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Bulletin 80

PALEONTOLOGY 10

REPORT OF THE STATE PALEONTOLOGIST 1903

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University of the State of New York

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Plate 1

Fossil trails on Potsdam sandstone, Bidwell's Crossing, Clinton co. Taking out the slab in sections [*see* p. 18]

University of the State of New York

New York State Museum

JOHN M. CLARKE State Paleontologist

Bulletin 80

PALEONTOLOGY 10

REPORT OF THE STATE PALEONTOLOGIST 1903

To the Regents of the University of the State of New York

I have the honor to report herewith on the work of this department during the year commencing Oct. 1, 1902.

Operations in the field 1902-3

Stratigraphic survey of the Schoharie region. The earliest stratigraphic determinations in New York based on a careful collation of paleontologic evidence were made in the valley of the Schoharie creek and the region immediately about Schoharie Court House by two generations of the Gebhard family. The formations along the creek south of Esperance are exposed to extraordinary advantage and their richness in organic remains, combined with the eager zeal for the study of nature possessed by the Gebhards, father and son, led to the appointment of John Gebhard jr as assistant on the original geological survey because of his familiarity with the geology and the contents of the rocks in this portion of the first district, then assigned to the charge of Lieutenant Mather. The outcome of this early study of the rocks in the Schoharie valley has made itself effective in the paleontology of New York in many ways. When Professor Hall came to study the paleontology of the formations there represented, he found it imperative for him to rely chiefly for his subject-matter on the extraordinarily fine and complete Gebhard collections. The account given by him of the species of the Lower Helderberg and Oriskany faunas, which constitutes volume 3 of the *Palaeontology of New York*, was so largely derived from these collections that it was deemed wise by the museum to subsequently acquire one of them, and on a later occasion still another was secured from the same source. Because of these facts the Schoharie section has become a basis of reference in studying these faunas, and for 50 years past it has been a region freely visited by students of geology; and yet during all this time no geologic map of the area has been published except on a very small scale in conjunction with and as a part of the maps of the State as a whole. To meet a definite want on the part of students, and for the more detailed exposition of the geology of that region a map has been completed during the present season on the quadrangle scale which covers the area from Middleburg northward to the south line of Montgomery county. The work has been carried out by Prof. A. W. Grabau, who has previously labored with much credit on similar problems, and his map and report thereupon are presented in the following pages.

Structure of the disturbed fossiliferous rocks in the cement district about Rondout. The lucid and very interesting exposition of the geology of Becraft mountain which was given in my last report has led to a consideration of the rather more complicated region of rocks of like age on the opposite or west side of the Hudson river. Becraft mountain in Columbia county is the remotest outlier of the series of rock beds which so extensively enter into the composition of the Helderberg mountains of Albany county. At Kingston, Hudson and eastward these rocks were caught in the Appalachian folding, and subsequent erosion of these folds has isolated the area at Becraft mountain entirely from the parent mass. At Rondout and vicinity the rocks have been left in continuity, but it has long been recognized that they are exposed under much perplexity of form, due to the folding and displacement of the beds. The structural problems presented there have never been understood and as long as geologic work has been carried on in this State the situation in this region has been somewhat timorously approached. These problems seemed to afford features of much interest connected with the tectonics of the region and the mode of the Appalachian disturbances, and the fact was recognized that a solution would probably not be found without the aid of the evidence derived from studying the fossils. I therefore asked Mr Gilbert van Ingen, who at that time was officially connected with this department and who had many years' familiarity with the region, to undertake the attack on the difficult situation there presented. Mr van Ingen with the assistance and cooperation of Mr P. Edwin Clark, for many years superintendent of the Newark Lime & Cement Co. at Rondout and mining engineer of long experience, has given the subject very detailed examination and careful study. His results were presented in the report of last year and will be found to afford a well illustrated exposition of the obscure and complicated structure of the region.

Traverses of the Catskill mountains and collections of the fauna of the Port Ewen beds. During a part of the season Mr George H. Chadwick has been engaged in reviewing the section of the Catskill mountains in Greene county, in the hope of ascertaining some new clues to the nature of the life forms in the higher strata. Subsequently he was occupied in collecting as freely as practicable from the limestone and shale beds which constitute the Port Ewen (formerly termed the Kingston) beds and best exposed in the vicinity of Rondout and Kingston. This formation is that at the top of the series originally termed the Helderberg and subsequently Lower Helderberg, and is a sedimentary facies reproducing that of the Catskill shaly limestone below, otherwise known as the New Scotland beds. The fauna of these upper beds has not been carefully analyzed, though there has been a well grounded belief that its affinities were with the later or Oriskany fauna rather than with that of the Helderbergian beneath.

Distribution of the Cobleskill limestone. Reference was made in the last report to the study of this formation, the importance of which as an element in the New York series had not heretofore been recognized. Mr C. A. Hartnagel has continued and concluded this study and has traced the formation from Port Jervis at the south, northward through Orange and Ulster counties and from Schoharie county westward through Otsego, Herkimer and Onondaga counties and on to Erie county. The outcome of Mr Hartnagel's work has been to demonstrate the continuity of this apparently feeble element in the rock succession and to indicate its significance as a closing phase of the Siluric formation and fauna in the State of New York. Originally brought into the nomenclature of the science as the Coralline limestone and believed to have a purely local significance in the Helderberg region and the adjoining districts westward, it is now found to have been notably underestimated in its continuity and extent.

Paleontology and stratigraphy of the slate belt of eastern New York. Mr Ruedemann, who has been concerned with the problems presented by the obscure and somewhat complicated structure of this region, has continued his investigations, giving special attention to the region about Granville, for the purpose of reexamining the localities from which Messrs Walcott, Dale and Prindle obtained paleontologic evidence during their study of the region. The exploitation of the graptolite faunas of these rocks, which here, as in other parts of the world, have been found of material importance for the correlation of these with distant formations, has led to the restudy of the structure of Mt Moreno near Hudson which, previously known by an excellent exposure of the Normanskill graptolite shale, has become still more interesting by the discovery of the uppermost zone of the Phyllograptus shale before known in New York only from the Deep kill section of Rensselaer county. All the data now obtainable bearing on the composition of these graptolite zones and the correlation of these geologic formations with those of remote regions of the world have been brought together in the form of a monograph of the graptolites of the older New York rocks, and this is now in press.

Beekmantown and Chazy formations of the Lake Champlain basin. In continuing an examination of the lower faunas of this region, which has been carried on during several seasons, the assistant paleontologist spent the greater part of the field season. The real import of these faunas in the paleontology of New York was not brought out in the early surveys of the region, and we owe our present knowledge of them, specially of the former, chiefly to the labors of Professors Brainerd and Seely of Middlebury Vt., whose investigations however were chiefly confined to Vermont, and to Professor Whitfield, who has described most of the fauna as now known. The congeries of life forms herein is surprisingly profuse and embodies a multitude of novel species of notable interest. It was deemed necessary for a successful exploitation of these two formations to determine the detailed succession of the faunas bed by bed at the typical exposures, Beekmantown and Chazy. Thereafter the exposures on Valcour island, which are of unusual interest, were examined in detail, specially the cliffs along the west and south shores. A large amount of material was acquired by this work, and some account of the new forms obtained is appended to this report. A fuller revision and description of the entire faunas of the Beekmantown and Chazy formations will be undertaken when the other exposures in this region have been carefully examined.

Correlation of the New York Devonic with that of Gaspé, Canada. In a previous report record was made of the effort to elucidate the composition and origin of the early Devonic faunas of New York by a comparative study of the Devonic areas in the eastern counties of the Province of Quebec. Here the faunas attained unexampled profusion of development and it was shown as a result of a brief collecting trip to Grande Grève, Quebec and Dalhousie N. B., by the paleontologist in 1900, that a close examination of the fauna of the Grande Grève limestones would bring out many facts helpful to the problems before us in New York. The Grande Grève limestones exposed on the north shore of Gaspé bay are repeated only at Percé, on the westernmost coast of Gaspé county, south of Gaspé bay, and this spot was visited during the past summer. The environs of the fishing village of Percé are of extraordinary interest to the student of the older rocks. The limestone series has been greatly disturbed here, the faulting having brought up sections of those rocks in different places and at differing angles. Only the Percé rock, a stupendous detached cliff cut off by the action of the sea from the mainland, satisfactorily represents that portion of the limestone series to which in northern Gaspé the term *Grande Grève limestones* has been applied. This mass of reddish and yellowish limestones rising from the sea with sheer walls and vertical strata is profuse in interesting fossils, of which a large number were obtained, together with interesting series from the limestone exposures of earlier age. It is safe to say that the collections in the possession of the State Museum, both of the fossils at Percé and of those at Grande Grève, are without equal. In a subsequent part of this report I have added a brief preliminary account of the stratigraphy and paleontology of Percé.

Areal survey of the Elmira, Watkins, Ithaca and Waverly quadrangles. As reported last year operations were carried on during the season of 1902 in cooperation with the United States Geological Survey in an areal survey of the Elmira quadrangle. Under this arrangement as carried into practice in the Olean and Salamanca quadrangles stratigraphers were furnished for the field work from the corps of the survey and their expenses were met from the appropriations of this department, and we undertook at the same time to acquire the necessary paleontologic collections for proving the stratigraphic work. The stratigraphic work on the Olean and Salamanca sheets was chiefly done by Prof. L. C. Glenn, a skilful and exact observer, and the paleontologic collections therein were acquired and largely determined by Mr Charles Butts, representing this department. In my judgment the work of these two men was carefully executed, though leading to some divergence of conclusion with regard to classification.

The basis of this cooperation conceded to us the use for our publications of such maps and reports as the geologists of the United States Geological Survey should prepare, but we have found it impracticable to avail ourselves of this provision, first, for the reason that the scale of the United States Geological Survey folio maps is one we regard unsuited to our practice and, again, that the execution of these maps and reports was to be so long deferred as to qualify their usefulness to us. We were therefore compelled to incur the unexpected expense of engraving these maps on the quadrangle scale and to have a special report prepared to accompany them. In the work on the Elmira quadrangle, it was my desire and plan to cover continuously therefrom in this areal survey the adjoining territory to the north and east, as therein were involved some interesting questions of classification of the rocks and faunas concerning which we had been diligently acquiring data for many years. The outcome of that work in 1902 was disappointing. No data were acquired by the stratigraphers on which even a preliminary areal map could be constructed and I was unable that year to send our more experienced workers into this rather difficult field to check up the determinations of the stratigraphers. In consequence therefore we decided to hereafter execute such work ourselves. It is hardly to be expected that geologists whose experience has been restricted to broad reconnaissance in imperfectly known regions can enter anywhere in this State where the rocks have been continuously studied for nearly 70 years and achieve the results required in New York. It is not our desire to encourage such enterprises. We have therefore made a new start this season beginning with the Elmira quadrangle and extending the work in detail north to the Watkins quadrangle. The undertaking has been essentially in charge of D. D. Luther, whose skill in the careful stratigraphic determination of the older rocks in New York is in my judgment not to be surpassed. This work has occupied essentially all of Mr Luther's time, with that of H. S. Mattimore, during the field season of 1903, with the result that the Elmira and Watkins maps are essentially complete and the Ithaca and Waverly sheets fairly covered.

Office work

Publications

During the past year the following publications have been issued by the department.

Memoir 5. Guelph Fauna in the State of New York. Q. 196p. 21 litho. pl. This is an exposition of a virtually new or heretofore unrecognized element in the New York faunas. It contains chapters as follows:

Typical Guelph dolomites of Ontario and their fauna
Guelph fauna of New York and its stratigraphic relations
Historical
Section of dolomites at Shelby, Orleans co.
Niagara county
Other manifestations in Orleans county
Monroe county
Wayne county
Southern Ontario—the section at Hamilton
Fauna of the Guelph dolomite in western New York
Synoptic list of Guelph fossils in New York
Conditions of life and sedimentation
Distribution of the Guelph

Memoir 6. Naples Fauna in Western New York, part 2. The first part of this treatise, which considered only the cephalopods of the fauna appeared in the *16th Annual Report of the State Geologist 1896* [1899]. It covered 169 pages and 9 plates, royal quarto. The present memoir is a completion of the subject, covering 215 pages and 21 plates. It includes chapters as follows:

The sea of Portage time
  Lake Oneonta
  Nonmarine stages succeeding Lake Oneonta
Bionic provinces of the Appalachian gulf during Portage time
  1 Oneonta province
  2 Ithaca province
  3 Genesee province
    Naples subprovince
    Chautauqua subprovince
Comparisons of stratigraphic sections in the Genesee province
Bionomic character of the fauna
  Lamellibranchiata
  The cardioconch condition
  Other components of the fauna
  Descriptions of the fauna
Development of the Intumescens fauna outside of New York
Range of species in the Chautauqua and Naples subprovince
Geographic distribution of the fauna of the Genesee province
Distinctive features of the subprovincial faunas
Correlation of the fauna ot the Genesee province with the Intumescens fauna of Europe
Relation of the fauna to the black shales
Summary

Bulletin 65. *Type Specimens of Paleozoic Fossils in the New York State Museum.* This catalogue, which has been an arduous compilation and long in press, is a record of the possessions of the museum in this important class of objects. Type specimens of natural objects, that is the actual material on which published descriptive accounts and discussions have been based, constitute the unique treasures of a museum. Such objects once lost or destroyed, replacement is impossible. Howsoever imperfect or fragmentary the type or original specimen may be, of however superior quality some other example of the same creature, the second can not serve to scientific students the function of the first. The type specimen is the basis of comparison and reference for all time.

