually enlarging tube, and less expansion of the grand chamber.

Formation and locality. The specimen was found in a loose mass of limestone of the Upper Helderberg group (the original source of which is unknown), at Ann Arbor, Michigan.

Nautilus (Discites) inopinatus, n. sp.

PLATE CX, FIGS. 1, 2.

Shell discoid, the greatest thickness of the disc being a little less than half the greatest transverse diameter. Volutions three or four, contiguous; somewhat gradually expanding in the inner volutions, and much more rapidly in the outer one. Umbilicus wide, showing the entire lateral faces of the volutions. Transverse section quadrangular, trapezoidal, the base shorter than the sides; sides nearly straight, and gradually diverging from the base; peripheral margin curved, convex outwardly, and longer than the side. Tube

regularly and gradually enlarging. Apical angle about $7\frac{1}{2}°$ on the convex ventral side, and 9° on the lateral faces.

Chamber of habitation large, not ventricose, occupying fully half a volution; becoming free from the adjacent volution near the aperture. Aperture, as inferred from the direction of the lines of growth, quite oblique, opening outwardly, with a very broad, deep sinus on the ventral side, and a gentle sinus on the lateral margins. Air-chambers undetermined—the shell covering that part of the specimen.

Septa, suture lines and siphuncle undetermined.

Test thin. Surface marked by fine, irregular, lamellose lines of growth, which are crossed by fine, sharp, irregular or undulating, thread-like, revolving striæ, giving a cancellated surface. Tube ornamented by a row of strong, rounded, slightly transverse nodes on the ventro-lateral angles; and a row of smaller and more slender transverse nodes on the dorso-lateral angles, which descend slightly into the umbilical cavity. The nodes on the umbilical margin are twice as numerous as those on the ventro-lateral angles.

Greatest diameter of the specimen about 100 mm.

This species, in its general features, resembles *N.* (*Discites*) *Marcellensis* of Vanuxem, but is distinguished by the quadrangular transverse section, with the sides flat or concave, and by the convex ventral side, which is wider than the dorsal side. It has likewise a smaller apical angle and different surface characters. In the proportions of width on the ventral and dorsal sides it is the reverse of *N.* (*D.*) *Marcellensis*, which is narrow and flat on the ventrum. The surface striæ are very similar in the two species; but the presence of a row of small, prominent nodes on the umbilical margins of this one is a strongly distinctive feature. The species is extremely rare, so far as known, but a single specimen having come under observation.

Formation and locality. In limestone of the Upper Helderberg group, near Sandusky, Ohio.

Nautilus (Discites) Marcellensis.

PLATES LXV, FIGS. 1, 2; CIX, FIGS. 9-12, AND PLATE—SUPPLEMENT.

Goniatites Marcellensis, Vanuxem. Geolog. Survey of N. Y.: Rep. Third District, p. 146, fig 2. 1842.
Discites ornatus. Hall. Thirteenth Report N. Y. State Cab. Nat. His., p. 103, figs. 21, 22. 1860.
Nautilus (Discites) Marcellensis (Vanux.), Hall. Illustrations of Devonian Fossils: Cephalopoda, plate 65, figs. 1, 2. 1876.

Shell large, discoid; the greatest thickness of the disc scarcely equal to half the lateral diameter. Volutions three or four, contiguous, not embracing. Umbilicus wide and deep, exposing the entire lateral faces of the inner volutions. Transverse section quadrangular, trapezoidal, with the sides slightly convex, and the angles alate. Dorso-ventral diameter the longer, the base about one-third wider than the apex, or ventral side. These proportions change somewhat as the tube expands toward the aperture. The width of the convex ventral side increases very gradually, the angle being only from 2° to 6°, the greater angle being on the outer volution of older shells. The concave dorsal side widens rapidly, making an angle of 26°, while the divergence of the lateral faces is about 13°.

Chamber of habitation large, somewhat ventricose, the length nearly twice the ventro-dorsal diameter at the aperture, occupying fully half of one volution, and having a capacity at least three times as great as all the chambered portion of the shell. Aperture oblique to the direction of the axis of the tube, opening slightly upward, with a deep, rounded sinus in the ventral margin, and a less conspicuous one on the middle of the lateral margins. Air-chambers numerous, somewhat regular, and gradually increasing in depth toward the base of the grand chamber. In a large specimen the increase in the depth of the chambers, in a single volution, as measured on the lateral face, is from 3 or 3.5 mm. to 10 mm., or an increase of 7 mm.; there being a slight difference in the measurement in two individuals, where the diameter of the disc is about the same.

Septa strongly imbricating, somewhat regularly increasing in distance from the apex to the base of the grand chamber, about four or five in the space of forty mm on the outer volution. The convexity in a dorso-ventral

direction is about 104°. From the centre of the dorsal side of the volution the septa are directed obliquely forward to the dorso-lateral angle, where they are recurved, making a gentle inflexion over the side of the volution, and again advancing to the ventro-lateral angle, are more abruptly bent backward and curve to the centre of the ventrum. The septa in this manner describe a distinct angular saddle on the umbilical margin, a broad shallow lobe on the lateral face of the volution, a distinct angular saddle on the ventro-lateral margin, and a rounded lobe on the ventrum. The suture lines are distinctly impressed.

Siphuncle ventral, near the surface, section circular, its diameter about one-seventh of the dorso-ventral diameter of the tube at the same point; slightly contracting between the septa, with its greatest diameter at its passage through the septa.

Test strong in old shells, having a thickness of one mm. on the side of the volution, and becoming thicker at the margins, where it is produced into strong nodes on the ventro-lateral angles, and makes a sharp carina on the dorso-lateral angles. Surface cancellated by fine undulating striæ of growth, which are crossed by very fine interrupted, revolving striæ. The tube is ornamented on the ventro-lateral angles with sharp nodes, of which there are two to every air-chamber. The concentric striæ make a deep retral curve on the middle of each lateral face, but do not follow the curvature of the septa; and in the same manner there is a retral curve on the ventrum, where they follow essentially the course of the septa.

The internal cast is mostly smooth, with the exception of the broad suture lines and the nodes upon the angles of the periphery. The ventrum, along the air-chambers, is marked by a well-defined, elevated line or carina, which is frequently limited on each side by a shallow groove.

The diameter of the disc, in large individuals, is 140 mm. The smallest specimen observed has a diameter half as great.

This species is easily distinguished from any other by the non-re-entrant volutions, the transverse section and form of aperture, the septa, siphuncle, and surface-markings and ornamentation. In a comparison with *N.* (*D.*) *inopinatus*,

the transverse diameters at the periphery and umbilical margins is distinctive, while the presence of a row of nodes upon the umbilical margin in that species constitutes a marked difference between the two forms.

This and the two preceding species form a natural group, very distinct from the other Devonian forms of the genus NAUTILUS. Their discoidal form, angular transverse section, position of the siphuncle, and character of surface ornamentation, indicate their relation to many of the Carboniferous forms of the genus. Although they may be true Nautili, in the ordinary acceptation of the term, they possess features which give them a Goniatitic aspect. The course of the septa in the last-described form is almost precisely the same as in *Goniatites Vanuxemi*, with the simple difference that, the siphuncle being so far beneath the ventral surface, the septa are not extended along its walls to form the narrow ventral lobe which penetrates the preceding air-chamber. I have, therefore, intentionally used the same terms in describing these parts.

In every aspect of form, position of siphuncle, curvature of septa and surface ornamentation, the three forms last described are remarkably distinct from all the other Nautili described in the present volume.

Formation and localities. In the Goniatite limestone of the Marcellus shale, at Schoharie; at Manlius and other places in Central New York, and is nowhere known above the horizon of that formation.

NOTE.—Mr. VANUXEM, in his report above cited, remarks, p. 147, concerning the Marcellus Goniatite: "This species is more abundant, and some are of great size. A fragment of one was found, which, when perfect, must have been nearly a foot in diameter." It is evident, therefore, that he regarded the large form as *G. Marcellensis*, and recognized the smaller ones as *G. expansus*. The *Nautilus Marcellensis* (*Goniatites* of VANUXEM) is not known to reach a larger size than those figured on plate 65; and it is far less abundant than *G. Vanuxemi*. The fragment of large size, referred to above, is a part of the outer chamber of *G. Vanuxemi*; and the original specimen of the Marcellus Goniatite, illustrated on plate 109, was imbedded in a separated fragment of the grand chamber of another specimen of *G. Vanuxemi*. From the remarks above cited, and without sufficient knowledge of the typical specimen, I had concluded that the two species of VANUXEM had been founded on the different phases of *G. Vanuxemi*, and proposed the name *Discites ornatus* for the nautiloid form.

GONIATITES, De Haan. 1825.

Goniatites, De Haan (*Monographiæ Ammoniteorum et Goniatiteorum Specimen*).

In 1838 Mr. T. A. Conrad described *Goniatites punctatus*, from the Hamilton group, near Sherburne, Chenango county, N. Y. (*Geolog. Surv. of N. Y : Pal. Dept., Annual Rep.*). The original of this species is not known, and the form has not been recognized by subsequent investigators.

In 1842 Mr. Lardner Vanuxem described *Goniatites expansus* [=*G. Vanuxemi*], *G. Marcellensis* [=*Nautilus* (*Discites*) *Marcellensis*] and *G. Chemungensis* (*Geolog. Surv. of N. Y.: Rep. Third Dist.*).

Mr. Conrad described *G. uniangularis*, from the shales of the Hamilton group (*Jour. Acad. Nat. Sci. Phila.*, vol. 8).

In 1843 James Hall described *Goniatites bicostatus*, *Clymenia complanatus* (=*Goniatites complanatus*) and *G. sinuosus*, from the Portage group (*Geolog. Surv. of N. Y.: Rep. Fourth Dist.*).

In 1843 Prof. L. de Koninck described *Goniatites rotatorius*, from the Carboniferous rocks of Belgium (*Descr. des Animaux Fossiles dans le Terr. Carbonifere*). (See *G. rotatorius: Thirteenth Rep. N. Y. State Cab. Nat. Hist.*, p. 101; and *G. Ixion*, p. 125.)

In 1855 Dr. B. F. Shumard described *Goniatites planorbiformis*, from the Coal Measures of Missouri (*Geolog. Survey of Missouri*).

In 1857 Mr. E. T. Cox described *Goniatites Nolinensis*, from the Coal Measures (*Geolog. Survey of Kentucky*, vol. 3).

In 1858 Dr. Shumard described *Goniatites minimus*, *G. parvus* and *G. politus*, from the Coal Measures of Missouri (*Trans. St. Louis Acad. Sci.*, vol. 1).

In 1860 James Hall described and illustrated *Goniatites Milhrax*, from the Upper Helderberg limestone; *G. discoideus* and *G. orbicella*, from the Hamilton group, and *G. Patersoni*, from the Portage group (erroneously referred to the Hamilton group); *G. Hyas*, *G. Oweni*, and *G. Oweni*, var. *parallellus*, from the Goniatite limestone of Indiana: also recognizing and illustrating *G. expansus*, Vanuxem, *G. uniangularis*, Conrad, and *G. bicostatus*, Hall, from the Hamilton and Portage groups; *G. rotatorius?* de Koninck (*Thirteenth Rep. N. Y. State Cab.*

Nat. Hist.): also describing and illustrating *G. Ixion*,—the form doubtfully referred to *G. rotatorius* of DE KONINCK, *ut cit.* (*Thirteenth Rep. N. Y. State Cab. Nat. Hist.*).

Messrs. MEEK and WORTHEN described *Goniatites globulosus*, from the Upper Coal Measures, and *G. Lyoni*, from the Kinderhook group (*Proc. Acad. Nat. Sci. Phila.*).

Mr. J. H. MCCHESNEY described *Goniatites Hathawayanus*, from the Coal Measures (*New Palæozoic Fossils*).

Prof. G. C. SWALLOW described *Goniatites Holmesi*, *G. Morganensis*, and *G. Osagensis*, from the Chemung group of Missouri (*Trans. St. Louis Acad. Sci.*, vol. 1).

In 1861 Mr. W. M. GABB described *Goniatites entogonus*, from the Carboniferous (*Proc. Acad. Nat. Sci. Phila.*).

In 1862 Mr. A. WINCHELL described *Goniatites Allei*, *G. Houghtoni*, *G. Marshallensis*, *G. propinquus* and *G. pygmæus*, from the Marshall group (*Am. Jour. Sci.*, second series, vol. 33); also *G. Whitii*, from the Portage group (*Proc. Acad. Nat. Sci. Phila.*).

J. HALL described *Clymenia Erato* [= *Goniatites Erato*], from the Portage group (*Fifteenth Rep. N. Y. State Cab. Nat. Hist.*).

In 1863 Dr. SHUMARD described *Goniatites Choctawensis* and *G. Texanus*, from the Coal Measures (*Trans. St. Louis Acad. Sci.*, vol. 2).

In 1874 J. HALL described *Goniatites unilobatus*, from the Hamilton group, and also referred *Clymenia complanata* to GONIATITES; describing *G. complanatus*, var. *perlatus*; *G.* (*Clymenia ?*) *Nundaia*, from the Portage group; *G. simulator* and *G. Chemungensis*, var. *æquicostatus*, from the Chemung group (*New Species of Goniatidæ*).