The publication of the *Palaeontology of New York* and the extensive list of papers accessory and supplementary thereto have given birth to a very large number of type specimens from the paleozoic strata of America. Some part of these, specially that utilized in the early volumes of the paleontologic reports, was the personal property of the author of those reports and passed from his hands to the possession of the American Museum of Natural History in the city of New York. Till the preparation of this catalogue was begun, no serious effort to bring together the type specimens in the State Museum of these and other descriptions into one place or record was ever carried to completion. Some years ago the writer undertook the work of publishing lists, believed to be complete at the time, of certain of the organic groups, namely the Crustacea, Vermes and Cephalopoda;[1] but a revision of these lists has shown considerable omissions, due somewhat to normal growth as investigations have progressed but more to the fact that these types have been scattered all through the collections of the museum both in the State Hall and in Geological Hall. It has been an arduous task to search out and bring together these specimens, which during the past half century have become so widely and carelessly diffused, but their number is noteworthy, and the importance of this record justifies the labor put on it.

[1] N. Y. State Geol. 11th An. Rep't. 1892. p.31–53; 12th An. Rep't. 1893. p.57–104.

This catalogue is arranged as follows:

The general classification is biologic and follows the broadest subdivisions. Each entry represents a single specimen and is accompanied by two numbers, the first serial, the second fractional and corresponding to the number borne by the specimen. In this fractional number the numerator carries the number assigned to the major division, the genus and the species, while the denominator indicates the number of the specimen of the species. Thus, the sponge Dictyospongia sceptrum Hall (sp.) carries the number $\frac{2264}{2}$. 2000 is the number assigned to the Spongiae, 2260 that assigned to the genus Dictyospongia, 2264 the number for D. sceptrum, the fourth species of that genus, and $\frac{2264}{2}$ the number for the second specimen of this species. In the scheme of numbering the following is the allotment made for the major biologic divisions.

Plantae	100	Lamellibranchiata	9 000
Protozoa	1 000	Gastropoda	10 000
Spongiae	2 000	Pteropoda	11 000
Cnidaria	3 000	Cephalopoda	12 000
Echinodermata	4 000	Crustacea	13 000 – 14 000
Vermes	5 000	Tracheata	15 000
Bryozoa	6 000	Pisces	16 000
Brachiopoda	7 000 – 8 000		

For ease of use it has been the purpose to keep these divisions as broad as practicable, in order to avoid duplicating too often the alphabetic arrangement of the species and to maintain the elasticity of the scheme in the incorporation of future additions. The work does not purport to be one on taxonomy, but aims to present the arrangement in the simplest form. During the progress of the printing of the catalogue, a period of 18 months, the continuous publication of paleontologic researches and acquisitions to the collections by gift and purchase have notably increased the number of type specimens and these have been added in a supplementary list brought up to February 1903.

While the main part of the book is devoted to the biologic arrangement of the type material, a second part gives a concise relisting of the species in their stratigraphic arrangement.

A chief purpose of this record is to make available to students the card catalogue of these types now in the possession of the museum. At the same time it serves to indicate the wealth of the museum in these important elements, of which upward of 5000 are here listed, a number which exceeds all type specimens of paleozoic organisms from the New York rocks in the possession of all other collections taken together.

This list of type specimens was complete up to the time of going to press, but the progress in our work since then has already necessitated the preparation of a second supplementary list including the increase to the present time, and such list is submitted as a part of this report. These accessions to our collection of type specimens now raise the total to 5700.

Bulletin 66. The Ellis *Index to Publications of the New York State Natural History Survey and New York State Museum.* This admirable compilation is entitled to special notice here, because of its exhaustive treatment of the paleontologic publications and its index to descriptions of genera and species of fossils. The latter part of the book covering 127 pages was prepared in this office. It has reference solely to dates of publication and undertakes no notice of subsequent revision of generic or specific names. It contains upward of 5000 references.

Bulletin 69. Report of the State Paleontologist for 1902. This bulletin contains the following scientific papers:

Dwarf Fauna of the Pyrite Layer at the Horizon of the Tully Limestone in Western New York. 5 litho. pl. By F. B. Loomis

Mastodons of New York. 3 pl. By John M. Clarke

Cambric Dictyonema Fauna in the Slate Belt of Eastern New York. 5 pl. By Rudolf Ruedemann

Sedentary Impression of the Animal whose Trail is Known as Climactichnites. 2 pl. By Jay B. Woodworth

Devonic and Carbonic Formations of Southwestern New York. 2 pl. 1 map. By L. C. Glenn

Fossil Faunas of the Olean Quadrangle. By Charles Butts

Construction of the Olean Rock Section. By John M. Clarke

Stratigraphy of Portage Formation between the Genesee Valley and Lake Erie. 1 map. By D. Dana Luther

Stratigraphy of Becraft Mountain, Columbia County, N. Y. 1 map, 2 sections. By Amadeus W. Grabau

A New Eurypterid Fauna from the Base of the Salina of Western New York. 21 litho. pl. By Clifton J. Sarle

Preliminary Observations on the Cobleskill (Coralline) limestone of New York. 2 pl. 1 map. By C. A. Hartnagel

Disturbed Fossiliferous Rocks in the Vicinity of Rondout N. Y. 13 pl. By Gilbert van Ingen and P. Edwin Clark

Torsion of the Lamellibranch Shell. 1 pl. By John M. Clarke

Some Devonic forms. 2 litho. By John M. Clarke

The labor necessary to preparing the publications above listed has been an essential part of the office duties of all members of the staff. We look on the outcome of the year in this regard as fruitful and satisfactory but as in nowise lessening the sum of the problems still before us.

I have added to this report a detailed discussion of the Lower Devonic rock section at Port Jervis prepared by Prof. H. W. Shimer of the Massachusetts Institute of Technology. The paper has features of special interest in the analysis of the faunas of the Port Ewen beds and the Oriskany limestone of Trilobite mountain.

Investigations in progress

Correlation study of the Helderberg, Oriskany and Grande Grève faunas. These investigations have progressed as opportunity has afforded and the work is near completion. The richness of the Grande Grève and Percé fauna in comparison with those of the New York Helderberg and Oriskany will make the faunal lists extensive, and the close analysis indicates variations due to different physical conditions, which in the fauna of a single geographic province might escape notice. The problems presented by this study are not merely those of the constitution of a fauna or certain allied faunas but rather the variations due to distribution or occurring in the dissemination of the fauna. Necessarily involved therewith is the interpretation of the paleography of the early Devonic of eastern America and incidental thereto the local geology of points both in New York and Gaspè. It is hoped to complete this work in course of the present year.

Graptolites of the slate belt of eastern New York. This series of investigations on the nature of the graptolite faunas of New York and their correlation with those of other parts of the world has been completed so far as relates to the earlier rocks. A second part of these investigations will include the later manifestations of the graptolite faunas. The graptolites have proved under the recent studies of European and American paleontologists the leading fossils for the subdivision of the Siluric deposits into zones of life and correlation. The first serious studies of their organization were made by James Hall and Ebenezer Emmons, and Professor Hall's elaborate and beautifully illustrated memoir on the *Graptolites of the Quebec Group,* 1865, republished in the 20th annual report of the State Museum as an "Introduction to the Study of the Graptolitidae" has been classical for the study of these forms. Our knowledge of these objects has however been greatly augmented by the investigations carried on by European authors, specially by Lapworth on the distribution and classification of the British graptolites. As far back as 1886 that writer indicated the general parallelism in the succession of these faunas in Canada and Great Britain, and in papers already published in our own reports the same line of inquiry and demonstration has been followed, together with contributions to their anatomy, physiology and bionomy. The present work covers with some degree of detail and in successive chapters the following subjects of inquiry: history of the study of the graptolites; methods of investigation and illustration; terminology; vertical range and geographic distribution; mode of existence; ontogeny and reproduction; morphology; histology; classification and phylogeny; synoptic tables; description of species—71 in all, of which 29 are new.

Fauna of the Beekmantown and Chazy formations. For many years before his death Professor Hall hoped for the opportunity to revise his first volume of the *Palaeontology of New York.* Back in the years from 1843 to 1847, when he was engaged in working out the fauna of the older rocks, the collectors were few and the localities but lightly explored. He did a work of the highest merit, but the revolving years have added much to our knowledge of these early faunas, though he found no opportunity to return to them. A special interest attaches to these early faunas of the earth, and their development in what is now the basin of Lake Champlain is most favorable, though it has not received merited attention. The collections which we have made in this region during the past five years are extensive and are now undergoing review preliminary to a careful reconsideration of the faunas. Actual additions to the numerical status of the faunas prove to be relatively numerous and of much interest, and these are brought together and presented with this report. Dr Ruedemann has been specially concerned in the collection and study of these bodies and has begun the preparation of a series of discussions pertaining thereto. I incorporate in this report some of his papers relating to certain aspects of the cephalopods, and these contributions will be found of more than ordinary interest in their exposition of the structural characters of these creatures. Prof. George H. Hudson of Plattsburg, who has long studied the rocks and fossil faunas of Valcour island, has also cooperated in this work by adding the descriptions of some interesting species discovered by him in the Chazy formation there.

Fossil plants of the paleozoic rocks. In the history of this office no serious effort has been specially directed to acquiring the plant remains found in the New York rock formations. Not that these have been intentionally ignored or overlooked but the collections which we possess have been acquired incidentally to the exploitation of the marine faunas. In the course of years these incidental collections have grown to be of considerable moment and embrace a few specimens of commanding size, such as the so called fern stumps from Gilboa, the gigantic seaweed (Nematoxylon) from Monroe, Orange co. and the great Lepidodendron from Naples—all from the Upper Devonic. Some forty years ago Professor Hall interested Sir William Dawson, who was generally acknowledged the most expert student of Devonic plants in America, in some of the New York material and both at that time and subsequently Sir William published brief accounts of some of our species. Professors D. P. Penhallow and C. S. Prosser have also given incidental attention to this class of fossils, though taken all together but little has been done in this important and interesting field. During the past year Mr David White, paleobotanist of the United States Geological Survey has given our collections careful examination and has expressed his conviction of their great importance and completeness. It is proposed with the aid of Mr White to elaborate the more interesting part of these plant remains, and he has in accordance with this plan begun preparing an introductory member of a series of papers relating to this subject.

Investigations at Rondout. Some months of the year were required by Mr Gilbert van Ingen for preparing his report on the geologic conditions at Rondout, which has already been published.

Stratigraphic and areal maps

The following is a list of the colored geologic maps of parts of the State on the scale of 1 mile to the inch (with one exception) which have been issued by this department.

Tarrytown and Ramapo sheets
Amsterdam sheet
Parts of Albany and Rensselaer counties
Niagara Falls and vicinity
Becraft mountain, Columbia county
Olean sheet
Portage division in western New York
Union Springs and vicinity

Printed and ready for distribution

Canandaigua-Naples sheet

Ready for publication

Tully sheet
Salamanca sheet
Part of Schoharie sheet
Elmira sheet
Watkins sheet

In preparation

Ithaca sheet
Waverly sheet

On the following topographic sheets work has been recorded and is more or less advanced toward completion.