In 1875 Messrs. MEEK and WORTHEN described *Goniatites compactus*, from the Coal Measures (*Proc. Acad. Nat. Sci. Phila.*).

J. HALL illustrated *G. discoideus*, var. *Ohioensis*, designated in the *Twenty-fourth Rep. N. Y. State Mus. Nat. Hist.*, 1872 (*Twenty-seventh Rep. N. Y. State Mus. Nat. Hist.*).

The new species of GONIATITES published by HALL in 1874 were republished in the *Twenty-seventh Rep. N. Y. State Mus. Nat. Hist.*

In 1876 J. HALL illustrated *Goniatites peracutus* (*Illus. of Devon. Fossils*).

Goniatites Mithrax.

PLATES LXIX, FIG. 7; LXXIV, FIG. 14.

Goniatites Mithrax, Hall. Thirteenth Rep. N. Y. State Cab. Nat. Hist., pl. 98, fig. 7. 1860.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 69, fig. 7. 1876.

Shell suborbicular, discoid or very depressed, the thickness of the disc being about one-fourth of its diameter; acutely rounded on the periphery. Volutions probably four or more; the number not determined. Outer volution embracing the inner ones for their entire extent, leaving the umbilicus closed. The increase in width of the outer volution, as preserved, is from 3.5 to 5. Transverse section of the volution elongate, semi-elliptical, the dorso-ventral and transverse diameters being about as two to one. Base truncate at the umbilicus, and deeply indented by the preceding volution; apex acutely rounded; lateral faces gently curved to the middle of the deep lateral lobe, and thence a little more rapidly to the periphery.

Chamber of habitation unknown. Aperture unknown, but inferring from the form of the volutions, it has been semi-elliptical, with the base deeply concave. Air-chambers regularly increasing in depth with the growth of the shell, the increase in a single volution being from eleven to fifteen mm. (= four mm.), as measured on the lateral lobe; about five to seven mm. a little within the middle of the lateral face, and from thirteen to more than twenty mm., measured on the periphery.

The septa curve gently forward from the umbilicus for nearly two-thirds of the width of the volution; thence more abruptly backward, forming a broad low undefined saddle, to a point nearly three-fourths of the width of the volution, when they again bend forward to the margin of the periphery, leaving a broad, deep lobe, which occupies nearly one-third the width of the volution; and thence turning abruptly backward to near the centre of the periphery, and sharply recurving, leave an acute triangular saddle on each of the margins, and a narrow, acute, ventral lobe. The saddle occupying the centre of the short, ventro-lateral curve is acute at the summit, having a height one-fourth greater than the width at the base, and curving a little

more abruptly on the ventral side. The ventral lobe extends about half the depth of the adjacent air-chamber, and is abruptly narrowed below, the walls being essentially parallel and coincident with those of the siphuncle. The septa are thin in the centre, thickened and imbricating at the margins, leaving a deeply marked suture line.

Siphuncle unknown, except as it appears in the termination of the ventral lobe in the cast.

Test and surface-markings unknown.

An imperfect cast of the interior measures about ninety mm. in its greatest lateral diameter, with a transverse diameter of less than twenty-five mm.

This species bears much general resemblance in form to *G. discoideus*, of the Hamilton group, but the disposition of the septa is very distinctive. In some of the characters it corresponds very nearly with *G. Ixion*, the lateral lobe being rounded, instead of acute. The specimen is calcareous, but with the surface entirely weathered.

Formation and locality. This specimen was received from the late Dr. MANN, of Delaware, O., as coming from the Upper Helderberg limestone, in the vicinity of Columbus.

GONIATITES VANUXEMI, n. sp.

PLATES LXVI—LXVIII; LXIX, FIGS. 3-6; CIX, FIGS. 7, 8.

Goniatites expansus, VANUXEM. Geolog. Surv. N. Y.: Rep Third Dist., p. 146, fig. 1. 1842.
" " " Hall: Thirteenth Rep. N. Y. State Cab. Nat. Hist., pp. 96, 97, figs. 1, 2. 1860.
" " " Hall: Illustrations of Devonian Fossils: Cephalopoda, pls. 64 A, 66–69. 1876.
Not " " VON BUCH. Ueber Goniatiten und Clymenien in Schlesien. Berl. Akad. Mon., 1838. Berlin, 1839.

SHELL large, discoid, flattened on the sides and upon the periphery in its advanced stages of growth. Transverse diameter varying according to the age of the shell, from one-half to one-third, and less than that proportion, of the greatest horizontal diameter; the younger forms are much more rotund, the two diameters being about as one to one and three-fourths.

Volutions of the spire about three to four in specimens of smaller and medium size, and not determined in the larger ones. Near the apex the inner volutions are embraced in the succeeding ones to the depth of one-half

their diameter, and gradually more in proportion as the outer volution becomes expanded toward the periphery, embracing about two-thirds the width of the preceding volution. Umbilicus large and open, exposing all the volutions of the spire; its sides in the young shells rounded, and in the older shells abrupt, leaving the margin obtusely angular, and descending almost rectangularly into the cavity. A transverse section presents the inner volution with a circular outline, the dorsal side of which is concave from embracing the preceding volution; the dorso-ventral diameter is about three-fourths as great as the transverse, varying in proportion at each successive volution. In the outer volutions the section presents an elongate, trapezoidal form, in which the dorso-ventral diameter is equal to once and a half to twice the basal diameter, which is measured from the greatest expansion at the margin of the umbilicus. The exterior or peripheral side is flattened in old specimens and measures about one-half, or less than one-half, the diameter across the base. The basal line is convex on each side, and concave in the centre for the reception of the embraced volution; the lateral faces are limited by gently curving lines, which become more nearly straight toward the aperture. The increase of width is nearly or quite double for each volution. Initial extremity small, globular, and closely surrounded by the succeeding volutions.

Chamber of habitation extremely large, occupying fully two-thirds of the last volution, with capacity at least four times as great as all the air-chambers together. Aperture of the same form as a section of the last volution, and, judging from the best preserved specimens, it is slightly expanded on the lateral margins, and much expanded at the baso-lateral angles, becoming auriculate; the anterior margin is deeply sinuate, with a shallower sinus in the lateral margins. In imperfect specimens these features are indicated by the striæ upon the surface.

Septa deeply concave, and with some exceptions, regularly increasing in distance toward the outer chamber; in mature specimens they are ten or twelve mm. distant from each other, and in the extremely large specimens more than fifteen mm. distant; sometimes several of the later septa are nearer

together than those preceding them. The concavity of the septa is greater than the depth of the air-chambers. The depth of the lobe is equal to the depth of two air-chambers. The margins of the septa advancing from their origin define a low axial saddle upon the umbilical angle, and thence gently curving backward include on each lateral face a single broad, flattened lobe which occupies the entire width of the volution. The summit of the saddle, occupying the angle formed by the lateral and peripheral faces, is rounded, curving abruptly upon the ventral side, and more gently on the lateral face, and becoming much more abrupt, and even subacute, in the older shells. The ventral lobe is very narrow and deep, with the sides, in young individuals, nearly parallel, and extending for half the depth of the adjacent air-chamber; the walls at its lower extremity sometimes appear to be continuous and coincident with the walls of the siphuncle. In older specimens the sides are less nearly parallel and the form is triangular. The substance of the septa is strong, and thickened at the margins, which are imbricating toward the aperture.

The siphuncle is well defined at the septa, close to the ventral side, and distinctly circular in section. In a specimen where the lateral diameter of the volution is forty-three mm., and its largest transverse diameter thirty-three mm., the siphuncle has a diameter of three mm., and in a smaller inclosed volution, which has a transverse diameter of about fourteen mm., the siphuncle is more than 1.5 mm. in diameter.

The test has a thickness of about one to two mm. on the outer chamber of older individuals, and is about half as thick in the smaller ones. It is always thicker toward the umbilicus, where it is sometimes three mm. The surface is marked by strong, lamellose, curving striæ; which in the young shells are crowded into fascicles, rising into ridges, and crowned by one or two stronger striæ at intervals of a millimetre, and increasing to two or three mm., when they become less prominent, and finally subdued in the general surface. These curving annulations are sometimes indicated, on the cast of the chamber of habitation of the young shell, by low undulations, as shown in figs. 5 and 6 of plate 69; but they maintain a distinctive feature

over the chamber of habitation in the largest individuals, where the distance may be two, three, or four mm., or even more; as indicated on the specimen, pl. 67, toward the periphery. These striæ, on the lateral faces, make a curvature very nearly corresponding to the curvature of the septa; and in the young shells they make an abrupt retral curve over the low saddle, thence to the middle of the periphery, where they are recurved; forming a deep sinus upon the ventrum. The place of the saddle is indicated by a double revolving groove, margined on each side by a low carina, and separated by a stronger similar one, As the shell enlarges, the lateral of these two grooves first becomes obsolete, and finally also the other, leaving a simple obtuse angle along the line of the saddle, over which the striæ in their retral curve are more conspicuous. The form of the sinus of the aperture is indicated by the direction of the striæ on the ventrum. A single individual of the species shows a smaller sinus on each side of the centre, and thence a broad, shallow sinuosity reaching to the baso-lateral angles of the aperture.

The internal cast, in the young specimens, often preserves the double ventro-lateral, revolving grooves, or frequently a single groove; and also the curving annular ridges upon the lateral faces. These are sometimes very conspicuous, gradually becoming obsolete on the chamber of habitation, as the shell increases in size. In the advancing growth of the shell the sides of the outer volution gradually become flattened, and often a little concave toward the outer margin, along a line parallel to the periphery. This feature is more conspicuous in old shells, and is especially marked in the specimen on plate 68. With these exceptions the cast of the interior is smooth. The suture lines are strongly impressed, and the septa are imbricating, leaving the posterior margin of the air-chamber curved or sloping, while the anterior edge is angular. A slender median ridge or carina has been observed along the centre of the ventrum, upon a partially exfoliated specimen, marking the inner or nacreous layer of the shell.

The individuals of this species present a great range in size and proportions. The smaller specimens do not exceed thirty mm. in their greatest dimensions, with the dorso-ventral and lateral diameters of their volutions about as ten

to twelve in the chambered portion, and about as twelve to fifteen at the aperture. Many specimens, in their greatest extent, have a diameter of 150 to 200 mm.; one specimen has a diameter of over 300 mm., with the periphery of the chambered portion measuring about the same, and the periphery of its incomplete grand chamber 500 mm. A specimen, measuring over 200 mm. in its lateral diameter, has a transverse diameter at the aperture of 80 mm.; the lateral diameter of the same specimen at the last air-chamber being about seventy-three mm.; with the thickness of the shell added, the diameter would be about 75–77 mm. at this point.

This species is very closely allied to *G. Bohemicus*, BARRANDE, and presents even a greater variety in the modifications of its form and surface characters. It attains a larger size than the Bohemian species, and the last volution is more rapidly expanding.

With a single exception this is the earliest appearance of the Goniatitic type in our strata, and its modifications of exterior form and its great expansion in size are truly remarkable. Its associations and the surrounding physical conditions mark an epoch of sudden change in the geological history, of which we have no parallel in the preceding record, andscarcely one of equal magnitude or degree in the entire palæozoic series. Its parallel in physical conditions and the aspect of the fauna are only to be found in the deposits of the carboniferous seas.

Formation and localities. In the Goniatite limestone of the Marcellus shale, at Schoharie, Cherry Valley, and near Manlius and Marcellus, in Onondaga county, N. Y.

GONIATITES UNILOBATUS.

PLATES LXXI, FIGS. 15, 16; LXXIV, FIG. 5.

Goniatites unilobatus, HALL. Descriptions of New Species of Goniatidæ, p. 1. May, 1874.
" " " Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., p. 133. 1875.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 71. 1876.
Compare *Goniatites Vanuxemi*, in the preceding descriptions and following illustrations.

SHELL discoid, the sides flattened, and joining the periphery at an obtuse angle. Periphery somewhat flattened; the proportions of the thickness and diameter of the disc not ascertained.

Volutions three or more, the outer ones rapidly expanding. Umbilicus open, exposing all the turns of the spire; margins of the inner ones rounded, and of the outer one angular, and bending almost rectangularly from the lateral face. Inner volutions embraced by the succeeding ones to the depth of one quarter or more of their dorso-ventral diameter. Transverse section elongate-trapezoidal, with the sides very little curved; the summit narrow and gently curving, and the base indented by the preceding volution; the baso-lateral angles obtuse and slightly auriculate. The inner volutions gradually increase in size at each turn, and are more rapidly expanding in the outer ones. The rate of increase cannot be satisfactorily determined on account of the condition of the specimens. The chambered portion of one specimen shows an increased diameter, in a single volution, from eight to twenty mm.