Auburn	Geneva	Plattsburg
Ausable	Genoa	Richfield
Berne	Greene	Rochester
Buffalo	Hammondsport	Schuylerville
Cambridge	Hoosick	Silver Creek
Cazenovia	Moravia	Skaneateles
Cherry Creek	Mt Morris	Syracuse
Chittenango	Norwich	Troy
Cohoes	Ovid	Wayland
Cortland	Penn Yan	Westfield
Coventry	Phelps	Whitehall
Dunkirk	Pitcher	

Miscellaneous

Fossil trails at Bidwell's crossing. In my last report Prof. J. B. Woodworth gave a brief illustrated account of certain remarkable trails on the surface of the Potsdam sandstone exposed on the farm of B. H. Palmer at Bidwell's crossing near Sciota, Clinton co. These trails are of a type which have frequently before been found in Potsdam strata and were termed by Sir William Logan, Climactichnites—the ladder-shaped track—from the crossbars which traverse it. Some years ago the State Museum undertook to remove a large slab of these trails from a quarry at Port Henry but the sandstone layer bearing them came out in such a fragmentary condition that the pieces could not be matched together and the undertaking was a qualified success. The exposure at Bidwell's crossing was of extraordinary interest in several respects. Over an area measuring about 30 feet in length by 10 feet in width and flush with the soil surface of a partly cleared brush lot lay a series of long trails averaging 5 inches in width and some of them 10 to 15 feet in length, the principal trails having a general parallelism to the length of the exposure, there being not less than 25 distinct trails visible on the slab. Each of these long serpentlike trails, when complete, ends in a distinct oval impression which has been considered by Professor Woodworth as the mark made by the body of the animal at rest. Such terminal

Plate 2

Fossil trails on Potsdam sandstone, Bidwell's Crossing, Clinton co.

markings have not been observed before either independently or in connection with these trails. Twenty-six of these oval scars are shown on the slab. Logan, Hall and other writers on such markings have generally regarded them as made by large trilobites and the undulated crossbars as caused by the oscillating ventral appendages of these animals in crawling over the long exposures of the sand beach at ebb tide. Professor Woodworth, however, believes that they were produced by a worm or large univalve mollusk and has given an account of some experiments made by himself to demonstrate that the markings must have been caused by a single rather than a multiple opposing surface, by the successive undulations of the gastropod foot rather than by the multiple impression of a trilobite's legs. We know in fact neither the remains of a trilobite nor of a gastropod mollusk in these rocks large enough to make such trails. Either may have been present and like the reptiles whose tracks are found by thousands in the Triassic sandstones of the Connecticut valley, have left no other evidence of itself. From theoretic considerations a crawling patelloid gastropod of commanding dimensions would have well fitted the marine fauna of these ancient Cambric times.

This remarkable display of these ancient trails on the sands of the primordial beach which skirted the primitive continent, now the crystalline nucleus of the Adirondack mountains, had been known to the countryside for many years but public attention was drawn to it first by the publication referred to. A singular bit of folklore has grown up about the trails as successive generations of settlers have wondered at their nature. I have been seriously informed by a venerable village philosopher that here was the very spot where Christ, in accordance with Pentateuchal prophecy, trod on the Serpent's head, and this interpretation seemed generally accepted in some considerable portion of the community as the true meaning of the trails. The oval scars well simulate the print of the human foot lying at or across the end of the serpentine trails.

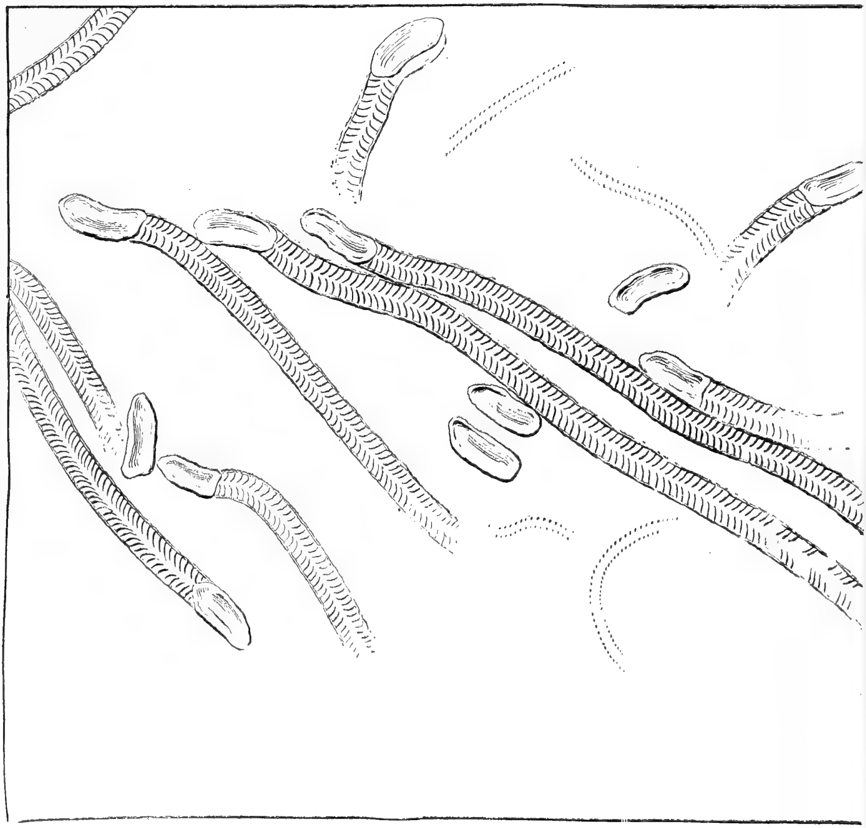
The location of so striking a display of these trails afforded us an opportunity for securing them for the museum. Accordingly an agreement was entered into with the owner, Mr Palmer, in the form of an option of purchase whenever it would become practicable for us to meet the necessary expense attending removal. At a later date I entered into a contract with Frederick Braun for the removal of the principal part of the exposure, having a length of 33 feet and a width of 10 feet. The undertaking was an extraordinarily arduous one, rendered the more difficult by the checking of the sandstone along parallel or converging joint faces which made it necessary to set each block in place in plaster of paris as it was removed. The work of removal required two months and on its completion the exposed slab had been taken out in six sections, the whole weighing 23 tons.

We have in this remarkable specimen an unexampled and impressive exhibit. Facilities for the display of such specimens simply do not exist in the present constitution of our museum but we can not on that account let slip opportunities which may not return, for acquiring such specimens. Storage has been found for these slabs with the Flint Granite Co. at the Cemetery station.

Lease of the Spring House lot. In order to secure for the museum a more extensive series of the rare crustaceans from the base of the Salina group, described by Clifton J. Sarle and myself in previous reports and to facilitate our own further studies of this fauna, I have negotiated a lease of the property adjoining the Erie canal at Pittsford for the purpose of excavating these remarkable fossils. We purpose to break ground at this place with the opening of the next field season.

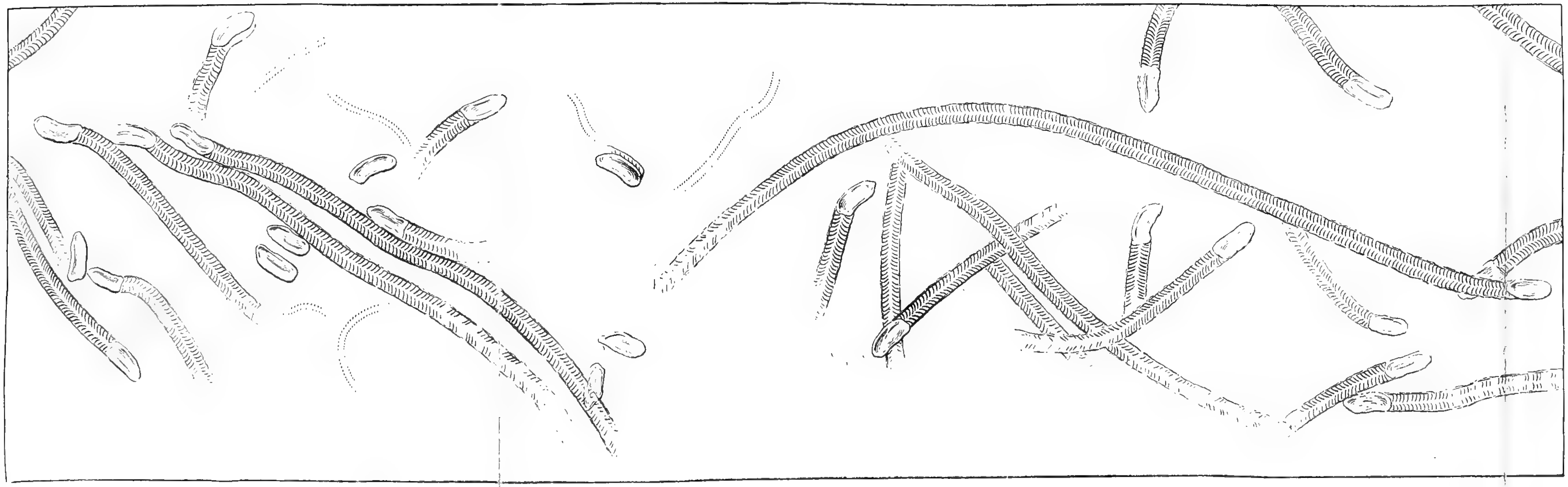
Proposed salt mine at Wyoming. During the past year it was proposed by the Silver Springs Salt Co. to put down a shaft for mining rock salt at Wyoming, Wyoming co. A company was organized for this purpose with the name Oatka Salt Co. under the management of John H. Duncan.

The section of the rock strata compiled by us some years ago from the Livonia salt shaft afforded the most complete information of the rock succession and sequence of faunas through 1600 feet of strata yet recorded in this State. It would be an important contribution to this science if we could duplicate and supplement this elaborate section, and consequently I entered into an understanding with



Trails on Pot

Plate 3



Trails on Potsdam sandstone, Bidwell's Crossing, Clinton co. Sketch made before removal. One twenty-eighth natural size.

Mr Duncan, by whose courtesy we were to be permitted to carry on our examinations and collections during the sinking of the shaft. Since the date of this arrangement Mr Duncan has retired from the management of the company and comparatively little progress has been made in carrying out the original plans for excavation. Should, however, the undertaking be continued we expect to prosecute our examination as originally purposed.

Proposed exhibit for the St Louis Exposition. At the request of the state commission proposals have been made in various form for an exhibition of the work of this department. The proposition which has seemed to best meet the approbation of the commissioners involves the exhibit of the slab of trails from the Potsdam sandstone, already described, supplemented by a series of our publications. I have been authorized to proceed with the preparation of this exhibit.

Purchase of the Ruedemann collection. Previous to his appointment on the staff of this division Dr Ruedemann had brought together an interesting collection of Silurian fossils from this State, in which was included the material utilized as the basis of his study of the graptolites and Conularia. We have acquired this collection by purchase and it constitutes one of the important acquisitions of the year, its type specimens being both numerous and important. A list of its contents is given in full among the accessions.

Appointment of lithographer. By the death of Philip Ast, who had been connected with this department as lithographer for upward of thirty years, it became necessary to fill the vacancy under the civil service requirements. In due conformity therewith William S. Barkentin has been appointed to the position.

Present staff

Permanent and temporary

John M. Clarke, state paleontologist
Rudolf Ruedemann, assistant state paleontologist
D. D. Luther, field assistant
George S. Barkentin, draftsman
William S. Barkentin, lithographer
Jacob Van Deloo, clerk

Martin Sheehy, general assistant

Horatio S. Mattimore, preparator

Gilbert van Ingen, special assistant in cooperation with State Engineer and Surveyor

Amadeus W. Grabau, George H. Chadwick, C. A. Hartnagel, P. Edwin Clark, Frederick Braun — engaged in special field operations

In the following appendixes are given the list of accessions to the museum by collection, purchase and gift, the list of new localities represented by these accessions and a supplementary list of type specimens of species, added to the museum collections since the publication of the catalogue of types.

Respectfully submitted

JOHN M. CLARKE

State Paleontologist

Oct. 1, 1903

APPENDIX 1

ACCESSIONS

The additions to the paleontologic collections have been by donation, purchase, exchange and collection. A detailed statement of these acquisitions is given herewith.

Donations

Wilson, J. D., Syracuse	
Undescribed gastropod. Agoniatite limestone, Manlius	1
Davis, E. E., Norwich	
Large block of Oneonta sandstone with Orthoceras. Oxford	1
Hall, E. B., Wellsville	
Chemung fossils from Wellsville and vicinity	125
Adams, A. P.	
Coal Measures. San Juan river, S. E. Utah	1
Woodward, A. S., London, Eng.	
Tilestones. Horeb Chapel near Llandovery, Wales	7
Total by donation	135

Purchases

Ward Natural Science Establishment, Rochester		
Pentamerus from Clinton limestone, Rochester; 1 group	1	
Ruedemann, R.		
Specimens of Conularia, Tetradium and graptolites from the Utica shale, Dolgeville, as follows:		
Conularia gracilis	58	(hypotypes)
Tetradium cellulosum	16	(hypotypes)
Diplograptus foliaceus, *D. ruedemanni*	40	(types and hypotypes)
Kazenstein, Mrs F., Hancock		
Archaeopteris. Oneonta sandstone, Hancock	1	
Total by purchase	116	

Exchanges

van Ingen, G.