Chamber of habitation large and deep; its extent and proportions not fully determined. Aperture, inferring from a section of the grand chamber, elongate-trapezoidal, with the sides nearly straight, and the peripheral margin narrow. Air-chambers regular, of moderate depth, gradually increasing with the enlargement of the tube toward the chamber of habitation, and on the middle of the lateral face, having a depth of 4½ mm. where the tube has a diameter of fifteen mm., and a depth of seven mm. near the chamber of habitation, where the lateral diameter of the volution is twenty-six mm.

The septa are thin, uniform, with the margins thickened, curving a little forward on the umbilical margin, and thence making a gentle retral curve, describing a broad simple lobe, which occupies almost the entire lateral face of the volution, and advancing more abruptly toward the periphery, make an acute retral bend on the ventro-lateral margin, defining a subacute saddle, and meeting upon the ventrum, include the elongate, acute ventral lobe. The lateral lobe has a depth about equal to the depth of a single air-chamber.

Suture lines distinctly marked by the thickened margins of the septa, which, on the broad lateral lobe, are gently imbricated toward the aperture, the imbrication being more extremely marked at the acute curving over the saddle.

Siphuncle close to the ventral margin; its characters not determined.

Test thin, and only partially preserved on the specimens examined. Surface marked by striæ of growth, which are essentially parallel to the direction of the septa; the striæ on the inner volutions are sometimes crowded into fascicles, making slightly elevated ridges. The sinus, inferring from the direction of the striæ on the periphery, has been deep, abrupt at the sides, and gently curving in the bottom.

The internal mould is essentially smooth, preserving some marks of the external striæ, and having the suture lines moderately impressed. The individuals of the species, judging from a few fragmentary specimens, have had a diameter of at least 100 mm., and probably more. The specimen figured on plate 71 has a diameter of thirty-eight mm., and is only a portion of the chambered part of the shell. Another imperfect specimen, preserving a part of the chamber of habitation to the length of about forty mm., has a diameter, at the last air-chamber, of thirty two mm.; the depth of the chamber being six mm.

This species closely resembles *G. Vanuxemi* in most of its characters. A specimen, preserving a portion of the chamber of habitation and several attached air-chambers, when compared with a portion of the tube of the same size, in three specimens of *G. Vanuxemi*, shows a difference in the depth of the air-chambers, nearly as six to ten: the outer ones in the fragments of *G. unilobatus* measuring but 5.5 mm. It is possible however, that these forms may prove to be identical when large collections shall be compared, and that the differences noted may be due to influences of the surrounding physical conditions during their existence. At present there are but few specimens of this species known, and these occur in a compressed and distorted condition.

Formation and locality. In the fissile shales of the Hamilton group, on the shore of Cayuga lake.

GONIATITES DISCOIDEUS.

PLATES LXXI, FIGS. 1-13; LXXIV, FIGS. 4, 5.

Goniatites discoideus, HALL. Thirteenth Rep. N. Y. State Cab. Nat. Hist., pp. 97, 98. figs. 3-6. 1860.
" " " Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., p. 136. 1875.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 71, 1876.
" *sinuosus*, HALL (in part). Geolog. Surv. N. Y.: Rep. Fourth Dist., p. 246. 1843.

SHELL depressed orbicular in the young state, becoming discoid in its advancing growth and varying conditions of preservation. In young shells the transverse and lateral diameters are about as five to ten, eleven to twenty, and twelve to twenty-four; in a medium sized specimen, preserving its natural proportions, the two diameters are as seventeen to forty-six A specimen, which is perhaps somewhat compressed, has a lateral diameter of sixty mm., with a transverse diameter of twenty mm. The lateral faces curve rapidly in young shells, and in older ones are very gently curving toward the periphery, which is abruptly rounded.

Volutions about four, embraced within the outer one, having the umbilicus closed exteriorly, and with a slight depression, which does not expose the inner whorls; somewhat gradually expanding in the young shell and more rapidly in the older ones. Transverse section, semi-elliptical with the base, deeply concave from the inclosed preceding volution. The increase in width of the last volution, in young, well-formed shells, is from eight to fifteen mm. In a large form it is from fourteen to twenty-eight mm., and in a specimen of sixty-five mm. in its greatest diameter, the increase in the last volution is from twenty-five to forty mm., while the largest specimen measured, which is much compressed and somewhat distorted, gives thirty-two and sixty mm. as the diameters of the base of the last volution and that at the aperture.

Chamber of habitation very large, having an area four times as great, and a capacity eight or ten times as great as all the air-chambers. Aperture, in old shells, elongate-semielliptical, with the base deeply indented by the embraced volution; toward the base the margin is laterally expanded, and distinctly auriculated at the baso-lateral angles; thence curving rapidly forward, it is again depressed anterior to the middle of the lateral face, forming a shallow sinus; whence it advances on the ventro-lateral portions,

and, abruptly curving backward, forms a deep sinus on the periphery. Air-chambers very shallow near the axis of the shell, continuing nearly parallel, and then becoming rapidly expanded toward the periphery, gradually increasing in depth with the increasing size of the volutions.

The septa, on each side, are closely arranged on the inner half of the volution, and first curve gently forward, and thence abruptly recurving on the middle of the lateral face, continue with a more gentle retral bend to the periphery, where they are more than three or four times as distant as at their origin. In their passage, they describe a broad and deep lateral lobe, which occupies the outer half of the volution; with a very shallow and scarcely marked saddle upon the peripheral border, and a very short and narrow, ventral lobe. In young shells the sides of the ventral lobe are nearly parallel, and extend about one-third of the distance across the adjacent air-chamber. The width of the saddle is equal to the width of the lobe, and the depth of the lobe is equal to one and a half or two air-chambers. The sutures are distinctly marked upon the exterior of the cast by the thickened margins of the septa, which are imbricating toward the outer chamber, and leave a strong groove when weathered.

Siphuncle very small, close to the ventral side, and nearly coincident with the walls of the peripheral lobe. In one specimen, having its greatest lateral diameter of twenty-eight mm., the width of the volution at the last septum is seven mm., and the diameter of the siphuncle about one mm. on the convex side of the septum. In a specimen exposing the siphuncle between several of the septa, its form is evidently subconical, narrower at the concave face, and wider at the convex face of the septum.

The test is very thin, in young specimens being not more than .2 mm., and in the older ones not more than .5 mm. The older shells are always extremely compressed. The surface is marked by fine, closely arranged striæ, which at intervals are raised in fascicles, giving an undulated aspect, which is often more conspicuous in young than in older shells. The striæ become more conspicuous as they pass from the lateral faces over the borders of the periphery. There are other fine, gently undulating, concentric striæ,

which are confined to a small area around the umbilicus, giving a delicately ornamented surface. Some of the specimens show a pitted or punctated surface, of similar character to that observed on the shell of the recent NAUTILUS beyond the covering of the mantle. The principal striæ make an abrupt, retral bend upon the ventro lateral margins, and describe a deep sinus upon the periphery.

The internal cast, in a large proportion of the specimens, is essentially smooth, being marked only by impressions of the striæ of growth, and in a few examples by gentle undulations, which indicate the course of the stronger fascicles of the external striæ. The marks of the undulating concentric striæ around the umbilicus are rarely preserved in the casts of the interior, but the punctate marking is more frequently seen. Small individuals of this species have a lateral diameter of ten mm., with a transverse diameter of six mm. The largest specimen measured, which is much compressed in the softer shales, has a greatest diameter of ninety-five mm. The prevailing forms are illustrated on plate 71. The natural rotundity of the young and medium sized specimens is illustrated in figures 5, 6, 8 and 9 of the same plate.

This species differs conspicuously from the young of *G. Vanuxemi* by its closed umbilicus, and the usual absence of undulations or annulations upon the shell surface or upon the casts. It is very closely allied to *G. uniangularis*, CONRAD; but the original of that species is less rotund, and the septa are more distant at their origin, and on the inner part of the volution; the lateral lobe is narrower, and the ventro-lateral saddle is much longer; while the dorsal lobe has similar proportions, the septa being comparatively more distant on the periphery. This species is less rotund than *G. bicostatus*, which it resembles in some of its features; but in that species the dorsal lobe and adjacent saddle are proportionally longer, and the lateral lobe narrower, while the septa do not make so abrupt a retral turn on the lateral face. In its vertical and horizontal distribution, this species has a greater range than any other of the group. It begins its existence in the Goniatite limestone of the Marcellus shale, where the young and smaller forms are of common occurrence. It likewise occurs in the Mar-

cellus shale, above the limestone, in the finer shales of the Hamilton group, in Central New York, and in the coarser shales of the group in the neighborhood of Cazenovia.

Formations and localities. In the Goniatite limestone, near Manlius and Schoharie, and in the black shales above the limestone at the same places; also in the Hamilton group on the shores of Skaneateles lake, Owasco, Cayuga and Seneca lakes; at Cazenovia and other places.

GONIATITES UNIANGULARIS.

PLATES LXXI, FIG. 14; LXXIV, FIG. 2.

Goniatites uniangularis, CONRAD. Journ. Acad. Nat. Sci. Phila., vol. 8, p. 268, pl. 16, fig. 4. 1842.
" " " Hall: Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 98, fig. 6 (*bis*). 1860.
" " " " Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., p. 136. 1875.
" " " " Illustrations of Devonian Fossils: Cephalopoda, pl. 71. 1876.

SHELL depressed, suborbicular, discoid, the transverse and lateral diameters of the original specimen being eight and twenty mm. respectively. Other specimens, referred to the same species, have similar proportions, a larger one being as eighteen to forty-six. The lateral faces are gently convex, a little more rapidly curving toward the outer margin, and the periphery is abruptly rounded.

Volutions all embraced within the outer one, somewhat gradually increasing in the younger shells, and more rapidly expanding as the shell enlarges in growth. The number is probably about four, but no entire exposure has been observed. Umbilicus closed externally, and marked by a distinct, rounded depression. Transverse section semi-elliptical, a little expanding on each side at the base, which is deeply indented by the preceding volution. The enlargement of the volutions in a single turn of the spire, in the septate portion of an incomplete specimen, is as six to eleven and six to twelve, and in a larger individual as twelve to twenty-eight. In one specimen referred to this species the increase is as nine to fourteen; and in another specimen, preserving a considerable portion of the chamber of habitation, the increase is about from ten to eighteen mm.

Chamber of habitation not fully observed. Aperture similar in form to a transverse section of the volution, and moderately auriculate at the posterior angles. Air-chambers numerous, shallow at their origin, expanding somewhat rapidly, and again contracting on the middle of the lateral face, beyond which they are again expanded toward the periphery.

The septa are thin, with the margins slightly thickened; closely arranged at the axis, and rapidly diverging, having a somewhat prominent saddle, which occupies the inner half of the disc; thence abruptly recurving, they describe a somewhat semi-elliptical curve, which limits the deep, lateral lobe; and in the retral curving, upon the peripheral margin, include a distinct saddle of semi-elliptical form, and sometimes with a subacute apex. The ventral lobe is narrowly triangular, and penetrates about one-third the depth of the preceding, adjacent air-chamber. The measurements show the elevation of the saddle to be greater than the depth of the lobe, the length of the two being equal. The height of the saddle is equal to the depth of two air-chambers, and the depth of the lobe equal to one air-chamber. In another specimen the height of the saddle is equal to the depth of the lobe, and each equal to nearly the depth of two air-chambers. The width of the saddle is greater than the width of the lobe. The sutures are well defined in the cast, showing an imbrication of the septa toward the aperture.

The siphuncle is small, and situated close beneath the test, on the ventral side, and distinctly expanding anteriorly between the adjacent septa. In a small individual it measures .5 mm., and in a larger specimen, in the anterior part of the chamber, it is 1.2 mm. in diameter.

Test thin, having a thickness not exceeding .2 to .5 mm., except where thickened from being replaced by iron pyrites. Surface striated, the striæ having essentially the direction of the septa, and making a moderately deep sinus on the periphery.

The internal casts are smooth, except the distinct impressions at the suture lines. A single fragment, from which the exterior shell has been exfoliated, shows a peculiar, delicate ornamentation on the inner walls of the air-chambers, consisting of very minute, wrinkled or interrupted striæ, which

are in some degree parallel, but usually a little oblique, to the direction of the septal lines, and covering the entire interseptal spaces.*

The specimens originally referred to this species have a lateral diameter of eighteen to forty-six mm., the largest measurement being of the incomplete, septate portion of an individual.

The original specimen, described by Mr. CONRAD and figured on plate 71, is an incomplete cast of the chambered portion of the shell, measuring twenty mm. in its greatest diameter.

This species is very clearly related to *G. discoideus*, and in some of its forms it is difficult to make a completely satisfactory separation. In the original of the species, and in others which are associated with it, the septa diverge more rapidly from the umbilical side, making a distinct curve toward the aperture and leaving a low, broad saddle, which is not conspicuous in *G. discoideus*, while the ventral saddle is much higher and more sharply defined. The lateral lobe is deeper, while the ventral lobe scarcely differs from that species.

In its vertical and horizontal distribution this species has an extensive range. The original specimen cited is from the Moscow shales, and similar forms have been found in the upper part of the Hamilton group in Canada West. A single specimen is known from the calcareous beds in the centre of the Hamilton group, while several well-marked specimens are recorded from the Portage group.

Formations and localities. In the Hamilton shales at Moscow, on the shores of Seneca lake, at Pratt's Falls, N. Y., and in the same formation in Canada West. Other specimens have been obtained from the shales of the Portage group, above Mount Morris, N. Y.

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* This ornamentation of the interior surface may be compared with that upon the walls of the earlier chambers of the ordinary NAUTILUS, but in the Goniatite they are not cancellated.

GONIATITES ORBICELLA.

Goniatites orbicella, HALL. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 99, fig. 8. 1860.

SHELL small, depressed, orbicular. Volutions not exposed; number unknown. Umbilicus closed, and the inner volutions all embraced within the outer one, which is ventricose. Transverse section and rate of increase in size of the volutions not determined.

Chamber of habitation incomplete, the portion remaining occupying about one-quarter of a volution. Aperture not determined. Air-chambers numerous, regular, very shallow at their origin and gradually increasing in depth till near the periphery, where they are about .75 mm. in depth, the outer one being slightly deeper than the preceding one.

Septa thin, curving gently forward from their origin, and making a slight retral curve about the middle of the lateral face of the volutions, and advancing with an increasing curvature, are again recurved from a point about one third the width of the volution from the periphery, thence passing to the ventral margin. This curvature gives a low, undefined saddle on the inner half of the volution, a shallow lobe in the middle, and a broader and more elevated saddle on the outer half of the volution. Periphery unknown. Suture lines distinctly marked upon the surface, and the septal margins slightly imbricating. Siphuncle unknown.

Test not observed. Surface-makings undetermined.

The cast of the interior preserves some evidence of lamellose striæ, and upon what appears to be the inner, nacreous layer are evidences of fine undulating striæ, quite different from those pertaining to the exterior surface. The only specimen observed has a lateral diameter of nine mm.; but its comparative thickness cannot be determined.

This species is smaller than any other known in the rocks of New York. It differs from any other species in the direction of the septa and the position of the outer saddle.

Formation and locality. The single known specimen is from the Hamilton shales, at Ludlowville, Cayuga county, N. Y.

Goniatites plebeiformis, n. sp.

PLATES XVI, FIGS. 25, 26; CX, FIGS. 3-9.

Porcellia? rotatoria. Hall. Illustrations of Devonian Fossils: Gasteropoda. pl. 16, figs. 25, 26. 1876.
Compare *Goniatites plebeius*, Barrande. 1865. Syst. Silur. du centre de la Boheme, p. 37, pl. 5, figs. 1–25; pl. 6, figs. 1–5; pl. 7, figs. 3–9, 12, 13; pl. 241, figs. 6–8; and pl. 242, figs. 2–10. 1867.

Shell discoid, gibbous; the thickness, as compared with the lateral diameter, is quite variable, being ordinarily as one to two, and more rarely as one to three. The condition is usually such as not to admit of exact measurement.

Volutions rounded exteriorly, about six or more, all exposed in the wide umbilicus. Transverse section concavo-convex, nearly semicircular, with the base concave for the reception of the exterior of the next inner volution. The enlargement of the volutions is very gradual. In a specimen of ordinary form, a single volution increases from a diameter of ten mm. to a diameter of eighteen mm. A similar measurement in another specimen gives an increase from nine mm. to seventeen mm. in a single volution.

Chamber of habitation expanding scarcely more rapidly than the preceding volution, occupying a length of something more than one turn of the spire, and so far as can be determined, about one volution and a quarter. The aperture has the same form as the section of the volutions, and in some specimens is apparently a little expanded. Air-chambers somewhat regular in the earlier volutions, but unequal in depth near the chamber of habitation; their depth in some cases being nearly equal to the ventro-dorsal diameter of the volution, and varying from four to six mm. between points where the tube has increased from a diameter of six to eight mm.

Septa thin, somewhat regularly and moderately concave, describing a gentle curve from the umbilical margin, and limiting a scarcely defined lobe; thence bending forward over the peripheral margin, they describe a curve which gives a broad, rather prominent saddle, the summit of which is half-way between the margin and the centre of the periphery; thence turning acutely backward, they subtend a narrow, acute, ventral lobe, which penetrates more than half the depth of the preceding air-chamber. The condition of the specimens is usually such that the course of the septa appears

to be simple inflexion over the sides of the volution, without indicating any deviation from the ordinary nautiloid curve, and except for the narrow ventral lobe, the generic character would not be recognized. The siphuncle is small, situated just beneath the ventral surface, its walls coincident with the narrow lobe penetrating the preceding volution, and having a diameter of a little more than one mm.

Test thin, having a thickness not exceeding .5 mm.; usually obliterated in the specimens. Surface marked by sharp, transverse striæ, of which there are about seven in the space of three mm., with flat interspaces which are marked by extremely fine striæ. The striæ curve gently backward over the sides of the periphery; but the sinus in striæ or aperture has not been observed. A single, partial cast, preserving a little of the inner layer of the shell, shows fine, longitudinal striæ, which are apparently a part of the shell-structure. The internal cast is smooth, showing strongly impressed suture lines. The moulds of the exterior have shown the lateral subangular margin to be ornamented by a series of nodes, which, also, are sometimes preserved in the casts of the interior. The specimens present a gradation in size from those having a diameter of forty-five or fifty mm. to others measuring nearly 100 mm. in their greatest extent.

This species bears little resemblance to any forms known in the rocks of New York; but is closely related to *G. plebeius*, BARRANDE (*ut cit.*), and assumes the great variety of form and expression which are so fully illustrated in the figures cited. The volutions in the Bohemian species are more numerous than in ours, and increase in size more gradually, while the septa are comparatively more distant.

In the New York specimens it has thus far proved impossible to obtain any satisfactory knowledge of the inner volutions, all the specimens which have been cut for this purpose showing scarcely anything more than is illustrated in figures 7 and 8 on plate 110. The inner volutions have usually been entirely dissolved by the action of iron pyrites, or have been broken up and irregularly disposed in the cavity, as shown in figure 9. Figure 4 of the same plate is from a gutta-percha impression in the cavity left by the partial solution and

removal of the fossil, and is a cast from the inside of the shell, which preserves only slight evidence of surface striæ, and the nodes represented are such only as would be preserved on a cast of the interior.

Until recently only two specimens of this species were known to me, and these, preserving little more than one volution, showed no evidence of septa or other indications of being a Cephalopod, and it was referred with doubt to the genus PORCELLIA, in the *Illustrations of Devonian Fossils* published in 1876. Further collections have added great numbers of individuals, but without giving satisfactory evidence of the entire structure. Of several hundred specimens only three present external evidence of the septate character, and the greater proportion of the specimens of which sections have been made, preserve only the chamber of habitation, with a simple curved septal termination, or with one or two septa and air-chambers.

The species has been found only in some shaly and pyritiferous calcareous layers in the Marcellus shale, and so far as known has a very limited vertical and horizontal distribution. It is associated with STYLIOLA and TENTACULITES figured on plate 31 A of this volume.

Formation and locality. In a calcareous band in the Marcellus shale at Cherry Valley, N. Y.

GONIATITES BICOSTATUS.

PLATES LXXII, FIGS. 6-10; LXXIV, FIG. 1.

Goniatites bicostatus, HALL. Geolog. Surv. of N. Y.: Rep. Fourth District, p. 245, fig. 8. 1843.
" " " Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 103, figs. 19, 20. 1860.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 72, figs. 6-10. 1876.

SHELL depressed-spheroidal in the young state, becoming discoidal in its advancing growth, with the sides more or less convex, and often flattened from compression, and the periphery regularly rounded. The proportions of thickness and lateral diameter, in a specimen which is somewhat compressed, are as one to three and a half. This proportion varies according to the stage of growth, accidents of imbedding, and mode of preservation.

Volutions about three or more, partially exposed; gradually enlarging

to the chamber of habitation, which is more rapidly expanding. Umbilicus small, rounded and very neatly defined, with the margins subangular, and the sides nearly vertical, the outer volution embracing almost the entire width of the inner volution. Transverse section in young shells broadly semi-elliptical or semicircular, with the basal or inner margin deeply indented by the preceding volution; the outer volutions and section of chamber of habitation semi-elliptical, with the vertical much greater than the transverse diameter; the sides curving gently, the apex rounded, and the base deeply indented; the baso-lateral angles are slightly auriculate. The enlargement in a single volution is from eleven to twenty-one mm.—the last measurement being over the first half of the grand chamber; and in one-half a turn of the last septate volution the increase is from eleven to fourteen.

Chamber of habitation moderately large, gradually expanding and somewhat ventricose, occupying apparently the greater part of one volution. The aperture is somewhat broadly semi-elliptical, with the sides gently curved, the anterior margin abruptly rounded and deeply sinuate. The base is deeply indented by the preceding volution, and the lateral angles slightly auriculate. Air-chambers irregular, gradually expanding from the umbilical margin, with the greatest depth usually upon the periphery; their depth on the lateral face varies from 1.5 to 4 mm. in less than half a volution on the same specimen, being equal to the greatest depth on the peripheral margins.

Septa thin, unequally distant at their origin, radiating from the umbilical margin, and curving gently forward to the middle of the lateral face of the volution, thence gently backward to a point about two-thirds the distance from the centre of the umbilicus to the periphery, where they suddenly bend backward, almost at right angles with their previous direction, to a point below that of their origin, and in a line nearly parallel to the periphery; following and partially producing the inner margin of a shallow, revolving groove upon the surface; thence bending gently forward to near the centre of the periphery where they turn abruptly backward, defining the short, narrow, ventral lobe, which penetrates a little more than one-third the depth

of the adjacent air-chamber. In this manner the septa describe a wide, shallow saddle, which is abruptly truncate on the outer side, and occupies more than half the width of the volution; and thence includes a lateral lobe with a straight and nearly vertical inner margin, the base being in a direction with the origin of the preceding septum, and terminating on the periphery, leaving a narrow ventral saddle between it and the ventral lobe. The suture lines are strongly marked, and over the inner half of the lateral face of the volution, there is a scarcely perceptible imbrication toward the aperture; on the outer lobe and saddle there is a strong imbrication of the margins of the septa. The siphuncle is small and close to the ventral side, but its other characters have not been determined.

The test is thin. The surface, toward the umbilicus, is marked by somewhat feeble striæ, which become more conspicuous on the middle of the lateral face, and decidedly strong and elevated toward the periphery, which is limited on each side by a prominent, revolving carina, having on its inner side a narrow depression, which is more strongly marked in the cast. Crossing this carina, which is sometimes crenulate or nodulose, the striæ bend abruptly backward, becoming stronger on the periphery. The sinus is not fully determined, but is very deep and apparently angular or subangular in the bottom.

The interior cast, or the exfoliated shell, is usually more or less marked by the impressions of the exterior striæ, which appear as low, undefined undulations. These markings are sometimes preserved where the interior cast is of iron pyrites. The lateral face, toward the periphery, is marked by a shallow, well-defined groove, which is limited externally by a sharp carinate line corresponding to the exterior carina. The centre of the periphery is marked by a narrow carina, which is perceptible in the inner shell-laminæ.

Many of the smaller specimens have a diameter not exceeding ten mm., while the larger ones are more than forty-five mm. in diameter. The specimen figure 8, plate 72, is represented in its natural proportions; figure 9 is enlarged to two diameters.

This species, both in its exterior characters and internal arrangement, is quite distinct from any other form known among the collections from the New York formations. In many of its characters it is closely similar to *G. retrorsus*, von Buch. In the manner of its septa it is very similar to the var. *lingua* and var. *typus* of that species, as represented by Sandberger, *Verstein. des Rhein. Schichtensystems in Nassau*, p. 109, tab. 10, fig. 20, and 10 *a*, figs. 4, 5; while the var. *undulatus*, pl. 10 *a*, figs. 17, 19, represents the surface-markings and the revolving carinæ. The var. *auris*, pl. 10, figs. 11–13, is represented in the young of our species.

Formation and locality. In the arenaceous shales of the Portage group, on the shores of Lake Erie, in Chautauqua county, N. Y.

Goniatites simulator.

PLATES LXIX, FIGS. 1, 2; LXXIV, FIG. 8.

Goniatites simulator, Hall.			Descriptions of New Species of Goniatidæ, p. 2. May. 1874.
"	"	"	Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., p. 133. 1875.
"	"	"	Illustrations of Devonian Fossils: Cephalopoda, pl. 69, figs. 1, 2. 1876.

Shell discoid, lateral faces gently curving from the umbilical side to the margin of the periphery, which is very symmetrically rounded. The transverse and lateral diameters, measured at the first quarter volution of the air-chamber, are about as eighteen to forty-two.

Volutions, three or more, closely coiled, leaving a moderately wide umbilicus in which less than half the width of each volution is exposed; inner margins of the volutions abruptly, and in the older ones almost rectangularly, curving into the umbilical depression. Transverse section symmetrically semi-elliptical, with the base deeply indented by the inclosed inner volution. The enlargement of the volutions to the first quarter of the outer chamber is regular and somewhat rapid, the last septate volution increasing in its outer half from twelve to seventeen mm. The diameter of the septate portion of the tube, at one volution back of the broken margin of the outer chamber, as compared with the width of the latter, is about as twelve to twenty-three.