Oriskany fossils from Glenerie, Ulster co. 1000

Kayser, Prof. Dr E. Marburg, Germany

Aphyllites inconstans *Phill.* Upper Middle Devonic. Adorf (Westphalia) 1

A. cancellatus *Arch. Vern.* Upper Middle Devonic. Brilon 2

Maeneceras terebratum *Sandb.* Upper Middle Devonic. Finnentrop (Westphalia) 3

M. terebratum *Sandb.* Upper Middle Devonic. Martenberg bei Adorf (Westphalia) 2

Pharciceras tridens *Sandb.* Upper Middle Devonic. Langenaubach near Dillenburg 1

P. (?) clavilobus *Sandb.* Upper Middle Devonic. Grube Constance near Langenaubach 1

Goniatites (Pharciceras) becheri v. *Buch.* Middle Devonic. Grube Constance, Langenaubach near Dillenburg 1

Goniatites simplex. Upper Middle Devonic. Finnentrop 1

G. sphaericus (*Mart.?*) *Kon.* 1880 var. Culm. Hagen (Westphalia) 2

G. (Gephyroceras?) aequabilis. Upper Middle Devonic. Langenaubach near Dillenburg 1

Beloceras kayseri *Holzapf.* Lower Upper Devonic. Oberscheld near Dillenburg 1

B. multilobatum *Beyr.* Lower Upper Devonic. Oberscheld near Dillenburg 2

Tornoceras mithracoides. Upper Middle Devonic. Grube Constanz near Langenaubach 1

T. circumflexiferum *Sandb.* Oderhauserkalk. Upper Middle Devonic. Urfethal (Kellerwald) 3

Triaenoceras costatum *Arch. Vern.* Upper Middle Devonic. Grube Constanz near Langenaubach (Dillenburg) 2

Prolobites delphinus *Sandb.* Clymenia beds. Oberscheld near Dillenburg 3

Discohelix (Euomphalus) rota *Sandb.* Stringocephalenkalk. Finnentrop (Westphalia) 1

Chiloceras subpartitum *Münst.* Nehden stage. Upper Middle Devonic? Cabrières (South France) 3

Bellerophon striatus *Br.* Upper Middle Devonic. Finnentrop (Westphalia) 2

Holopella tenuisulcata *Sandb.* Middle Devonic. Freter Mühle near Finnentrop 3

Spirifer hercyniae *Gieb.* Lower Coblenz beds. Stadtfeld 2

S. hercyniae *Gieb.* var. primaeviformis *Scup.* Lower Coblenz beds. Stadtfeld (Eifel) 1

S. decheni *Kays.* (=fallax *Gieb.*) Hercyn. Lower Devonic. Erbsloch (Kellerwald) 3

S. decheni *Kays.* Hercyn. Lower Devonic. Erbsloch (Kellerwald) 2

S. maureri *Holzapf.* Upper Middle Devonic. Finnentrop (Westphalia) 1

S. hians v. *Buch.* Stringocephalenkalk. Schladethal near Gladbach (Köln) 5

S. malaisei *Goss.* Lower Upper Devonic. Stolberg near Aachen 1

Pentamerus rhenanus *F. Roemer.* Stringocephalenkalk. Greifenstein near Wetzlar 2

P. oehlerti *Barrois.* Middle Devonic. Tentaculite beds. Leun near Wetzlar 2

P. baschkiricus *de Vern.* Middle Devonic. River Ai, Ural mountains 2

Orthis ivanovi *Tschernysch.* Lower Upper Devonic. Stolberg near Aachen 3

Newberria amygdalina *Stein. Goldf.* Stringocephalenkalk. Pelm (Eifel) 2

N. amygdalina *Stein. Goldf.* Lenneschiefer. Attendorn (Westphalia) 1

Amphigenia beyrichi *Holzapf.* Upper Middle Devonic. Finnentrop 1

Meganteris damesi *Holzapf.* Upper Middle Devonic. Finnentrop (Westphalia) 2

Athyris globosa *Roem.* Ibergerkalk. Lower Upper Devonic. Bieber (Nassau)	3
Leptaena retrorsa *Kays.* Lower Upper Devonic. Cornelimünster near Aachen	3
Rhynchonella pugnus *Mart.* Ibergerkalk. Langenaubach	6
Liorhynchus formosus *Schnur.* Lower Upper Devonic. Büdesheim (Eifel)	3
Strophalosia productoides *Murch.* Upper Devonic. Aachen (Rhineland)	3
Amphipora ramosa *Phill.* Upper Stringocephalenkalk. Schladethal near Berg Gladbach (Westphalia)	1
Philipsastraea? roemeri *E. H.* Ibergerkalk. Lower Upper Devonic. Alter Schalsteinbruch, Langenaubach near Dillenburg	3
Proetus eremita *Barr.* Lower Middle Devonic (Mnenianerkalk). Greifenstein	1
P. orbitatus *Barr.* Lower Middle Devonic. Greifenstein. (Mnenianerkalk). Greifenstein	1
Dechenella verneuili *Barr.* Stringocephalekalk. Pelm (Gerolstein)	2
Cheirurus cf. sternbergeri *Barr.* Upper Middle Devonic. Grube "Martha" near Wetzlar	3
Odontochile hassiaca *Kays.* Upper Lower Devonic or Lower Middle Devonic? Kleinlinden near Giessen	1
Phacops caecus *Gürich.* Upper Devonic. Langenaubach near Dillenburg	3
Harpes gracilis *Sandb.* Intumescens zone. Sessacker near Oberscheld	1
Posidonia venusta *Münst.* Upper Upper Devonic. Sessacker near Oberscheld	1
Buchiola aquarum *Beush.* Upper Middle Devonic (Odershäuserkalk). Wildungen	1
Kochia dispar *Sandb.* Upper Upper Devonic. (Clymenienkalk). Oberscheld	3
Chascothyris barroisi *Holzapf.* Upper Middle Devonic. Finnentrop (Westphalia)	1
Total by exchange	1106

Collections

The paleontologist	
Devonian and Silurian rocks, Percé, Quebec	700
Hamilton fossils from Adamsdale Pa.	10
Ruedemann, R.	
Beekmantown and Chazy fossils from Clinton county	4000
Ruedemann, R. and van Ingen, G.	
Oriskany fossils from Glenerie, Ulster co.	600
Luther, D. D. and Mattimore, H. S.	
Upper Devonic fossils from the Elmira, Watkins, Waverly and Ithaca quadrangles	1500
Mattimore, H. S.	
Trenton limestone, Watertown N. Y.	175
Black river limestone, Brownsville N. Y.	15
Hartnagel, C. A.	
Cobleskill limestone fossils from Orange and Ulster county	1200
van Ingen, G.	
Rondout, Manlius and Helderbergian from Rondout and vicinity	800
Chadwick, G. H.	
Fossils from the Esopus grit. Athens-Leeds turnpike, Greene county	100
Port Ewen beds, South Rondout	129
Catskill shale, Summit cut, Delhi & Andes Railway, Delaware county	36
Ithaca beds, bed of Town brook, Hobart, Delaware co.	17
Total by collection	9282
Total accessions	10639 (2 types; 112 hypotypes)

APPENDIX 2

NEW ENTRIES ON GENERAL RECORD OF LOCALITIES OF AMERICAN PALEOZOIC FOSSILS BELONGING TO THE STATE MUSEUM

ALPHABETIC LIST OF LOCALITIES

Accord (Orange co.), 3316, 3317, 3318, 3319

Adamsdale Pa., 3306

Argusville (Schoharie co.), 3254

Athens (Greene co.), 3284

Beekmantown (Clinton co.), 3329
Binnewater station (Ulster co.), 3270
Brownville (Jefferson co.), 3365
Buttermilk creek (Tompkins co.), 3352, 3354
Buttermilk falls (Tompkins co), 3355
Cape Barré P. Q., 3301
Cape Cannon P. Q., 3305
Carlisle (Schoharie co.), 3252, 3253
Catskill (Greene co.), 3255
Cayuga lake (Tompkins co.), 3342, 3343, 3359, 3360, 3361, 3362
Central Bridge (Schoharie co.), 3243
Chazy (Clinton co.), 3330, 3331, 3333, 3334, 3335
Cherry Valley (Otsego co.), 3231
Clarks cave (Schoharie co.), 3240, 3241
Collar Back hill (Greene co.), 3255
Cooperville (Clinton co.), 3332
Creek Locks (Ulster co.), 3271
Cuddebackville (Orange co.), 3309, 3310
East Beekmantown (Clinton co.), 3326, 3327
East Kingston (Ulster co.), 3261, 3262
Eddyville (Ulster co.), 3268, 3278
Esty glen (Tompkins co.), 3360
Ellenville (Ulster co.), 3323
Esopus creek (Ulster co.), 3280, 3281
Fiddler's Elbow (Ulster co.), 3317, 3318
Fox creek (Schoharie co.), 3234
Geneva (Ontario co.), 3279
Glasco (Ulster co.), 3260
Glenerie (Ulster co.), 3280, 3281
Glenwood ravine (Tompkins co.), 3359
Green lake (Greene co.), 3284
Grovenor's Corners (Schoharie co.), 3250, 3251
Havana glen (Schuyler co.), 3295
High Falls (Ulster co.), 3275, 3276, 3277
Hobart (Delaware co.), 3307

Sharon Springs (Schoharie co.), 3254
Shutters Corners (Schoharie co.), 3233
" Steep Rocks " (Ulster co.), 3263
South Rondout (Ulster co.), 3285, 3286, 3287, 3288, 3289, 3290
Union Corners (Livingston co.), 3283
Valcour island (Clinton co.), 3336, 3337, 3338
Vlightberg, The (Ulster co.), 3264, 3265, 3266
Watertown (Jefferson co.), 3363, 3364
Watkins (Schuyler co.), 3293
Wellsville (Allegany co.), 3232
West Camp (Ulster co.), 3256, 3257, 3258, 3259
West Chazy (Clinton co.), 3328, 3333, 3334, 3335
West mountain (Schoharie co.), 3242, 3243
Whiteport station (Ulster co.), 3269
Wilbur (Ulster co.), 3267
Williams brook (Tompkins co.), 3344, 3345
Zoller's hill (Ulster co.), 3288, 3289

NEW YORK LOCALITIES ACCORDING TO COUNTIES

Names in italic are new to the record

Allegany co.
Wellsville
Clinton co.
Beekmantown
East Beekmantown
Chazy
Cooperville
Ingraham
Kings bay
Little Monty bay
Valcour island
West Chazy
Columbia co.
Hudson
Mt Moreno
Delaware co.
Hobart
Greene co.
Athens
Catskill
Collar Back hill
Green lake
Leeds
Herkimer co.
Litchfield
Jefferson co.
Brownville
Watertown
Livingston co.
Union Corners
Onondaga co.
Onondaga
Ontario co.
Geneva

Orange co.
Cuddebackville
Otisville
Port Jervis
Otsego co.
Cherry Valley
Schoharie co.
Argusville
Carlisle
Central Bridge
Clark's cave
Fox creek
Grovenor Corners
Howes Cave
Schoharie
Schoharie creek
Sharon Springs
Shutters Corners
West mountain
Schuyler co.
Havana glen
Montour Falls
Watkins
Tompkins co.
Buttermilk creek
Buttermilk falls
Cayuga lake
Esty glen
Glenwood ravine
Ithaca

Tompkins co. (*continued*)
MacKinney's glen
MacKinney's station
Williams brook
Ulster co.
Accord
Binnewater station
Creek Locks
East Kingston
Eddyville
Ellenville
Esopus creek
Fiddler's Elbow
Glasco
Glenerie
High Falls
Kerhonkson
Mt Marion station
Napanock
Rondout
Rondout creek
Rosendale
"Steep Rocks"
South Rondout
Vlightberg, The
West Camp
Whiteport station
Wilbur
Zoller's hill

INDEX TO FORMATIONS

RECORD OF LOCALITIES

3231 Bertie waterlime. 1 m. north of Cherry Valley. C. A. Hartnagel, collector. 1902.

3232 Chemung beds. Near Wellsville. E. B. Hall, donor. 1902.

3233 Cobleskill limestone. Shutters Corners, 3 m. east of Schoharie, on farm of Seth Stevens. C. A. Hartnagel, collector. 1902.

3234 Cobleskill limestone. Outcrops 1½ m. northeast of Schoharie and ½ m. south of Fox creek. C. A. Hartnagel, collector. 1902.

3235 Cobleskill limestone. Outcrops on hillside ¼ m. northeast of Mix and O'Reilly's quarry at Schoharie. C. A. Hartnagel, collector. 1902.

3236 Cobleskill limestone. Brown's quarry, north of road ¼ m. southeast of Schoharie postoffice. From the 38 in. basal layer of the Cobleskill. C. A. Hartnagel, collector. 1902.

3237 Cobleskill limestone. Brown's quarry. Fossils from the 16 in. layer above basal layer. C. A. Hartnagel, collector. 1902.

3238 Cobleskill limestone. Brown's quarry. Thin layers of limestone at top of Cobleskill, grading into the cement rock above. C. A. Hartnagel, collector. 1902.

3239 Rondout. E. Vroman's quarry. 150 yd southwest of Brown's quarry. Fossils from limestone intercalated in Rondout, 5 ft above top of Cobleskill. C. A. Hartnagel, collector. 1902.

3240 Cobleskill limestone. Clark's cave, ⅓ m. north of Schoharie creek bridge, Schoharie. C. A. Hartnagel, collector. 1902.

3241 Rondout. In the drab colored layers, 6 ft thick, above the Cobleskill limestone at Clark's cave, Schoharie. C. A. Hartnagel, collector. 1902.

3242 Cobleskill limestone. Northeast point of West mountain, 2 m. north of Schoharie. C. A. Hartnagel, collector. 1902.

3243 Cobleskill limestone. Outcrop on West mountain, 1 m. south of Central Bridge, Schoharie co. C. A. Hartnagel, collector. 1902.

3244 Cobleskill limestone. Roadside near old tunnel at Howes Cave, Schoharie co. C. A. Hartnagel, collector. 1902.

3245 Rondout. In cement beds just above the Cobleskill limestone at Howes Cave. C. A. Hartnagel, collector. 1902.

3246 Cobleskill limestone. Exposure in small creek, 1 m. northeast of Howes Cave. C. A. Hartnagel, collector. 1902.

3247 Cobleskill limestone. Tarr's farm, 1½ m. northeast of Howes Cave. C. A. Hartnagel, collector. 1902.

3248 Cobleskill limestone. On farm of Eugene Maxwell, 2½ m. north of Howes Cave. C. A. Hartnagel, collector. 1902.

3249 Cobleskill limestone. Farm of Judson Grovenor, 3 m. north of Howes Cave. C. A. Hartnagel, collector. 1902.

3250 Cobleskill limestone. Grovenor Corners, 1 m. west of 3249 and 3 m. directly north from Howes Cave. C. A. Hartnagel, collector. 1902.

3251 Cobleskill limestone. Roadside 1 m. northwest of Grovenor Corners, Schoharie co. C. A. Hartnagel, collector. 1902.

3252 Cobleskill limestone. In field by roadside, 1 m. northwest from Carlisle village, Schoharie co. C. A. Hartnagel, collector. 1902.

3253 Cobleskill limestone. South of highway, 2½ m. northwest from Carlisle. C. A. Hartnagel, collector. 1902.

3254 Cobleskill limestone. 3 m. east of Sharon Springs, south of highway leading to Argusville. C. A. Hartnagel, collector. 1902.

3255 Cobleskill limestone. Fossils from north end of Collar Back hill, 1 m. west of Catskill, Greene co. C. A. Hartnagel, collector. 1902.

3256 Cobleskill limestone. West Shore Railroad cut, Greene co., 1 m. north of West Camp, Ulster co. C. A. Hartnagel, collector. 1902.

3257 Rondout, base of. 1 m. north of West Camp, Greene co. C. A. Hartnagel, collector. 1902.

3258 Wilbur limestone. South end of syncline which terminates a short distance west of West Camp station. C. A. Hartnagel, collector. 1902.

3259 Wilbur limestone. West limb of syncline, 1 m. northwest of West Camp, Ulster co., near the county line. C. A. Hartnagel, collector. 1902.

3260 Cobleskill limestone. 1 m. west of Glasco, Ulster co. C. A. Hartnagel, collector. 1902.

3261 Wilbur limestone. Old quarry entrance, 1 m. north of East Kingston, Ulster co. C. A. Hartnagel, collector. 1902.

3262 Cobleskill limestone. ¾ m. north of East Kingston. C. A. Hartnagel, collector. 1902.

3263 Cobleskill limestone, top of. At "Steep Rocks," 1 m. north of Rondout, Ulster co. C. A. Hartnagel, collector. 1902.

3264 Wilbur limestone. East side of the "Vlightberg," Rondout. C. A. Hartnagel, collector. 1902.

3265 Wilbur limestone, top of the. South end of the "Vlightberg," Rondout. C. A. Hartnagel, collector. 1902.

3266 Rondout. Middle limestone or Leperditia layer at the "Vlightberg," Rondout. C. A. Hartnagel, collector. 1902.

3267 Cobleskill limestone. Across Rondout creek, opposite Wilbur, Ulster co. C. A. Hartnagel, collector. 1902.

3268 Wilbur limestone. Along highway ½ m. southwest from Eddyville, Ulster co. C. A. Hartnagel, collector. 1902.

3269 Wilbur limestone. Railroad cut 1 m. southwest of Whiteport station, Ulster co. C. A. Hartnagel, collector. 1902.

3270 Cobleskill limestone. ¼ m. north of Binnewater station, Ulster co. C. A. Hartnagel, collector. 1902.

3271 Wilbur limestone. Vertical layers exposed at old cement mine west of Creek Locks, Ulster co. C. A. Hartnagel, collector. 1902.

3272 Wilbur limestone. 1 m. northeast of Rosendale, Ulster co., at cement mine. C. A. Hartnagel, collector. 1902.

3273 Wilbur limestone. Sandy layers at base of the cement, Rosendale. C. A. Hartnagel, collector. 1902.

3274 Cobleskill limestone. Rosendale. C. A. Hartnagel, collector. 1902.

3275 Wilbur limestone. Thin layer below cement beds, High Falls, Ulster co. C. A. Hartnagel, collector. 1902.

3276 Wilbur limestone. Below cement bed at High Falls, Ulster co. C. A. Hartnagel, collector. 1902.

3277 Cobleskill limestone. High Falls, Ulster co. C. A. Hartnagel, collector. 1902.

3278 Cobleskill limestone. Black shaly layer at top of Cobleskill, southwest from Eddyville, Ulster co., at old cement mine. C. A. Hartnagel, collector. 1902.

3279 Onondaga limestone. 2 m. north of Geneva, Ontario co. H. C. Magnus, collector. 1902.

3280 Oriskanian. Along roadside, right bank of Esopus creek north of Glenerie, Ulster co., near Mt Marion station. R. Ruedemann and G. van Ingen, collectors. 1899.

3281 Oriskanian. Along roadside, right bank of Esopus creek, for ½ m. north of old Ulster White Lead Co. at Glenerie, near Mt Marion station. G. van Ingen, exchange. 1903.

3282 Coal Measures. Southeastern Utah; San Juan river. A. P. Adams, donor. 1903.

3283 Portage (Naples). Union Corners, Livingston co. J. M. Clarke, collector. 1890.

3284 Esopus. Athens–Leeds turnpike, Greene co., just west of road to Green lake; from lower 40 ft of grit rock usually referred to Esopus, but having more distinct bedding. Marly layer with numerous fossils is near top of section, 3 ft below Esopus. G. H. Chadwick, collector. 1903.

3285 Port Ewen beds. South Rondout, quarried masses of lower members, north end of hill near Rondout creek. G. H. Chadwick, collector. 1903.

3286 Port Ewen beds. Loose blocks from hanging wall of Port Ewen in upper quarry toward Rondout creek, South Rondout. G. H. Chadwick, collector. 1903.

3287 Port Ewen beds. Loose at South Rondout. G. H. Chadwick, collector. 1903.

3288 Port Ewen beds. West quarry, Zoller's hill, South Rondout. G. H. Chadwick, collector. 1903.

3289 Port Ewen beds. Mouth of cave, west end of Zoller's hill, South Rondout. G. H. Chadwick, collector. 1903.

3290 Port Ewen beds. Hanging wall of Becraft limestone quarry, South Rondout. G. H. Chadwick, collector. 1903.

3291 Catskill shale. Summit cut, Delhi & Andes Railway, Delaware co. Green shales near middle section; red shales at top. G. H. Chadwick, collector. 1903.

3292 Beekmantown graptolite shales. Ash hill quarry, Mt Moreno, near Hudson N. Y. R. Ruedemann, collector. 1903.

3293 Portage. Quarry on roadside, road running from Montour Falls to Watkins, west side of valley, ¼ m. south of fair grounds. D. D. Luther and H. S. Mattimore, collectors. 1903.

3294 Portage. (Ithaca). Quarry 1 m. northeast of Montour Falls. D. D. Luther and H. S. Mattimore, collectors. 1903.

3295 Portage. Havana glen. Foot of Portal cascade. D. D. Luther and H. S. Mattimore, collectors. 1903.

3296 Red, yellow and drab limestones of the Grande Grève series (Oriskany). Percé rock, Percé, P. Q. J. M. Clarke, collector. 1903.

3297 Gray, thin bedded limestone with intercalated shales. North end of Mt Joli Percé P. Q. Upper Siluric. J. M. Clarke, collector. 1903.

3298 Gray arenaceous limestones with interbedded shales. South flank of Mt Joli, Percé P. Q. Lower Siluric. J. M. Clarke, collector. 1903.

3299 Limestones of Cap Blanc. Thin slabs from the middle and lower or south end of the section. Percé P. Q. J. M. Clarke, collector. 1903.

3300 Limestones of Cap Blanc. Red limestone from the upper or north end of the section. Percé P. Q. J. M. Clarke, collector. 1903.

3301 Gray calcareous shales with thin limestones. Upper Siluric (Lower Devonic?). Percé P. Q. Cape Barré; north end of North Beach. J. M. Clarke, collector. 1903.

3302 Blow Hole on sea wall north of North Beach, Percé P. Q. Equivalent in age to the Percé rock. J. M. Clarke, collector. 1903.

3303 Nodular limestones and limestone conglomerate with fossils of the Percé rock. Le Coulé, Percé P. Q. J. M. Clarke, collector. 1903.

3304 Bonaventure conglomerate. Mt St Anne and other localities. Pebbles containing the fossils of Percé rock and others of earlier date. Percé P. Q. J. M. Clarke, collector. 1903.

3305 Limekiln escarpment back of Cape Cannon. Heavy bedded limestone, massive, with Lower Siluric fossils. J. M. Clarke, collector. 1903.

3306 Hamilton shales. At Adamsdale, Schuylkill co. Pa. J. M. Clarke, collector. 1903.

3307 Ithaca beds. Loose in bed of Town brook. Hobart, Delaware co. G. H. Chadwick, collector. 1903.

3308 Cobleskill limestone. Field west of house of Mr Case, 1½ m. southwest of Otisville, Orange co. C. A. Hartnagel, collector. 1903.

3309 Cobleskill limestone. 1 m. east of Cuddebackville, Orange co., near old limekiln. C. A. Hartnagel, collector. 1903.

3310 Cobleskill limestone. Old quarry just west of 3309; transient into Rondout waterlime. C. A. Hartnagel, collector. 1903.

3311 Decker Ferry beds. Outcrop in lane leading diagonally up the bluff on Nearpass farm, 3 m. south of Port Jervis, Orange co. C. A. Hartnagel, collector. 1903.

3312 Decker Ferry beds. Fossils from near base of bluff on Nearpass farm 3 m. south of Port Jervis. C. A. Hartnagel, collector. 1903.

3313 Decker Ferry beds. Fossils from red crystalline limestone on Nearpass farm 3 m. south of Port Jervis. C. A. Hartnagel, collector. 1903.

3314 Cobleskill limestone. Fossils from 6 foot band just below Rondout waterlime, Nearpass farm 3 m. south of Port Jervis. C. A. Hartnagel, collector. 1903.

3315 Bossardville limestone; below Decker Ferry formation. Nearpass farm 3 m. south of Port Jervis. C. A. Hartnagel, collector. 1903.

3316 Decker Ferry beds. Fossils from Chonetes jerseyensis zone in cut of Ontario & Western Railroad, ½ m. southwest of Accord, Ulster co. C. A. Hartnagel, collector. 1903.

3317 Cobleskill limestone. Fiddler's Elbow on Delaware & Hudson canal, ½ m. southwest of Accord. C. A. Hartnagel, collector. 1903.

3318 Wilbur limestone horizon. Basal arenaceous layer above which is found Cobleskill limestone with typical Cobleskill fauna. Fiddler's Elbow on Delaware & Hudson canal, ½ m. southwest of Accord. C. A. Hartnagel, collector. 1903.

3319 Cobleskill limestone. Cut on Ontario & Western Railroad, ½ m. southwest of Accord. C. A. Hartnagel, collector. 1903.

3320 Cobleskill limestone. On Joseph Chipp farm, ¼ m. north of Kerhonkson, Ulster co. C. A. Hartnagel, collector. 1903.

3321 Cobleskill limestone. Wheelock farm, Litchfield, Herkimer co. C. A. Hartnagel, collector. 1903.

3322 Manlius limestone. Nearpass quarry, 3 m. south of Port Jervis. C. A. Hartnagel, collector. 1903.

3323 Oriskany sandstone. Benjamin C. Smailes farm, 5 m. northeast of Ellenville, Ulster co. C. A. Hartnagel, collector. 1903.

3324 Helderbergian. John Hornbeek quarry, a short distance south of Eastern Reformatory at Napanoch, Ulster co. The presence of Leptaenisca adnascens H. & C. indicates the New Scotland age of these beds. C. A. Hartnagel, collector. 1903.

3325 Guelph dolomite. Niagara falls, Canadian side. Exposure made by the Ontario Power Co. C. A. Hartnagel, collector. 1903.

3326 Beekmantown beds. Kirby ledge near East Beekmantown, south of county poorhouse. Station 227. R. Ruedemann, collector. 1903.