The chamber of habitation is preserved for about one-quarter of a volution, and continues with about the same rate of enlargement as the preceding volu-

tion, becoming a little more ventricose. Aperture unknown. Transverse section of the outer chamber the same as the preceding volutions, semi-elliptical, with the base indented by the inclosed volution, and the baso-lateral angles auriculate. Air-chambers regular, gradually increasing in depth with the increase of the volution; shallow on the umbilical margin, and more than twice as deep on the middle of the lateral face, which measures the greatest elevation of the lateral saddle.

Septa moderately thick and strong, with the margins thickened and imbricating toward the aperture; those of the outer volution having a distance from a little less to a little more than one mm. at the umbilical margin; thence making a retral curve they turn forward, reaching the greatest advance about the middle of the lateral face; thence curving backward to near the ventro-lateral margin they make an acute bend forward to the margin of the periphery, and again gently returning to near the centre of the periphery they describe a short, narrow lobe upon the ventral margin. This disposition of the septa leaves a shallow lobe just outside of the umbilical margin, with a broad, elevated saddle occupying the central portion of the lateral face, a narrow, deep lobe near the peripheral margin, with a low, rounded saddle on either edge of the periphery, and a short, narrow central lobe which indents the adjacent air-chamber to about one-eighth of its depth, or .75 mm. where the chamber is five mm. in depth. In the measurements of the curves of the septa the width of the lateral lobe is equal to half the width of the saddle; the depth of the lobe is equal to half the height of the saddle and equal to the depth of two air-chambers.

Test thin, not preserved upon the specimen. Surface-markings unknown. Sinus undetermined, but probably narrow and not deep. The shell has been crystallized, and inferring from some fragments remaining, it probably had a thickness of about one mm. The internal cast is smooth, with suture lines strongly impressed.

The specimen figured, which is imperfect, has a lateral diameter of about forty-five mm., with a transverse diameter of about eighteen mm. Its variation in dimensions and entire form are unknown.

This species has the form and proportions of *G. discoideus* and *G. uniangularis;* but is readily distinguished by its open umbilicus, and by the shallow umbilical lobe, the high lateral saddle, acute ventro-lateral lobe, and short dorsal lobe.

It differs from all the other forms known to me, in the disposition and character of the septa, and the proportions of the umbilicus. In the latter feature, and in its septal arrangement, it is somewhat nearly related to *G. lamellosus* of SANDBERGER (*Verstein. des Rheinischen Schichtensystems in Nassau*, tab. 8, fig. 1), but is a much less rotund form, with the lateral faces more gently curved and the periphery narrower. The species is of rare occurrence, and little is known of its vertical and horizontal distribution.

Formation and locality. In the Chemung group, near Ithaca, N. Y.

GONIATITES COMPLANATUS.

PLATE LXX, FIGS. 8-11.

Clymenia? complanata, HALL. Geolog. Surv. of N. Y.: Rep. Fourth Dist., pp. 243, 244, fig. 5. 1843.
Clymenia complanata, " Descriptions of New Species of Fossils, etc., p. 35. 1851.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 63. 1862.
Clymenia Erato, HALL. Descriptions of New Species of Fossils, etc., p. 36. 1861.
" " " Fifteenth Rep. N. Y. State Cab. Nat. Hist., p. 64, pl. 10, fig. 1. 1862.
Goniatites complanatus, HALL. Descriptions of New Species of Goniatidæ, p. 1. May, 1874.
" " " Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., p. 132. 1875.
Clymenia Erato, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 70, figs. 6, 7. 1876.
Goniatites (Clymenia?) complanatus, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 70. 1876.

SHELL discoid; inferring from the depth of the umbilicus, the disc may have had a thickness of about eight mm., where the diameter has been about thirty-five mm.

Volutions about four or more, gradually expanding from the apex, the outer ones embracing the inner for about one-fourth to one-third of their width, or sometimes a greater proportion. In their natural condition they are rounded and subventricose, but are usually flattened. Umbilicus wide, exposing all the inner volutions. Transverse section short, semi-elliptical, or trapezoidal, with the apex rounded, and the base indented by the preceding volution, the baso-lateral angles auriculate. The enlargement of the volutions is very gradual to the termination of the septate portion, where the rate of increase is moderately augmented.

The chamber of habitation is very deep, occupying more than half a volution, and becoming moderately expanded toward the aperture. Aperture semi-elliptical; lateral margins but slightly curved; indented at the base by the preceding volution, with the baso-lateral angles slightly auriculate. The anterior margin, inferring from the direction of the striæ, is deeply sinuate. Air-chambers numerous, regular, except toward the chamber of habitation, having a depth on the middle of the lateral face about equal to one-fifth the width of the volution at that point, or a depth of two mm. where the diameter of the tube is ten mm., and with scarcely a measurable difference where the tube is a millimetre more or less in diameter.

The septa are thin and very slightly thickened at their margins. Rising from the axis, they make a gentle retral bend, and are recurved toward the aperture from a point about one-third the width of the volution from the umbilical margin, describing a shallow lateral lobe; thence arching more abruptly, they include a more elevated lateral saddle, the apex of which is at a point about two-thirds the width of the volution from the umbilical margin. From this point the septa arch backward, limiting a narrow, acute lobe on the peripheral margin. The course of the septa on the periphery and the form and character of the ventral lobe have not been determined.

Siphuncle not observed.

Test thin, rarely or but partially preserved in the specimens under examination. Surface marked by fine, regular striæ, which are curved a little forward from the umbilical side of the volution, and, when reaching a point near the periphery, or about three-fourths of the width of the volution, are bent backward into a shallow, undefined, revolving groove, from which they make an abrupt turn to the periphery. The sinus, inferring from the direction of the striæ, is comparatively deep.

The internal mould is smooth, except the septal indentations, and the impressions of the surface striæ are scarcely visible The specimens have a prevailing lateral diameter of from thirty to forty-five mm., while the transverse diameter, owing to the usually flattened condition of the specimens, has not been satisfactorily determined.

This species is distinguished among others here described, by its wide umbilicus and gradually enlarging volutions, and in its flattened condition, by the fine, even, thread-like striæ. The species was originally founded upon specimens like figures 10 and 11 of plate 70, in which the septate character is usually very obscure, and often not all preserved, the general form and surface-markings being all that remain. The specimen figure 8, plate 70, is a cast of the interior, from which all remains of the external shell have been removed. The volutions are somewhat rotund.

The form described as *Clymenia Erato*=*Goniatites Erato* is probably only a variety of *G. complanatus*. The specimens are larger than *G. complanatus* in its usual condition, and the outer volution embraces somewhat more of the inner one; but with these exceptions they are too nearly similar to be separated, especially as no complete comparison can be made between the septa in the two forms.

Among a considerable number of specimens, preserving the general form and proportions of figures 10 and 11, of plate 70, but little difference has been observed. The specimen figure 12 of plate 71 has a much greater diameter, and the proportional distance of the septa is greater than in any previously recognized form of *G. complanatus*. It is readily distinguished from *G. sinuosus* by the direction of the septa, though the general form of the shell and surface-markings are similar.

Formations and localities. In the green shales of the Portage group, at Cashaqua creek, in Livingston county, N. Y.; in the lower beds of the same formation, on the east side of Cayuga lake; and in some concretionary layers in the upper part of the Hamilton group, on the shore of Lake Erie.

Goniatites complanatus, var. perlatus.

PLATE LXX, FIG. 12.

Goniatites complanatus, var. *perlatus*, Hall. Descriptions of New Species of Goniatidæ. p. 1. 1874.
" " " " " Twenty-seventh Rep. N.Y. State Cab. Nat. Hist., p. 132. 1875.
" " " " " Illustrations of Devonian Fossils: Cephalopoda, pl. 70. 1876.

Shell large, discoid; the proportions of lateral and transverse diameters not determined; the shell being flattened by compression, the original rotundity is not known.

Volutions gradually expanding from the apex; about four or five in number, all of which are exposed in the wide umbilicus. The inner volutions are embraced by the successive whorls to nearly one-half their width. The transverse section was apparently somewhat trapezoidal or semi-elliptical, with the base deeply indented by the preceding volution, and the postero-lateral angles auriculate. The enlargement of the inner volutions of the tube is very gradual. In its flattened condition the width of the exposed portion at the end of the second volution is less than five mm.; at the end of the third volution it is nearly nine mm., while the embraced portion has a width of twelve mm. The entire width on the chamber of habitation at half a volution from its origin is about thirty-two mm.

Chamber of habitation large, its capacity being considerably greater than all the septate portion of the shell; its full dimensions unknown. Aperture not determined, but apparently it has been trapezoidal, with the apex but slightly convex and deeply sinuate; the sides little expanded laterally, but with concave or broadly sinuate margins, and the base indented by the preceding volution. The baso-lateral angles have been auriculate. Air-chambers regular, as far as observed, having a depth of four mm. at their origin, where the diameter of the tube is about eighteen or twenty mm.

Septa thin, regular, curving backward from the umbilical margin, and describing a shallow lobe, which occupies about one-quarter of the width of the volution, and thence recurving, include a moderately deep, somewhat regularly convex saddle, from the summit of which they curve toward the periphery; but their character on the outer part of the volution has not

been observed. The convexity of the saddle is about equal to the depth of the chambers at the umbilical margin; and where the distance of the septa at their origin is four mm., they are distant about seven mm., as measured from the summits of the adjacent saddles. The suture-lines, so far as preserved, are delicately marked on the flattened surface of the compressed specimen. Siphuncle undetermined.

The test is only preserved in a macerated and exsolute condition, and in some parts covering the cast with a thin film, or leaving the surface-markings impressed upon the interior. The surface-markings, as preserved, and as impressed upon the matrix consist of regular sublamellose striæ, which are about .5 mm. distant, but become crowded upon some parts of the surface. The striæ are gently curved backward from the umbilicus, making a broad curve over the lateral face of the volution; thence advancing toward the aperture, as they approach the exterior margin, they make a sudden retral bend over the periphery, forming a deep sinus in the ventral side. As the striæ approach the periphery, and become recurved upon that portion of the shell, they are much stronger. The form of the sinus is undetermined.

The internal cast is extremely flattened, preserving the impressions of the surface striæ and the suture lines. The greatest diameter of the specimen figured, which is probably a little increased by pressure and distortion, is about eighty mm.

This form has a very close general resemblance to *G. complanatus*, and the surface striæ are of precisely the same character, and have the same course and direction, except that the shallow, undefined groove, on the lateral face near the periphery, has not been observed. The umbilicus is entirely open, as in that species, and the proportions of the inner volutions are similar; but the outer one is more rapidly expanding, and embraces a greater proportion of the inner volution. The septa, however, in this form have a much greater proportional distance. This feature alone should be regarded as distinctive, when compared with the same on the specimen, fig. 8 of pl. 70.

Formation and locality. In the lower beds of the Portage group, at Homer, Cortland county, N. Y.

Goniatites sinuosus.

PLATES LXX, FIGS. 13-15; LXXII, FIG. 11; LXXIV, FIG. 11.

Goniatites sinuosus, Hall. Geolog. Surv. N. Y.: Rep. Fourth Dist., p. 243, fig. 6. 1843.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 72, fig. 11. 1876.
" (*Clymenia?*) *Nundaia*, Hall. Descriptions of New Species Goniatidæ, p. 3. May, 1874.
" " " " Twenty-seventh Rep. N. Y. State Mus. Nat. Hist., p. 134. 1875.
" " " " Illustrations Devon. Fossils: Cephalopoda, pl. 70, figs 13-15. 1876.

Shell broadly discoid, with the sides gently curving, or sometimes nearly flat; the thickness of the disc is thirty mm. or more in old specimens where the lateral diameter is about 100 mm.

Volutions about three or four, the inner ones gradually enlarging, while the outer ones expand much more rapidly and become ventricose in the chamber of habitation. The outer volutions embrace the inner ones to an extent of one-quarter of their diameter. Umbilicus wide, exposing all the inner volutions, its margins nearly vertical, the exterior angle rounded. Transverse section semi-elliptical, having a height of once and a half the breadth at the base, in the outer volution; the sides curve gently toward the periphery, which is abruptly and regularly convex, having a width about half as great as the base, which is two-thirds as wide as the lateral face, and slightly indented by the preceding volution; the baso-lateral angles slightly auriculate. The rate of increase, in two outer volutions of a nearly entire large specimen, including more than half a volution of the chamber of habitation, is from four to twelve and forty-two mm. The specimen figure 15, plate 70, shows an increase in the outer volution from less than fourteen to forty-five mm.

Chamber of habitation large, occupying more than half a volution in entire specimens, and having a capacity much greater than all the chambered portion of the shell. Aperture semi-elliptical, with the apex somewhat truncate and the sides gently expanded. The base is slightly indented by the preceding volution, and the baso-lateral angles are auriculate. Air-chambers numerous, somewhat irregular, and gradually increasing in depth toward the chamber of habitation, except the last one or two, which are shallower than the pre-

ceding. The depth of the chambers is sometimes five mm. where the diameter of the tube is thirty-five mm., and from three to four mm. when the tube has a diameter of nineteen mm.

The septa are thin, presenting, at their origin on the umbilical side, a gentle forward curve for the distance of a few millimetres, and are a little more abruptly recurved to about the same depth. From this point they make an abrupt angular return describing a broad curve over the middle of the lateral face, and descending a little deeper than before, they make an acute return and describe a shorter curve to the peripheral margin. By this disposition of the septa we have a narrow convex umbilical saddle, a broad central or lateral saddle, and a narrower peripheral saddle of a little greater width, but more convex than that on the umbilical side. It gives a short acute lobe, with its apex about one-fourth the width of the tube from the umbilical side, and a larger triangular lobe, with its apex at a point about one-fourth the width of the tube from the peripheral margin. The direction of the septa on the periphery is undetermined. The sutures are usually but faintly impressed, and often very obscure upon the casts of the shell. Siphuncle unknown.

Test strong, rarely preserved, having in old shells an approximate thickness of nearly two mm. on the chamber of habitation. Surface marked by strong sublamellose striæ, which make a gentle retral curve over the lateral face of the volution, and arching somewhat abruptly forward as they approach the margin of the periphery are suddenly recurved over the ventral side. The striæ are somewhat regular and even on the lateral faces of the volutions, there being often about six in the space of five mm., and on the smaller volutions ten in the same space; approaching the aperture they become stronger, and there are only three in the space of five mm. The sinus, inferring from the direction of the striæ, is abrupt and of moderate depth.

The internal mould is essentially smooth, and but faintly marked by the suture lines. The external striæ are sometimes impressed upon the cast, and in some conditions, the partial casts or interior of the shell, show a punctate-marking.

The largest specimens have a diameter of more than 100 mm., and the smallest specimen identified with this species has a diameter of about fifty-five mm.

The *Goniatites sinuosus*, as originally illustrated in the *Geolog. Surv. of N. Y.: Rep. of Fourth Dist.*, included two very distinct species. In order to rectify this error, I published, in 1874, a description of *G. Nundaia*, recognizing the species as being in part those forms which had before been included under *G. sinuosus*. By this rectification it was intended to leave the form figured on page 245 of the *Geological Report* as the representative of *G. sinuosus*. The condition of preservation of the original specimen is such as to preclude a critical examination of the septa and other important characters, while its form and external aspect are so nearly similar to *G. discoideus* that I am induced to unite the two as one species. The appearance of an umbilicus in the original figure is due to some adhering stone upon that part of the shell.

The specimen, figure 11 of plate 72 is one of those originally referred to *G. sinuosus*. It is a part of the chamber of habitation from its commencement, and the characters of the last septum cannot be fully determined, owing to the imperfect condition of the margins. Unlike the specimen just mentioned, it possesses a wide umbilicus; and in the proportions of the outer chamber and the position of the summit of the saddle, relatively to the dorsal and ventral margins, it has the character of those forms referred to *G. Nundaia*, and these must therefore be referred to the same species; and since *G. sinuosus* has the priority, the forms previously recognized as *G. Nundaia* will be included under the original designation. It is to be remarked, however, that one of the original specimens of *G. sinuosus* possesses some differences which are quite marked, but which are apparently not of specific importance. A comparison of fig. 11, pl. 72, with figs. 13–15, of pl. 70, will show that the fragment illustrated on pl. 72 has a proportionally smaller umbilicus, and more rapidly enlarging tube.

This species, in its various conditions of preservation, has much general resemblance to *G. complanatus*, var. *perlatus*, but the volutions are less deeply embracing, the septal lobes and saddles are conspicuously different, and the

surface striæ are coarser. It differs from *G. Patersoni* in the volutions being more exposed in the umbilicus; in the broader and shallower median saddle, and the lesser length and angularity of the lobes upon the lateral faces.

Formations and localities. This species occurs in the Portage shales and sandstones, near Mount Morris, Livingston county; near Portland Harbor, Chautauqua county; above the lower falls at Portage, and in a similar geological position at Truxton, in Cortland county. It also occurs in the Portage and lower part of the Chemung group, near Ithaca, N. Y.

GONIATITES PERACUTUS.

PLATES LXIX, FIG. 8; LXXIV, FIG. 13.

Goniatites peracutus, HALL. Illustrations of Devonian Fossils: Cephalopoda, pl. 69, fig. 8. 1876.

The only specimen observed is a fragment, which has been extremely macerated, and the surface-characters entirely removed. The form has been discoid; and it may be inferred that the transverse section was semi-elliptical.

The inner volutions are embraced in the outer one; the rate of their enlargement cannot be estimated. The umbilical depression is narrow in the cast, and the inner volutions were probably not at all exposed in the shell.

The fragment preserves a small portion of the chamber of habitation, and a few of the air-chambers.

The septa, from their origin, curve a little forward, continuing in that direction nearly to the middle of the lateral face of the volution, when they curve abruptly backward on a line almost parallel with the periphery, describing a deep, obliquely semi-elliptical lobe, which, measured from the summit of the saddle at the most advanced curve of the septa to the bottom of the lobe, has a depth equal to the semi-diameter of the volution. From the bottom of this lobe the septum advances abruptly forward, describing a very acute saddle, the summit of which is within a few millimetres of the periphery, and thence abruptly recurves and passes over the margin of the disc.

The septa are thin, somewhat thickened and imbricating at the margins. Suture-lines distinct, but not deeply impressed. The siphuncle is unknown.

The test and surface-marking are unknown.

The internal cast preserves the septal markings; but it is so much weathered that no indications of surface-markings are preserved. The fragment, measured from the umbilicus to the periphery, at the last septum, has a diameter of forty-five mm. The septa at the base of the lobes are distant from each other nine mm.

The absence of an open umbilicus leaves the comparison of this species, in its external form and features, with *G. uniangularis* and *G. discoideus*. In the direction of the septa it differs conspicuously from these, and in this feature it differs from any form here described.

Formation and locality. In the Portage or lower part of the Chemung group, at Ithaca, N. Y.

Goniatites Patersoni.

PLATES LXXII, FIGS. 1-5; LXXIV, FIG. 15.

Goniatites Patersoni, Hall. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 99, figs. 9, 10. 1860.
" " " Twenty-seventh Rep. N. Y. State Cab. Nat. Hist., p. 136. 1875.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 72, figs. 1-5. 1876.

Shell large, discoid; the thickness of the disc equal to a little more than one-third the lateral diameter of the shell in young and medium-sized specimens.

Volutions about four, the outer ones embracing the inner to the depth of one-half or more of their dorso-ventral diameter. Umbilicus of moderate width, exposing all the inner volutions. Transverse section somewhat semi-elliptical, with the lateral faces convex near the base, slightly concave beyond the middle of the width, and abruptly rounded at the apex or periphery The base is deeply indented by the preceding volution, and subauriculate at the baso-lateral angles. The enlargement of the volutions is very gradual in the young state, and more rapidly increasing as the shell advances in age. From the third to the fourth volution the increase is from a diameter of fifteen mm. to thirty-one mm. in a single turn.

Chamber of habitation very large, in one specimen occupying more than half a volution; its full extent not known; its capacity is at least twice as great as all the chambered portion of the shell. Aperture elongate, semi-elliptical, narrowing toward the anterior margin, which is subacutely rounded. Base deeply indented by the preceding volution, and inferring from the form, it is subauriculate at the baso-lateral angles. Air-chambers numerous, often somewhat irregular in their depth, those near the chamber of habitation sometimes shallower than those preceding. In a portion of the tube, which has a lateral diameter of about forty mm. at the smaller extremity, and of forty-six mm. at the base of the chamber of habitation, making about one-quarter of a volution, there are nine air-chambers, which vary in depth from six to ten mm., as measured from the summits of the lateral saddles, the shallowest being the last but one. In a smaller individual there are nine chambers in less than half a volution of the septate portion preceding the commencement of the chamber of habitation.

The septa are strong, especially in older shells; much thickened on their exterior margins, and strongly imbricating. In their course from their origin on the umbilical margin they curve more or less abruptly backward to a point from one-quarter to one-third the diameter of the volution, or sometimes even less, where they make an acute return, and curving forward over the lateral face of the volution, make a retral bend, which terminates at a point within one-fifth or one-sixth of the width of the volution from the peripheral margin, whence they make an acute turn forward, and pass over the margin of the periphery in an abrupt curve, and descending slightly, describe a narrow, acute lobe upon the centre of the ventrum. This course of the septa includes a narrow acute lobe, near the inner margin of the volution, and thence describes a broad, obliquely semi-elliptical saddle; a second narrow, elongate acute lobe, near the outer margin, and a narrow obtuse saddle on the periphery, with one side extremely elongate, and the other very short. The septum describing the wide lateral saddle extends forward, in its advancing curve, to a distance equal to the greatest depth of nearly two air-chambers beyond its origin at the umbilical margin. In its retral

curve to the bottom of the acute outer lateral lobe, the distance is equal to the depth of two and a half to three and a half air-chambers, measured in their greatest depth. The ventral lobe is short, penetrating the adjacent air-chamber about 2.5 mm., where the entire depth is nine mm. The suture-lines are strongly impressed upon the interior cast, and in a simply exfoliated specimen are comparatively very wide, from the thickening of the septa at their margins.

The siphuncle is small, cylindrical, and placed close beneath the shell, on the peripheral margin.

The test is known only upon a single individual, and has a thickness of about one mm. at the base of the chamber of habitation. The surface is imperfectly preserved, showing somewhat lamellose, transverse striæ, with faint indications of other markings. The sinus, inferring from the direction of the striæ, has been narrow and shallow.

The internal cast is essentially smooth, preserving the septal margins or impressed suture-lines, with impressions of the fine surface striæ. A specimen, of which a cast in iron pyrites is preserved, measures about forty-five mm. in its greatest diameter; another well-marked individual of the species has had a diameter at least twice as great; and another large individual, referred to this species, has a lateral diameter of about ninety-five mm., and, measured from the outer margin of the grand chamber across the centre, has a width of more than 110 mm.

In its smaller forms this species has much general resemblance to *G. simulator*, in which the volutions are more rotund, and the periphery broader. In the septate character there is also a considerable general resemblance between the two forms. In *G. simulator*, however, the inner lateral lobe is very shallow, the lateral saddle less elevated, and the exterior lateral lobe much less extended and less acute. These differences are well shown on comparing figures 1 and 2 of plate 69 with figures 1 and 2 of plate 72, where the specimens are of nearly the same size. In older individuals of *G. Patersoni* the differences are more strongly marked, as may be seen in figures 3 and 4 of plate 72. When occurring in the same rock and in similar conditions of

preservation, with the septa obscure, it bears much resemblance to *G. sinuosus*, but may be distinguished by the outer volution overlapping the inner ones to a greater proportionate width, and a comparatively greater expansion of the chamber of habitation. It is readily distinguished from all the other species known to us in the New York formations.

Formations and localities. This species is known in the shales of the Portage group, on Paterson's creek, near Moscow, N. Y.; at Gibson's Mill, near the Genesee river, above Mount Morris; and above the lower Portage Falls, near Portageville. It also occurs in the lower part of the Chemung group, at Pine Valley, in the town of Catharine, Schuyler county, N. Y.

Goniatites Chemungensis.

PLATES LXIX, FIG. 9; LXXIV, FIG. 6.

Goniatites Chemungensis. Vanuxem. Geolog. Surv. of N. Y.: Rep. Third Dist., p. 182, fig. 1. 1842.
" " " Hall: Illustrations of Devon. Fossils: Cephalopoda, pl. 69, fig. 9. 1876.

Shell discoid, expanded. Inferring from the condition of the compressed specimen, the transverse section of the tube has not exceeded one-fourth that of its lateral diameter.

Volutions gradually expanding, about four (or five?); all exposed in the wide, shallow umbilicus; the inner ones partially embraced in the outer. The transverse section is broadly oval, and a little sinuate, or somewhat expanded in the middle of the sides of the outer one; rounded upon the periphery, and concave on the umbilical side. The enlargement of the volutions is very gradual; the base of the air-chamber, at the end of about the fourth volution, measures a little more than thirty mm. The inner volutions are not in a condition to be measured.

The chamber of habitation, known only at its commencement, is continued in the same proportions as the preceding chambered portion of the shell. Aperture unknown. Air-chambers numerous; the width of the volution is equal to about three chambers in their greatest depth, and nearly twice as many at the umbilical margin.

Septa thin, somewhat regular in their arrangement; the margins moderately thickened, and slightly imbricating; distant from each other, at their origin on the umbilical side, from three to five mm. in the last fourth of the outer volution, the last two being closer than any of the preceding. From the umbilical side the septa proceed in a generally transverse direction, making several abrupt curves, the posterior ones of which are angular, and describing four saddles, of gradually increasing height and dimensions, and three shallow, angular lobes on the inner half of the width of the volution: on the outer half of the volution there are deeper and more abrupt curves; and leaving the base of an angular lobe at about the centre, the septa describe a wider semi-elliptical saddle, a deeper elongate subangular lobe, and a still more elongate and more elevated saddle, which has its apex near the periphery. On the outside of this there is a narrow lobe, and an abrupt turn of the septum to the periphery, upon which its course has not been observed. This arrangement gives six lobes on the lateral face of the volution, each one of which has an increasing depth from the umbilical margin. There are likewise six saddles, each successive one of which is higher and wider than the preceding, except the last which is much higher, but not quite so wide as the one preceding it. Suture-lines narrow, moderately impressed upon the cast, and more strongly marked at and near the extremities of the lobes and saddles. Siphuncle unknown.