3327 Beekmantown beds. Spelman ledge near East Beekmantown. Station 228. R. Ruedemann, collector. 1903.

3328 Beekmantown beds. From ridge crossing the road from West Chazy to Ingraham. Station 230. R. Ruedemann, collector. 1903.

3329 Upper Chazy beds. From exposures on the road from Ingraham to Beekmantown, 1½ m. west of Ingraham. Station 232. R. Ruedemann, collector. 1903.

3330 Lower Chazy beds. On Nightingale farm near Chazy village. From A, B, and C of Brainerd and Seely's sections 1 and 2. R. Ruedemann, collector. 1903.

3331 Middle Chazy beds. Chazy village. West of Little Monty bay. Station 233. R. Ruedemann, collector. 1903.

3332 Chazy conglomerate. Boulder on road from Coopersville station to King's bay. Station 234. R. Ruedemann, collector. 1903.

3333 Lower Chazy bed. West of Chazy and north of road leading from Chazy to West Chazy. Station 237. A5. R. Ruedemann, collector. 1903.

3334 Lower Chazy bed. Red spot, layer of A8, exposed half way between Chazy and West Chazy. Station 239. R. Ruedemann, collector. 1903.

3335 Middle Chazy bed. From ridge extending north of road from Chazy to West Chazy. Station 240. R. Ruedemann, collector. 1903.

3336 Middle Chazy bed. Along west side of Valcour island, from first promontory south of Laclaire farm to exposure at southermost cove. Station 241. R. Ruedemann, collector. 1903.

3337 Middle Chazy bed. Southwest corner of Valcour island. Maclurea bed with silicified fossils. Station 242, 1. R. Ruedemann, collector. 1903.

3338 Middle Chazy bed. Valcour island. Exposure on lake shore, directly north of Christmas farm. Station 243, 1. R. Ruedemann, collector. 1903.

3339 Upper Chazy bed. ½ m. south of farm of Judson Trembly, behind schoolhouse at Little Monty bay. Station 243. R. Ruedemann, collector. 1903.

3340 Coal Measures. Mazon creek, Illinois. Dr Joseph Simms, donor. 1903.

3341 Agoniatite limestone. Onondaga, Onondaga co. John D. Wilson, donor. 1904.

3342 Portage. Outcrop on road running on west side of Cayuga lake below railroad ¼ m. south of head of lake; ½ m. north of Ithaca N. Y. (390 ft A. T. A1) D. D. Luther and H. S. Mattimore, collectors. 1903.

3343 Portage. Southwest corner of Cayuga lake; cliff 10 ft above lake; 1 m. north of Ithaca. (387 ft A. T. A2) D. D. Luther and H. S. Mattimore, collectors. 1903.

3344 Portage. Just north of Williams brook, 20 ft above lake. (298 ft A. T. A3) D. D. Luther and H. S. Mattimore, collectors. 1903.

3345 Portage. Old quarry along railroad, ½ m. south of Williams brook, Tompkins co. (393 ft A. T. A4) D. D. Luther and H. S. Mattimore, collectors. 1903.

3346 Portage (Ithaca). Quarry no. 1 above railroad, 1 m. south of fair grounds, Ithaca. (525–560 ft A. T. B1) D. D. Luther and H. S. Mattimore, collectors. 1903.

3347 Portage (Ithaca). Roadside outcrop above quarry no. 1. (580 ft A. T. B2) D. D. Luther and H. S. Mattimore, collectors. 1903.

3348 Portage (Ithaca). Quarry no. 2, 1 m. northeast of quarry no. 1. (580 ft A. T. B3) D. D. Luther and H. S. Mattimore, collectors. 1903.

3349 Portage (Ithaca). On highway leading southwest from Lehigh Railroad station at Ithaca; ⅛ m. from station. (500 ft A. T. B4) D. D. Luther and H. S. Mattimore, collectors. 1903.

3350 Portage (Ithaca). Roadside outcrop on Hector street, Ithaca. (540 ft A. T. B4) D. D. Luther and H. S. Mattimore, collectors. 1903.

3351 Portage. Along Cliff street, Ithaca; ½ m. from Lehigh Railroad station. B6. D. D. Luther and H. S. Mattimore, collectors. 1903.

3352 Portage. Quarry no. 3, north of Buttermilk creek and south of Ithaca. (750 ft A. T. C2) D. D. Luther and H. S. Mattimore, collectors. 1903.

3353 Portage. Outcrop on roadside leading up hill 1 m. south of Ithaca. C1. D. D. Luther and H. S. Mattimore, collectors. 1903.

3354 Portage. Buttermilk creek; fossils collected in creek bed at lower falls. (460–500 ft A. T. C3) D. D. Luther and H. S. Mattimore, collectors. 1903.

3355 Portage. Base of Buttermilk falls, Tompkins co. (400 ft A. T. C4) D. D. Luther and H. S. Mattimore, collectors. 1903.

3356 Portage. Quarry no. 4 (Fowler's) on lower road, ½ m. south of Ithaca. C5. D. D. Luther and H. S. Mattimore, collectors. 1903.

3357 Portage. Quarry no. 5 (Sheehy's), a short distance northeast of quarry no. 4. C6. D. D. Luther and H. S. Mattimore, collectors. 1903.

3358 Portage. Quarry no. 6, ¼ m. southeast of fair grounds, Ithaca. (725–800 ft A. T. D1) D. D. Luther and H. S. Mattimore, collectors. 1903.

3359 Portage (Ithaca). Glenwood ravine west side of Cayuga lake, 4 m. north of Ithaca. (440–450 ft A. T. E1, 490 ft A. T. E2, 535 ft A. T. E3, 588 ft A. T. E4, 640 ft A. T. E5, 750 ft A. T. E6) D. D. Luther and H. S. Mattimore, collectors. 1903.

3360 Portage. Esty glen, east side of Cayuga lake, 4 m. north of Ithaca. F1. D. D. Luther and H. S. Mattimore, collectors. 1903.

3361 Portage (Ithaca). MacKinney's glen, east side of Cayuga lake, 2 m. north of Ithaca. (20 ft G1, 55 ft G2, 75 ft G3, 130 ft above lake G4)

3362 Portage. East side of Cayuga lake, ½ m. north of MacKinney's station. (10 ft above lake H1) D. D. Luther and H. S. Mattimore, collectors. 1903.

3363 Trenton limestone. Small quarry west end of Front street near Sloath and Greenleaf's lumber yard, north bank of Black river, Watertown N. Y. H. S. Mattimore, collector. 1902.

3364 Trenton limestone. North side of Black river near water edge, Front street, opposite Babcock & Co.'s carriage factory, Watertown N. Y. H. S. Mattimore, collector. 1902.

3365 Black river limestone. Small quarry 100 yd east of river bridge at Brownville, Jefferson co. N. Y. H. S. Mattimore, collector. 1902.

RECORD OF FOREIGN LOCALITIES

Specimens bearing lemon-yellow tickets

124 Old red sandstone flags. Stromness, Scotland. J. M. Clarke, collector. 1902.

125 Old red sandstone flags. Sandwich, Orkney islands. Purchased.

126 Old red sandstone. Cromarty, Scotland. J. M. Clarke, collector. 1902.

127 Old red sandstone flags. Thurso, Scotland. Purchased.

128 Tilestones. Horeb Chapel, near Llandovery, Wales. A. S. Woodward, donor. 1903.

APPENDIX 3

CATALOGUE OF

TYPE SPECIMENS OF PALEOZOIC FOSSILS[1]

Supplement 1

PLANTAE

PSILOPHYTON Dawson

Psilophyton princeps Dawson

5160 $\frac{290}{1}$ TYPE (unnamed) Vanuxem. Geological survey of New York; report on the 3d district. 1842. p.161.

Psilophyton princeps Dawson. Quarterly journal of the Geological society of London. 1859. 18:479.

Hamilton beds? North New Berlin, Chenango co. N. Y.
Geological survey collection

COELENTERATA

SPONGIAE

HYPHANTAENIA Vanuxem

Hyphantaenia chemungensis Vanuxem (sp.)

5161 $\frac{2360}{5}$ HYPOTYPE Hall & Clarke. New York state museum memoir 2. 1898. pl.45, fig.1.

Chemung beds Union, Broome co. N. Y.
Oberlin College exchange

ECHINODERMATA

Cyathocrinus ornatissimus *see* Scytalocrinus ornatissimus

MELOCRINUS Goldfuss

Melocrinus clarkei (Hall mss.) Williams

439 $\frac{4340}{1}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.D, E.

Genesee shale Canandaigua lake, N. Y.
J. M. Clarke, donor

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[1] The body of the catalogue was published as Museum bulletin 65. 1903.

PENTREMITES Say

Pentremites leda Hall

5162 $\frac{4420}{3}$ HYPOTYPE Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.1, fig.1.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

SCYTALOCRINUS Wachsmuth & Springer

Scytalocrinus ornatissimus Hall (sp.)

5163 $\frac{4530}{1}$ HYPOPLASTOTYPE Cyathocrinus ornatissimus Hall (sp) Geology of New York; report on the 4th district. 1843. p.247, fig. 108.
Scytalocrinus ornatissimus Clarke. New York state museum memoir 6. 1903. pl.F.
Portage (Naples) beds
Lake Erie shore, Portland N. Y.

VERMES

COLEOLUS Hall

Coleolus (?) spinulus Hall

5164 $\frac{5065}{1}$ TYPE Coleolus (?) spinulus Hall. Transactions of the Albany institute. 1881. 10:18 (abstract)
Hall. 11th annual report of the Indiana state geologist. pl.33, fig.8.
Niagaran — Waldron Ind.

PALAEOCHAETA Clarke

Palaeochaeta devonica Clarke

5165 $\frac{5151}{1}$ TYPE Palaeochaeta devonica Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1238, pl.28, fig.2.
Portage beds — Grimes gully, Naples N. Y.
J. M. Clarke, donor. 1901

5166 $\frac{5151}{2}$ TYPE Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.28, fig.3.
Portage beds — Tannery gully, Naples N. Y.
D. D. Luther, coll. 1902

5167 $\frac{5151}{3}$ TYPE Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.28, fig.4.
Portage beds — Tannery gully, Naples N. Y.
D. D. Luther, coll. 1902

PROTONYMPHA Clarke

Protonympha salicifolia Clarke

5168 $\frac{5210}{1}$ TYPE (original and counterpart) Protonympha salicifolia Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1237, pl.27, fig.1, 2.

Portage (West hill sandstones)

Italy hill, Yates co. N. Y.

D. D. Luther, coll. 1902

5169 $\frac{5210}{2}$ TYPE (original and counterpart) Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.27, fig.3, 4.

Portage beds Tannery gully, Naples N. Y.

D. D. Luther, coll. 1902

5170 $\frac{5210}{3}$ TYPE: PLASTOTYPE Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.28, fig.1.

Portage beds Italy hill, Naples N. Y.

D. D. Luther, coll. 1902

TENTACULITES Schlotheim

Tentaculites bellulus Hall (?) *mut.* **stebos** Clarke

5171 $\frac{5286}{1}$ HYPOTYPE Orthoceras stebos Clarke. United States geological survey bulletin 16. 1885. p.29.

Tentaculites bellulus Hall (?) mut. stebos Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.5, fig.8.

Tully pyrite Livonia salt shaft, Livonia N. Y.

D. D. Luther, coll. 1891

Tentaculites gracilistriatus Hall *mut.* **asmodeus** Clarke

5172 $\frac{5287}{1}$ HYPOTYPE Orthoceras asmodeus Clarke. United States geological survey bulletin 16. 1885. p 31.

Tentaculites gracilistriatus Hall mut. asmodeus Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.4, fig.11.

Tully pyrite Livonia salt shaft, Livonia N. Y.

D. D. Luther, coll. 1891

Tentaculites tenuicinctus F. A. Roemer

5173 $\frac{5288}{1}$ HYPOTYPE Tentaculites tenuicinctus F. A. Roemer. Beitr. 1 zur geol. Kenntnisse d. nordw. Harzgebirges. 1850. p.28.

Clarke. New York state museum memoir 6. 1903. pl.20, fig.20.

Portage (Naples) beds Naples, Ontario co. N. Y.

J. M. Clarke, donor

On slab with original of pl.20, fig. 21.

5174 $\frac{5288}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.21.

Portage (Naples) beds Naples N. Y.

J. M. Clarke, donor

On slab with original of pl.20, fig.20.

BRYOZOA

FENESTELLA Lonsdale

Fenestella pertenuis Hall

5175 $\frac{6397}{1}$ TYPE (of description) Fenestella pertenuis Hall. Transactions of the Albany institute. 1881. 10:6 (abstract).

Hall. 11th annual report of the Indiana state geologist. 1881. p.251.

Niagaran Waldron Ind.

On slab with type of Stictopora orbipora, Ind. state geol. 11th an. rep't, p.248.