Test entirely unknown. The surface-markings cannot be satisfactorily determined on the cast of the interior or upon the weathered impression of the exterior, which are the only portions preserved.

The cast of the interior is marked by nodulose annulations, which are nearly continuous on the inner half of the volution, and interrupted on the outer half: the median line of the volution being marked by a row of depressed nodes, which become obsolete toward and upon the chamber of habitation. The intermediate spaces are essentially smooth, or marked only by a peculiar pitted or indented surface, which has not been identified with any external marking. The fossil has had a lateral diameter of nearly eighty mm., and perhaps more than that in its entire condition.

This species has no analogous forms in the New York formations. It may be compared with *Goniatites tuberculoso-costatus*, D'A. and DE V., as illustrated by the Doctors SANDBERGER in *Verstein. des Rhein. Schichtensystems in Nassau*, pl. 1, fig. 1; pl. 8, fig. 2.

Formation and locality. In the Chemung group, near Owego, N. Y.

GONIATITES CHEMUNGENSIS, var. EQUICOSTATUS.

PLATE LXIX, FIG 10.

Goniatites Chemungensis, var. *equicostatus*, HALL. Descriptions of New Species of Goniatidæ, p. 3. 1874.
" " " " " Twenty-seventh Rep. State Mus. Nat. Hist., p. 135. 1875.
" " " " " Illustrations of Devonian Fossils: Cephalopoda, pl. 69, fig. 10. 1876.

This variety was indicated chiefly on account of the uninterrupted and more prominent annulations crossing the volutions, which are more closely arranged, being about as four or five to three in the typical specimen. The exterior volution is more slender, and there is a ridge or carina extending along the middle of the lateral face, connecting the annulations.

The umbilicus is wide, but the inner volutions are not preserved. The septa and suture-lines are very imperfectly preserved, and it is only possible to say that the septa describe numerous small lobes and saddles which are similar to those of the typical form, but which cannot be described in detail owing to the imperfection of the specimen.

Surface-markings undetermined.

Formation and locality. The specimen was found in a bowlder of arenaceous shale containing several species of Brachiopoda, which indicate its origin to be from the lower beds of the Chemung group.

The following species are from the Goniatite limestone of Rockford, Indiana; and having been originally described in the *Thirteenth Report on the N. Y. State Cabinet of Natural History*, in 1860, are here introduced for comparison with those of the New York formations:

Goniatites Oweni.

PLATES LXXIII, FIGS. 3-8; LXXIV, FIG. 9.

Goniatites Oweni, Hall. Thirteenth Rep. N. Y. State Cab. Nat. Hist., pl. 100, figs. 11, 12. 1860.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 73, figs. 3-8. 1876.

Shell discoid, depressed suborbicular, with the lateral faces somewhat flattened, and the periphery regularly rounded; the greatest lateral diameter equal to about twice and a half the thickness of the disc.

Volutions ventricose, about six to eight or nine, the lateral and vertical, or dorso-ventral, diameters being nearly equal. All the turns are exposed in the umbilicus to about one-fourth or less of their width, the remaining three-fourths or more being embraced in each succeeding volution. Umbilicus deep and of moderate width, subject to considerable variation; the margins descend by a series of vertical steps, the inner face of the volutions being flat and essentially rectangular to the lateral face. Transverse section semi-elliptical, the height equal to the diameter at the base, which is deeply impressed by the preceding volution, leaving the portion beyond its periphery nearly equal to, or a little more than the embracing portion of the volution. The rate of enlargement of the volutions, in a well-preserved specimen of medium size, is from thirteen mm., the diameter of the inner of two volutions, to twenty-one mm., the diameter of the outer one, and in a larger individual the proportions are about as twenty-one to twenty-eight mm. In a smaller specimen, having its largest diameter of twenty mm., the rate of increase is from six to nine mm. in a single volution.

Chamber of habitation not satisfactorily determined. In many specimens it appears to occupy more than an entire volution, there being no external indication of septa, as in figures 7 and 8 of plate 73; while in other forms, of similar dimensions, there are evidences of septa in the exterior volution. A specimen, having a lateral diameter of ninety mm., and cut in horizontal section, shows a full volution and a half, free from air-chambers. In one specimen, where the basal portion of the outer chamber is clearly

preserved for the extent of a quarter of a volution, its rate of increase is continuous with the preceding portion of the shell, being apparently a little more expanded on the umbilical margin, and carrying about four transverse constrictions on the inner half of the volution. The aperture, inferring from the form of the volution, as far as preserved, has been semi-elliptical, with a length greater than the transverse diameter at the base, which is invaded by the preceding volution to more than one-third of its length. The baso-lateral angles have been somewhat expanding and auriculate. The apertural sinus is undetermined. Air-chambers numerous, often quite regular, and having a depth on the middle of the lateral face equal to one-fourth the ventro-dorsal diameter of the volution; frequently quite irregular in depth, becoming shallower toward the aperture. The change from the deeper to the shallower air-chambers is sometimes abrupt; the latter, having about half the depth of those preceding, continue with great regularity to the base of the chamber of habitation.

Septa thin, with the margins thickened and imbricating; turning backward from their axis, they are acutely recurved on the umbilical angle, and thence bending gently forward, make an advance equal to the greatest depth of two air-chambers, as measured on the lateral face of the volution; and thence abruptly recurving, extend to a point on the face of the volution about one-third of its width from the peripheral margin, where they bend acutely forward to a point a little in advance of the previously described forward arch, and are thence abruptly curved over the margin of the periphery, and backward, almost in a line parallel with the direction of the volution, to a depth equal or greater than the previous central curve; and thence twice recurving in a narrow space, define the ventral lobe. By this course the septa define a narrow triangular lobe on the umbilical margin; a wide, moderately elevated saddle, the summit of which lies a little within the centre of the lateral face of the volution; a deep triangular lobe, with an acute base, the point of which lies about one-third of the width of the volution from the peripheral margin; and a narrower, more elevated saddle, the summit of which lies upon the curve of the periphery. The ventral lobe is tridentate

at its base, having two minute saddles, embracing the narrow, central portion, where the septa are coincident with the walls of the siphuncle, and penetrates to at least four-fifths of the depth of the adjacent air-chamber. Suture-lines distinctly impressed and clearly defined, but not wide; imbricating at the summits of the saddles and at the bottom of the lobes.

Siphuncle small, cylindrical; its other features not determined.

Test about .5 mm. in thickness, rarely preserved in any of the specimens. Surface marked by fine transverse striæ, the characters not fully ascertained, but which make a gentle curve forward, and bend backward toward the periphery, often indicating the existence of a fascicular arrangement, or an attenuation of stronger striæ, which produce the low, gentle undulations sometimes observable in the worn and macerated fossil, especially toward the umbilical margin. The sinus has not been determined.

The internal cast is essentially smooth, with the suture-lines distinctly impressed, and in certain conditions of weathering these lines become more conspicuous from absorption or solution of the prominent portions of the saddles and the angular basis of the lobes. The diameter of an ordinary specimen is from thirty to fifty or sixty mm. The smallest specimen measured has a greatest diameter of thirteen mm., but the individual does not retain the chamber of habitation; its greatest transverse diameter is ten mm., showing it to be more rotund than the older specimens. The largest specimen measured has a lateral diameter of about 100 mm., and several others measure eighty to ninety mm.

This species bears comparatively little critical resemblance to any of the species of the New York formations, in none of which are the volutions so rotund except *G. plebeiformis*, and in young forms of *G. expansus*. It has a general resemblance, in the direction of the septa, to *G. Patersoni;* but in that one the inner angular lobe is outside of the umbilical margin, the lateral saddle is narrower and more elongate, and the outer lobe is more extended and acute, though holding a similar position on the volution.

Formation and locality. In the Goniatite limestone, at Rockford, Indiana.

Goniatites Oweni, var. parallela.

PLATES LXXIII, FIGS. 1, 2; LXXIV, FIG. 10.

Goniatites Oweni, var. *parallela*, Hall. Thirteenth Rep. State Cab. Nat. Hist.. p. 101, figs. 13, 14. 1860.
" " " " " Illustrations Devon. Fossils: Cephalopoda, pl. 73, figs. 1, 2. 1876.

The *Goniatites Oweni*, var. *parallela*, was indicated in the original description of the species.

The form and general proportions of this variety are not materially different from the typical forms of the species, though the volutions are sometimes less rotund. The umbilicus is always smaller, and the inner volutions a little more covered. The sides of the dorsal lobe are quite parallel, and the extremities reach beyond the arch of the saddle in the next posterior septum. This gives an apparent continuity to the septa, and the ventrum is thus impressed with two parallel continuous grooves limiting the margins of the ventral lobes. This feature indicates a closer arrangement of the septa throughout—a feature usually quite perceptible on the lateral faces of the volutions.

In addition to these characteristics the tube is often, or usually, distinctly constricted at somewhat regular intervals by shallow, transverse grooves, which affect the smallest specimens, but which become more conspicuous in older ones, as shown in figure 8 of plate 73.

It is, however, by no means established that this constriction affects only the var. *parallela*, for it is sometimes seen in the younger and more rotund forms possessing the typical characteristics, while the septa are comparatively more distant, the impressed lines on the ventrum are not continuous, and the ventral lobe does not extend so far as the summit of the next posterior saddle. This is true in some well-preserved forms of younger individuals, and it may be a question whether the characters distinguishing the varietal form are not acquired in the progress of growth.

The two varieties of form occur in the same locality and position and without marked difference in comparative numbers.

Goniatites Ixion.

PLATES LXXIII, FIGS. 12-14; LXXIV, FIG. 12.

Goniatites rotatorius? de Koninck. Hall: Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 101, figs. 15, 16.
" *Ixion*, Hall. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 125, figs. 1-3. 1860.
" " " Illustrations of Devonian Fossils: Cephalopoda, pl. 73, figs. 12-14. 1876.

Shell discoid, with the transverse and lateral diameters nearly as one to three; greatest thickness at a point distant from the umbilicus about one-fourth of the diameter of the volution, and the surface sloping thence with a gentle curve to the peripheral margin. The younger specimens are more rotund, having a thickness equal to half the greatest lateral diameter.

Volutions seven or eight; their lateral diameter equal to about once and a half the transverse diameter. Umbilicus closed, or very small in the casts of the interior, and the inner volutions not at all exposed. Transverse section semi-elliptical, with the height equal to about once and a half the width at the base; the sides gently curving and converging to the peripheral margin, which is somewhat abruptly rounded; base indented to nearly half its height by the preceding volution. The rate of enlargement of the volutions in a specimen having a greatest diameter of eighty mm. is from twenty-eight to fifty-two mm.—an increase of twenty-four mm. in a single volution. In a small specimen, measuring eighteen mm. in its greatest diameter, the outer volution increases from six to thirteen mm., or seven mm., in a single turn. In a specimen of forty-five mm. in its greatest diameter, the last volution enlarges from fourteen to twenty-six mm., or an increase of twelve mm.

Chamber of habitation unknown. Aperture not observed, but probably having the same form as the transverse section. Air-chambers numerous, regular, shallow; their greatest depth on the middle of the lateral faces of large individuals is five, and rarely six mm., and the depth at the peripheral margin about twelve mm., while at the umbilical margin the depth does not exceed one mm. In the smallest specimens observed, the depth of the chambers on the lateral face is less than two mm., while on the peripheral margin the depth is about five mm.

Septa strong, the margins thickened and imbricating — a feature more especially shown at the extremities of the acute lobes and at the margins of the peripheral saddle. Their lateral margins, adjoining the inner volutions, are distinctly more advanced toward the aperture than their exterior margins. From their origin at the axis the septa curve somewhat rapidly toward the aperture for a distance of more than one-third the width of the volution, and then somewhat angularly recurving, recede to a point much behind that of their origin at the umbilical margin. From this point they are bent forward at a very acute angle, and in a line nearly parallel to the periphery of the shell, advancing beyond the summit of the preceding elevation; and curving over the peripheral margin, they are abruptly turned backward, assuming a course parallel to the direction of the volutions, and suddenly contracting to the centre of the periphery, enclose a narrow, linguiform ventral lobe, with its extremity mucronate. This course of the septa describes an angular umbilical lobe, a broad lateral saddle, a deep, acute lateral lobe, and a narrow and much elevated peripheral saddle on each lateral face of the volution. The linguiform ventral lobe, with its mucronate extremity, penetrates almost the entire depth of the adjacent, preceding air chamber, and sometimes reaches even below the anterior limits of the second preceding air-chamber. The suture-lines are strongly impressed and quite conspicuous in all the specimens.

Siphuncle minute, perceptible only in the mucronate extension of the ventral lobe.

Test unknown, all the specimens observed being casts of the interior. Surface unknown.

The internal casts are well preserved, and strongly marked by the suture-lines, which distinctly define the lobes and saddles. The smallest specimens observed have a lateral diameter of about eighteen mm., and the larger ones are about eighty-five to ninety mm. in their greatest lateral diameter. These measurements pertain only to the septate portion, which may be incomplete.

This species differs from all the other forms with which we are acquainted. Although bearing some general resemblance to *Goniatites Oweni*, it differs in very important particulars, especially in the closed umbilicus, the less rotund periphery, and the simple, linguiform, mucronate, ventral lobe. The species was originally identified with *G. rotatorius*, DE KONINCK, to which it bears a very close resemblance. An examination of the original of DE KONINCK'S species shows a greater rotundity of the periphery of the volutions, and a depressed area around the umbilicus, corresponding with the description given. These features may also be observed in a comparison of the figures of the two species. *G. rotatorius* is stated by DE KONINCK to have a diameter of eleven centimetres, which nearly corresponds with the figure given by him. In that figure nineteen air-chambers are shown; and in a specimen of *G. Ixion*, of eighty-five mm. in diameter, twenty-two air-chambers are exposed. A specimen of *G. Ixion*, having its greatest diameter forty-seven mm., exposes nineteen air-chambers in its entire outer volution. Noting such differences in the character of the two forms, I am still disposed to continue the American form under a distinct designation.

In the general form of the shell and the direction of the septa, this species may be compared with *G. Mithrax*, in which the lateral lobe is obtuse and rounded at its extremity.

Formation and locality. In the Goniatite limestone of Rockford, Ind.

GONIATITES LYONI.

PLATES LXXII, FIG. 12; LXXIII, FIGS. 9–11; LXXIV, FIG. 7.

Goniatites Lyoni, M.–W. Proc. Acad. Nat. Sci. Phila., vol. 12, p. 471. October, 1860.
" " " Geolog. Surv. Illinois, vol. 2, p. 165, pl. 14, fig. 11. 1866.
" *Hyas*, HALL. Thirteenth Rep. N. Y. State Cab. Nat. Hist., p. 102, figs. 17, 18. December, 1860.
" *Lyoni*, M.–W. Hall: Illustrations of Devonian Fossils: Cephalopoda, pl. 72, fig. 12; pl. 73, figs. 9–11. 1876.

SHELL discoid, depressed, often flattened from compression; the thickness of the disc is from eight to ten mm. where the lateral diameter is from sixty to eighty mm.

Volutions six or more, in entire individuals, all exposed in the very wide, shallow umbilicus, a small proportion only (less than one-fifth) of the inner being overlapped by the outer ones, which are grooved upon their inner margins for the reception of the periphery of the inclosed volution; the groove has a depth of about two mm. where the dorso-ventral diameter of the embracing volution is twenty-one mm. Transverse section of the outer volutions trapezoidal (of the inner ones semi-elliptical), the sides nearly flat, the apex truncated, with the angles rounded; the base is concave in the middle, with the baso-lateral margins rounded. The greatest transverse diameter is equal to two-thirds of the dorso-ventral diameter, the difference in the proportions increasing in the outer volutions. The volutions enlarge very gradually; the measurements give seven and thirteen, and eleven and eighteen, or an increase of six and seven mm. in a single turn. In a larger individual the increase in half a volution is from nineteen to twenty-three mm., or equal to eight mm. in a single volution.

Chamber of habitation unknown, all the specimens observed being incomplete. Aperture unknown. Air-chambers numerous, slightly irregular in depth, and as a rule, gradually increasing toward the outer chamber.

Septa strong, distinctly thickened and imbricating at their margins, and remarkable for the regularity of their curvature. From their origin they advance toward the aperture, in a nearly direct line, obliquely over the umbilical margin to a point on the lateral face about one-fifth of its diameter; thence bending abruptly backward they describe an extremely abrupt curve, including a linguiform mucronate lobe, and return to a point in the centre of the volution greatly in advance of their first retral bending. From the summit of this curve or saddle on the centre of the face of the volution they describe a somewhat longer and scarcely wider retral and advancing curve, which in like manner limits a narrow linguiform and mucronate lobe, and from which the septum curves over the margin of the periphery, thence abruptly descending and turning acutely forward describes a narrow triangular mucronate lobe on the ventral side. This order gives an obtusely subtriangular saddle on the umbilical margin, a narrow lobe, and a very narrow and

elongate lateral saddle, the apex of which is almost precisely in the centre of the lateral face of the volution, and much in advance of the summit of the umbilical saddle; on the outside of this is another lobe similar to the first, and a peripheral saddle in which the summit is still more advanced than the one on the umbilical margin, and less advanced than the central one. These characters of the lateral face are better shown in figure 12 of plate 72 than in the figures on plate 73. The suture-lines are strongly marked and usually deeply impressed upon the weathered surfaces. Siphuncle minute; not satisfactorily determined.

Test and surface-markings unknown. Upon the peripheral margins of some of the casts there is an impression indicative of the imprint of curving striæ, which may mark the margins of the sinus.

The internal casts are smooth, with the exception of the deep indentation along the suture lines. The fossil usually occurs in a fragmentary condition, and few entire individuals have been observed. These measure from sixty to sixty-five mm. in their greatest diameter; but fragments of other individuals of larger size indicate that the shell has had a diameter of eighty or ninety mm., exclusive of the chamber of habitation. The slender and much expanded form has rendered it more easily broken and dismembered than the other species with which it is associated.

This species is quite unlike any other known to me in our formations, though presenting, in its septa, some general resemblance to *G. Chemungensis.*

Formation and locality. This species occurs in the same association with *G. Ixion,* in the Goniatite limestone, at Rockford, Indiana.

ADDENDA.

(REFERENCES TO PLATES XXVI–XXX.)

NOTE.—The printing of the text of the Gasteropeda before the completion of Plates XXVI–XXX, has necessitated the following additional references:

Page 14, line 19, add PLATE XXIX, FIG. 8.
Page 16, line 7, add PLATE XXVIII, FIG. 20.
Page 27, line 19, add PLATE XXVIII, FIG. 16.
Page 33, line 17, add PLATE XXVIII, FIG. 17.
Page 40, line 2, add PLATE XXVIII, FIG. 5; line 22, add PLATE XXVIII, FIG. 4.
Page 43, line 20, add PLATE XXVIII, FIGS. 1–3.
Page 44, line 2, add PLATE XXVIII, FIG. 8.
Page 45, line 2, add PLATE XXVIII, FIGS. 6, 7, 7*a*.
Page 47, line 2, add PLATE XXVIII, FIG. 15.
Page 51, line 7, add PLATE XXVIII, FIGS. 18, 19.
Page 55, line 6, add PLATE XXVII, FIGS. 1–4; PLATE XXIX, FIG. 7.
Page 56, line 28, after PLATE XXVII, add FIG. 8.
Page 62, line 11, add PLATE XXVII, FIGS. 5, 6.
Page 64, line 3, add PLATE XXX, FIGS. 26, 27.
Page 67, line 2, add PLATE XXX, FIGS. 10, 11, 23, ?24.
Page 69, line 2, add PLATE XXX, FIGS. 8, 9.
Page 73, line 18, for XXVIII read XXX, FIGS. 15–17.
Page 74, lines 17, 18, for plate 28 read plate 30.
Page 76, line 8, add PLATE XXX, FIG. 2.
Page 79, line 2, add PLATE XXX, FIG. 13.
Page 80, line 12, add PLATE XXX, FIG. 1.
Page 81, line 19, add PLATE XXX, FIG. 3.
Page 85, line 8, for FIG. 19 read FIGS. 4, 19.
Page 86, line 2, for FIG. 18 read FIGS. 12, 18.
Page 87, line 2, for FIG. 25 read FIGS. 5, 25; line 20, for FIGS. 20, 21 read FIGS. 6, 20, 21, 22.
Page 92, line 17, for PLATE XXVIII read PLATE XXX.
Page 93, line 8, add PLATE XXX, FIG. 28.
Page 95, line 14, add PLATE XXVI, FIG. 1.
Page 100, line 3, add PLATE XXVI, FIGS. 10–12.
Page 106, line 6, add PLATE XXVI, FIG. 13.
Page 110, line 17, add PLATE XXVI, FIG. 24.

CORRIGENDA.

Page 3, line 26, add PLATE II, FIGS. 30, 31.
Page 17, line 18, *dele* "and *P. dumosum:*" line 19, should refer only to plate 7.
Page 21, line 7; page 22, lines 3, 22; page 23, lines 1, 12, 21, 27, 30; page 24, lines 1, 20, 27; page 25, lines 15, 18; page 26, lines 7, 19; page 27, lines 11, 18; page 28, line 16; page 29, lines 7, 12, 17, 21, 25; page 31, line 3; page 35, line 23; page 36, line 27; page 38, lines 4, 21; page 39, line 21; page 40, lines 1, 21; page 41, lines 7, 14, 24; page 42, lines 13, 19; page 43, lines 10, 14; page 44, lines 1, 18; page 46, lines 1, 23; page 49, line 5; page 50, lines 9, 17, 35; page 51, lines 1, 6; page 52, line 18; page 53, line 4, for the terminal *a* or A, in specific names, read *um* or UM.

Page 32, line 9, for MACROCHEILUS HEBE read MACROCHEILUS (? POLYPHEMOPSIS) HEBE.
Page 32, line 26; page 33, line 12; page 34, line 6; page 49, line 26, for the terminal *us* or US, in specific names, read *um* or UM.
Page 34, lines 6, 15, for PLEUHONEMA read CALLONEMA.
Page 37, line 1, for *-iltonia* read *-iltoniæ*.
Page 38, line 4, for OBSOLETA read OBSOLESCENS.
Page 39, line 19, and page 40, line 18, for *attenuata* read *emaceratum*.
Page 40, line 2, for FIGS. 1–6 read FIGS 1–3.
Page 44, lines 16–17, for Upper Helderberg read Hamilton.
Page 45, line 27, for *delphicola* read *Delphicola*.
Page 47, line 1, for DELPHICOLA read DELPHICOLA.
Page 52, line 20, add to Ohio river, below hydraulic beds.
Page 56, line 2, before decollated insert usually.
Page 60, line 2, for 16–18 read 17, 18.
Page 67, line 11, for anterior read external.
Page 69, line 20, for coronate read carinate.
Page 70, line 14, for Upper Helderberg read Hamilton.
Page 78, last line, add and in the Chemung group, at Ithaca, N. Y.
Page 90, last line, add below Hydraulic beds.
Page 99, line 4, for HYALINA read HYALINUS; also in Explanation of Plate XXVI.
Page 100, line 3, for FIGS. 3–6 read FIGS. 3–10.
Page 102, line 13, for *trilirata* read *triliratus*.
Page 119, line 5, for 19–24 read 19–23.
Page 123, line 6, for SUBGENUS CYRTONELLA read CYRTONELLA, n. subgen.
Page 145, line 31, for crassicostata read crassicostatus.
Page 158, line 29, for 159 and 165 read 161 and 167.
Page 179, last line, for *gracilistriata* read *gracilistriatus*.
Page 180, line 2, *dele* reference to fig. 2.
Page 187, line 1, for ACICULUM read ACICULA; also in Explanation of Plate 32 A.
Page 190, line 19, for GRACILIS read GRACILE; also in Explanation of Plate 32 A.
Page 194, line 26, for four read six.
Page 219, line 13, for *infundibiliformis* read *infundibuliformis*.
Page 226, line 23, for *Casteln.* read *Stokes*.
Page 243, line 5, for OBLIQUUM read VASTATOR.
Page 294, line 17, add Pratt's Falls, Onondaga county, N. Y.
Page 352, line 20, for FIG. 2 read FIGS. 1, 2.
Page 359, line 2, for *Nautilus liratum* read *Nautilus liratus;* line 25, for *Nautilus subliratum* read *Nautilus subliratus*.
Page 360, line 24, for PLATE CXIV read PLATE CXI.
Page 375, line 25, for *G. citum* read *C. citum*.
Page 432, line 24, for *æquicostatus* read *equicostatus*.
Explanations of Plates IX and X, in first four species change the terminal A in species and varieties to UM.
Explanation of Plate XI, in first two species make the above change.
Explanation of Plate XII, for PRIMÆVUS, LIRATA and CONCINNA read PRIMÆVUM, LIRATUM and CONCINNUM.
Explanation of Plate XIII, change termination of species, except the 5th, 9th and 11th, to UM.
Explanation of Plate XXV, refer BELLEROPHON OBSOLETUS to page 128.
Explanation of Plate XXVI, refer BELLEROPHON REPERTUS to page 128; and B. LEDA to page 110, instead of page 120. For B. TRILERATUS, juvens, read B. TRILIRATUS, juvenis.
Explanation of Plate CXI, for GONIOCERAS? PANDUM read TROCHOCERAS? (GONIOCERAS?) PANDUM, as in text, page 403.

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[The heavier figures indicate a description of the genus or species.]

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