STICTOPORA Hall

Stictopora orbipora Hall

5176 $\frac{6900}{1}$ TYPE (of description) Stictopora orbipora Hall. Transactions of the Albany institute. 1881. 10.5 (abstract).

Hall. 11th annual report of the Indiana state geologist. 1881. p.248.

Niagaran Waldron Ind.

On slab with type of Fenestella pertenuis, Ind. state geol. 11th an. rep't, p.251.

BRACHIOPODA

AMBOCOELIA Hall

Ambocoelia umbonata Conrad *mut.* **pluto** Loomis

5177 $\frac{7044}{1}$ TYPE Ambocoelia umbonata Conrad mut. pluto Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.905, pl.2, fig 16–18.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

Ambocoelia umbonata Conrad *mut.* **pygmaea** Loomis

5178 $\frac{7045}{1}$ TYPE Ambocoelia umbonata Conrad mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.905, pl 2, fig.13–15.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

CAMAROTOECHIA Hall & Clarke

Camarotoechia hudsonica Grabau

5179 $\frac{7224}{1}$ TYPE Camarotoechia hudsonica Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1048, fig.8, a, b.
Manlius limestone
Becraft mountain, Columbia co. N. Y.
A. W. Grabau, coll. 1902

5180 $\frac{7224}{2}$ TYPE Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1048, fig 8c.
Manlius limestone
Becraft mountain, Columbia co. N. Y.
A. W. Grabau, coll. 1902

5181 $\frac{7224}{3}$ TYPE Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1048, fig.8d.
Manlius limestone
Becraft mountain, Columbia co. N. Y.
A. W. Grabau, coll. 1902

CYRTINA Davidson

Cyrtina hamiltonensis Hall *mut.* **pygmaea** Loomis

5182 $\frac{7387}{1}$ TYPE Cyrtina hamiltonensis Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.904, pl.3, fig.16.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

Leiorhynchus? hecate *see* Spirifer mucronatus *mut.* hecate

NUCLEOSPIRA Hall

Nucleospira concinna Hall *mut.* **pygmaea** Loomis

5183 $\frac{7843}{1}$ TYPE Nucleospira concinna Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.904, pl.1, fig.4; pl.2, fig.5.
Tully pyrite — Greigsville, Livingston co. N. Y.
D. D. Luther, coll.

Orbicula concentrica *see* Ontaria concentrica

PRODUCTELLA Hall

Productella spinulicosta Hall *mut.* **pygmaea** Loomis

5184 $\frac{8095}{1}$ TYPE Productella spinulicosta Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.907, pl.2. fig.11.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

RHYNCHOSPIRA Hall

Rhynchospira excavata Grabau

5185 $\frac{8212}{1}$ TYPE Rhynchospira excavata Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1050, fig.9a-c.
Manlius limestone — Mt Bob, Columbia co. N. Y.
A. W. Grabau, coll. 1902

SPIRIFER Sowerby

Spirifer belphegor *see* Spirifer tullius *mut.* belphegor

Spirifer eriensis Grabau *var.* Grabau

5186 $\frac{8342}{3}$ HYPOTYPE Spirifer eriensis Grabau var. Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1043, fig.7a, b.
Manlius limestone
Becraft mountain, Columbia co N. Y.
A. W. Grabau, coll. 1902

5187 $\frac{8342}{4}$ HYPOTYPE Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1043, fig.7c.
Manlius limestone Becraft mountain, N. Y.
A. W. Grabau, coll. 1902

5188 $\frac{8342}{5}$ HYPOTYPE Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1043, fig.7d.
Manlius limestone Becraft mountain, N. Y.
A. W. Grabau, coll. 1902

Spirifer corallinensis Grabau

5189 $\frac{8367}{1}$ HYPOTYPE Spirifer corallinensis Grabau. Geological society of America bulletin. 1900. 11:352.
Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1042, fig.6.
Manlius limestone Becraft mountain, N. Y.
A. W. Grabau, coll. 1902

Spirifer fimbriatus Conrad *mut.* **pygmaeus** Loomis

5190 $\frac{8368}{1}$ TYPE Spirifer fimbriatus Conrad mut. pygmaeus Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.901, pl.2, fig.8, 9.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

Spirifer fimbriatus Conrad *mut.* **simplicissimus** Loomis

5191 $\frac{8369}{1}$ TYPE Spirifer fimbriatus mut. simplicissimus Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.901, pl.3, fig.1, 2.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

Spirifer granulosus Conrad *mut.* **pluto** Clarke

5192 $\frac{8370}{1}$ HYPOTYPE Spirifer pluto Clarke. United States geological survey bulletin 16. 1885. p.31.

Spirifer granulosus Conrad mut. pluto Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.3, fig.7, 8.

Tully pyrite Canandaigua lake, N. Y.

D. D. Luther, coll.

Spirifer medialis Hall *mut.* **pygmaeus** Loomis

5193 $\frac{8371}{1}$ TYPE Spirifer medialis Hall mut. pygmaeus Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.902, pl.3, fig.9, 10.

Tully pyrite Canandaigua lake, N. Y.

D. D. Luther, coll.

Spirifer mucronatus Conrad *mut.* **hecate** Clarke

5194 $\frac{8372}{1}$ HYPOTYPE Leiorhynchus? hecate Clarke. United States geological survey bulletin 16. 1885. p.31.

Spirifer mucronatus Conrad mut. hecate Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.3, fig.13–15.

Tully pyrite Moscow, Livingston co. N. Y.

D. D. Luther, coll.

Spirifer pluto *see* Spirifer granulosus *mut.* pluto

Spirifer tullius Conrad *mut.* **belphegor** Clarke

5195 $\frac{8373}{1}$ HYPOTYPE Spirifer belphegor Clarke. United States geological survey bulletin 16. 1885. p.30.

Spirifer tullius Conrad mut. belphegor Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.3, fig.3, 4.

Tully pyrite Canandaigua lake, N. Y.

D. D. Luther, coll.

Spirifer vanuxemi Hall

5196 $\frac{8374}{1}$ HYPOTYPE Spirifer vanuxemi Hall. Paleontology of New York. 1859. 3:198.

Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1041, fig.5a.

Manlius limestone

Becraft mountain, Columbia co. N. Y.

A. W. Grabau, coll. 1902

5197 $\frac{8374}{2}$ HYPOTYPE Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1041, fig.5b.
Manlius limestone Becraft mountain, N. Y.
A. W. Grabau, coll. 1902

STROPHALOSIA King

Strophalosia truncata Hall *mut.* **pygmaea** Loomis

5198 $\frac{8395}{1}$ TYPE Strophalosia truncata Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.906, pl.2, fig. 10.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

5199 $\frac{8395}{2}$ TYPE Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.2, fig.12.
Tully pyrite Canandaigua lake, N. Y.

TRIGERIA Bayle

Trigeria lepida Hall *mut.* **pygmaea** Loomis

5200 $\frac{8501}{1}$ TYPE Trigeria lepida Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.907, pl.3, fig.11.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

TROPIDOLEPTUS Hall

Tropidoleptus carinatus Conrad *mut.* **pygmaeus** Loomis

5201 $\frac{8531}{1}$ TYPE Tropidoleptus carinatus Conrad mut. pygmaeus Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.906, pl.3, fig.12.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

WHITFIELDELLA Hall & Clarke

Whitfieldella *cf.* **nitida** Hall

5202 $\frac{8563}{6}$ HYPOTYPE Whitfieldella cf. nitida Grabau. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1051, fig.10a-c.
Manlius limestone
Becraft mountain, Columbia co. N. Y.
A. W. Grabau, coll. 1902

LAMELLIBRANCHIATA

ACTINOPTERIA Hall

Actinopteria sola Clarke

5203 $\frac{9020}{1}$ TYPE: PLASTOTYPE Actinopteria sola Clarke. New York state museum memoir 6. 1903. p.263, pl.20, fig. 20.
Portage (Naples) beds
Cashaqua creek, Livingston co. N. Y.
J. M. Clarke, purchase

Astarte subtextilis *see* Euthydesma subtextile
Avicula dispar *see* Loxopteria dispar
Avicula fragilis *see* Pterochaenia fragilis

BUCHIOLA Barrande

Buchiola? (Puella?) sp.

5204 $\frac{9081}{1}$ TYPE Buchiola? (Puella?) sp. New York state museum memoir 6. 1903. pl.10, fig.17.
Portage (Naples) beds Naples, Ontario co. N. Y.
J. M. Clarke, donor

Buchiola angolensis Clarke

5205 $\frac{9082}{1}$ TYPE: PLASTOTYPE Buchiola angolensis Clarke. New York state museum memoir 6. 1903. p.300, pl.10, fig.29.
Portage (Naples) beds
Farnham creek, near Angola N. Y.
D. D. Luther, coll. 1897

5206 $\frac{9082}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.30.
Portage (Naples) beds
Farnham creek, near Angola N. Y.
J. M. Clarke, coll. 1898

5207 $\frac{9082}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.31.
Portage (Naples) beds
Farnham creek, near Angola N. Y.
D. D. Luther, coll. 1897

5208 $\frac{9082}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.32.
Portage (Naples) beds Big Sister creek, Angola N. Y.
D. D. Luther, coll. 1897

5209 $\frac{9082}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.33.
Portage (Naples) beds
Smith's Mills, Chautauqua co. N. Y.
D. D. Luther, coll. 1902

Buchiola conversa Clarke

5210 $\frac{9083}{1}$ TYPE Buchiola conversa Clarke. New York state museum memoir 6. 1903. p.300, pl.10, fig.20.
Portage (Naples) beds Farnham creek, Angola N. Y.
J. M. Clarke, coll. 1898

5211 $\frac{9083}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.21.
Portage (Naples) beds Angola, Erie co. N. Y.
J. M. Clarke, donor

5212 $\frac{9083}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.22.
Portage (Naples) beds Big Sister creek, Angola N. Y.
J. M. Clarke, coll. 1898

Buchiola *cf.* **eifelensis** Beushausen

5213 $\frac{9084}{1}$ HYPOTYPE Buchiola *cf.* eifelensis Clarke. New York state museum memoir 6. 1903. pl.11, fig.3.
Lower Upper Devonic Büdesheim, Germany

Buchiola halli Clarke

5214 $\frac{9085}{1}$ TYPE Buchiola halli Clarke. New York state museum memoir 6. 1903. p.301, pl.10, fig.16.
Hamilton shale
Near Norton's landing, Cayuga lake, N. Y.
H. H. Smith, coll. 1871

Buchiola (?) livoniae Clarke

5215 $\frac{9086}{1}$ TYPE Buchiola (?) livoniae Clarke. New York state museum memoir 6. 1903. p.299, pl.11, fig.1.
Genesee beds (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, coll. 1899

5216 $\frac{9086}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.2.
Genesee beds (Genundewa limestone)
Livonia salt shaft, Livingston co. N. Y.
D. D. Luther, coll. 1891

Buchiola lupina Clarke

5217 $\frac{9087}{1}$ TYPE *Buchiola lupina* Clarke. New York state museum memoir 6. 1903. p.301, pl.10, fig.34.
Portage (Gardeau) beds
Wolf creek, Genesee valley, Wyoming co. N. Y.
D. D. Luther, coll. 1897

5218 $\frac{9087}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.35.
Portage (Gardeau) beds
Mouth of Wolf creek, Wyoming co. N. Y.
D. D. Luther, coll. 1897

5219 $\frac{9087}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.36.
Portage (Gardeau) beds
Mouth of Wolf creek, Wyoming co. N. Y.
D. D. Luther, coll. 1897

Buchiola *cf.* **prümiensis** Steininger (sp.)

5220 $\frac{9088}{1}$ HYPOTYPE *Cardium prumiense* Steininger. Geognost. Beschreibung der Eifel. 1853. p.51.
Buchiola cf. *prümiensis* Clarke. New York state museum memoir 6. 1903. pl.10, fig.18.
Portage (Naples) beds
Big Sister creek at Angola N. Y.
D. D. Luther, coll. 1897
On slab with type of pl.10, fig.19.

5221 $\frac{9088}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.19.
Portage (Naples) beds
Big Sister creek at Angola N. Y.
D. D. Luther, coll. 1897
On slab with type of pl.10, fig.18.

Buchiola retrostriata von Buch

5222 $\frac{9089}{1}$ HYPOTYPE *Venericardium retrostriatum* von Buch. Ueber Goniatiten. 1832. p.50.
Buchiola retrostriata Clarke. New York state museum memoir 6. 1903. pl.10, fig.1.
Portage (Naples) beds Naples, Ontario co. N. Y.
J. M. Clarke, donor

5223 $\frac{9089}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.2.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5224 $\frac{9089}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.3.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5225 $\frac{9089}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.4.
Portage (Naples) beds
Near Mt Morris, Livingston co. N. Y.
C. Van Deloo, coll.

5226 $\frac{9089}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.5.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5227 $\frac{9089}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.6.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5228 $\frac{9089}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.7.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5229 $\frac{9089}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.8.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5230 $\frac{9089}{9}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.9.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5231 $\frac{9089}{10}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.10.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5232 $\frac{9089}{11}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.11.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5233 $\frac{9089}{12}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.12.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5234 $\frac{9089}{13}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.13.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5235 $\frac{9089}{14}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.14.
Genesee shale Canandaigua lake, N. Y.
J. M. Clarke, coll. 1899

5236 $\frac{9089}{15}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.14.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

Buchiola retrostriata von Buch *mut.* **pygmaea** Loomis

5237 $\frac{9089a}{1}$ TYPE Buchiola retrostriata von Buch mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.911, pl.2, fig.7.
Tully pyrite Moscow, Livingston co. N. Y.
D. D. Luther, coll.

Buchiola scabrosa Clarke

5238 $\frac{9089b}{1}$ TYPE Buchiola scabrosa Clarke. New York state museum memoir 6. 1903. p. 299, pl.10, fig.25–27.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5239 $\frac{9089b}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.10, fig.28.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

Cardiola clarkei *see* Ontaria clarkei
Cardiola doris *see* Paracardium doris
Cardiola duplicata *see* Praecardium duplicatum

CARDIOMORPHA de Koninck

Cardiomorpha obliquata Clarke

5240 $\frac{9095}{1}$ TYPE: PLASTOTYPE Cardiomorpha obliquata Clarke. New York state museum memoir 6. 1903. pl.9, fig.3.
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5241 $\frac{9095}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.4,5.
Portage (Naples) beds
Little Canadaway creek, Lake Erie, N. Y.
D. D. Luther, coll. 1897

5242 $\frac{9095}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.6.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5243 $\frac{9095}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.7.
Portage (Naples) beds
Near Smith's Mills, Chautauqua co. N. Y.
D. D. Luther, coll. 1902

Cardium prumiense *see* Buchiola *cf.* prümiensis

Cardium? vetustum *see* Praecardium vetustum

CONOCARDIUM Bronn

Conocardium eboraceum Hall *mut.* **pygmaeum** Loomis

5244 $\frac{9146}{1}$ TYPE Conocardium eboraceum Hall mut. pygmaeum Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.911, pl.2, fig.6.
Tully pyrite Moscow N. Y.
D. D. Luther, coll.

Conocardium gowandense Clarke

5245 $\frac{9147}{1}$ TYPE Conocardium gowandense Clarke. New York state museum memoir 6. 1903. p.310, pl.12, fig. 35, 36.
Portage (Naples) beds
Gowanda, Cattaraugus co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

ELASMATIUM Clarke

Elasmatium gowandense Clarke

5246 $\frac{9200}{1}$ TYPE Elasmatium gowandense Clarke. New York state museum memoir 6. 1903. p.294, pl.12, fig.21.
Portage (Naples) beds Chautauqua county, N. Y.

5247 $\frac{9200}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.22.
Portage (Naples) beds Chautauqua county, N. Y.

5248 $\frac{9200}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.23.
Portage (Naples) beds Chautauqua county, N. Y.

5249 $\frac{9200}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig 24.
Portage (Naples) beds Chautauqua county, N. Y.

5250 $\frac{9200}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.25.
Portage (Naples) beds Gowanda forks of Cattaraugus creek, Chautauqua co. N. Y.
D. D. Luther, coll. 1897

5251 $\frac{9200}{6}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.26.
Portage (Naples) beds
Gowanda forks of Cattaraugus creek, N. Y.
D. D. Luther, coll. 1897

5252 $\frac{9200}{7}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.27.
Portage (Naples) beds
Gowanda forks of Cattaraugus creek, N. Y.
D. D. Luther, coll. 1897

5253 $\frac{9200}{8}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.28.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5254 $\frac{9200}{9}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.29.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

EUTHYDESMA Hall

Euthydesma subtextile Hall

5255 $\frac{9215}{3}$ HYPOTYPE Astarte subtextilis Hall. Geology of New York; report on the 4th district. 1843. p.245.
Euthydesma subtextile Clarke. New York state museum memoir 6. 1903. pl.9, fig.8.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5256 $\frac{9215}{4}$ HYPOTYPE: HYPOPLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.9.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5257 $\frac{9215}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.10.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5258 $\frac{9215}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.11, 12.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5259 $\frac{9215}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.13.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5260 $\frac{9215}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.14.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5261 $\frac{9215}{9}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.15.
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
D. D. Luther, coll. 1902

5262 $\frac{9215}{10}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.16.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5263 $\frac{9215}{11}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.9, fig.17.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

GRAMMYSIA de Verneuil

Grammysia constricta Hall *mut.* **pygmaea** Loomis

5264 $\frac{9299}{1}$ TYPE Grammysia constricta Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.910, pl.2, fig.1, 2.
Tully pyrite — Greigsville, Livingston co. N. Y.
D. D. Luther, coll.

HONEOYEA Clarke

Honeoyea desmata Clarke

5265 $\frac{9299F}{1}$ TYPE: PLASTOTYPE Honeoyea desmata Clarke. New York state museum memoir 6. 1903. p.260, pl.6, fig.23.
Portage (Naples) beds — Tannery gully, Naples N. Y.
J. M. Clarke, donor

Honeoyea erinacea Clarke

5266 $\frac{9299Fa}{1}$ TYPE Honeoyea erinacea Clarke. New York state museum memoir 6. 1903. p.256, pl.6, fig.15, 18.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5267 $\frac{9299Fa}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.16, 19.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5268 $\frac{9299Fa}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.17.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5269 $\frac{9299Fa}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.20.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5270 $\frac{9299Fa}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.21.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5271 $\frac{9299Fa}{6}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.22.
Portage (Naples) beds — Parrish gully, Naples N. Y.
J. M. Clarke, donor

Honeoyea major Clarke

5272 $\frac{9299}{1}Fb$ TYPE Honeoyea major Clarke. New York state museum memoir 6. 1903. p.258, pl.6, fig.10.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5273 $\frac{9299}{2}Fb$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.11.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5274 $\frac{9299}{3}Fb$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.12.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5275 $\frac{9299}{4}Fb$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.13.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5276 $\frac{9299}{5}Fb$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.14.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

Honeoyea simplex Clarke

5277 $\frac{9299}{1}Fc$ TYPE Honeoyea simplex Clarke. New York state museum memoir 6. 1903. p.259, pl.6, fig.1-3.
Genesee beds (Genundewa limestone)
Genundewa, Canandaigua lake, N. Y.
J. M. Clarke, donor

Honeoyea styliophila Clarke

5278 $\frac{9299}{1}Fd$ TYPE Honeoyea styliophila Clarke. New York state museum memoir 6. 1903. p.258, pl.6, fig.4, 5.
Genesee beds (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

5279 $\frac{9299}{2}Fd$ TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.6.
Genesee beds (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

5280 $\frac{9299}{3}$Fd TYPE Clarke. New York state museum memoir 6. 1903. pl.6, fig.7–9.
Genesee beds (Genundewa limestone)
Canandaigua lake, N. Y.

KOCHIA Frech

Kochia (Loxopteria) laevis *see* Loxopteria laevis

Kochia ungula Clarke

5281 $\frac{9299}{1}$M TYPE Kochia ungula Clarke. New York state museum memoir 6. 1903. p.270, pl.13, fig.1, 2.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5282 $\frac{9299}{2}$M TYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.3.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5283 $\frac{9299}{3}$M TYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.4.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5284 $\frac{9299}{4}$M TYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.5.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5285 $\frac{9299}{5}$M TYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.6.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5286 $\frac{9299}{6}$M TYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.7.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5287 $\frac{9299}{7}$M TYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.8.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

LEDA Schumacher

Leda rostellata Hall *mut.* **pygmaea** Loomis

5288 $\frac{9304}{1}$ TYPE Leda rostellata Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.909, pl.1, fig.5.

Tully pyrite Greigsville, Livingston co. N. Y.
D. D. Luther, coll.

5289 $\frac{9304}{2}$ TYPE Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.1, fig.6.

Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

LEPTODOMUS McCoy

Leptodomus interplicatus Clarke

5290 $\frac{9358}{1}$ TYPE Leptodomus interplicatus Clarke. New York state museum memoir 6. 1903. p.315, pl.12, fig.32.

Portage beds (Hatch shales) Naples N. Y.
J. M. Clarke, donor

5291 $\frac{9358}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.33.

Portage beds (Hatch shales)
Naples valley, Ontario co. N. Y.
J. M. Clarke, donor

5292 $\frac{9358}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.34.

Portage beds (Hatch shales) Naples valley N. Y.

Leptodomus multiplex Clarke

5293 $\frac{9358a}{1}$ TYPE Leptodomus multiplex Clarke. New York state museum memoir 6. 1903. p.315, pl.12, fig.30.

Portage beds (Rhinestreet black shales) Naples N. Y.
J. M. Clarke, donor

LOXOPTERIA Frech

Loxopteria (Sluzka) corrugata Clarke

5294 $\frac{9359}{1}$ TYPE Loxopteria (Sluzka) corrugata Clarke. New York state museum memoir 6. 1903. p.277, pl.14, fig.15.

Portage (Naples) beds Correll's point, Lake Erie

5295 $\frac{9359}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.18.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5296 $\frac{9359}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.19.
Portage (Naples) beds
Smith's Mills, Chautauqua co. N. Y.
D. D. Luther, coll. 1902

5297 $\frac{9359}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.20.
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5298 $\frac{9359}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.21.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5299 $\frac{9359}{6}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.22.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke, donor

5300 $\frac{9359}{7}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.23.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5301 $\frac{9359}{8}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.24.
Portage (Naples) beds Forestville N. Y.

5302 $\frac{9359}{9}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.25.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5303 $\frac{9359}{10}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.26.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

Loxopteria dispar Sandberger (sp.)

5304 $\frac{9359a}{1}$ HYPOTYPE *Avicula dispar* Sandberger. Verstein. des rhein. Schichtensyst. in Nassau. p.284.
Loxopteria dispar Clarke. New York state museum memoir 6. 1903. pl.13, fig.9.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5305 $\frac{9359a}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.10.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5306 $\frac{9359a}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.11.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5307 $\frac{9359a}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.12.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5308 $\frac{9359a}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.13.
Portage (Naples) beds
Gowanda, Cattaraugus co. N. Y.
J. M. Clarke, donor

5309 $\frac{9559a}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.14.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5310 $\frac{9359a}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.15.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5311 $\frac{9359a}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.16.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5312 $\frac{93592a}{9}$ HYPOTYPE: HYPOPLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.13, fig.16.
Portage (Naples) beds
Walnut creek, Forestville N. Y.
J. M. Clarke, donor

Loxopteria (Sluzka) intumescentis Clarke

5313 $\frac{93592b}{1}$ TYPE Loxopteria (Sluzka) intumescentis Clarke. New York state museum memoir 6. 1903. p.276, pl.14, fig.8.
Portage (Naples) beds Lake Erie shore, Ripley N. Y.
J. M. Clarke, donor

5314 $\frac{93592b}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.9.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke, donor

5315 $\frac{93592b}{3}$ TYPE: PLASTOTYPE New York state museum memoir 6. 1903. pl.14, fig.10.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5316 $\frac{93592b}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.11.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5317 $\frac{93592b}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.12.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5318 $\frac{93592b}{6}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.13, 14.
Portage (Naples) beds
Smith's Mills, Chautauqua co. N. Y.
D. D. Luther, coll. 1902

5319 $\frac{93592b}{7}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.16.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5320 $\frac{93595b}{8}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.17.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Loxopteria laevis Frech

5321 $\frac{93595c}{1}$ HYPOTYPE Kochia (Loxopteria) laevis Frech. Die Devonischen Aviculiden Deutschlands; Abhandl. z. geolog. Specialkarte Preuss. u. d. Thür. St. 1891. v.9, Heft 3, p.76.
Loxopteria laevis Clarke. New York state museum memoir 6. 1903. pl.14, fig.1.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5322 $\frac{93595c}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.2, 3.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5323 $\frac{93595c}{3}$ HYPOTYPE: HYPOPLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.4.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke, donor

5324 $\frac{93595c}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.5.
Portage (Naples) beds Gowanda forks of Cattaraugus creek, Chautauqua co. N. Y.
D. D. Luther, coll. 1897

5325 $\frac{93595c}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.6.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5326 $\frac{93595c}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.14, fig.7.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Loxopteria vasta Clarke

5327 $\frac{93595d}{1}$ TYPE Loxopteria vasta Clarke. New York state museum memoir 6. 1903. p.275, pl.13, fig.18.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

LUNULICARDIUM Münster

Lunulicardium sp. nov. ? Clarke

5328 $\frac{9407}{1}$ TYPE Lunulicardium sp. nov. ? Clarke. New York state museum memoir 6. 1903. p.245, pl.2, fig.19.
Genesee beds (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

Lunulicardium sp. nov. Clarke

5329 $\frac{9408}{1}$ TYPE Lunulicardium sp. nov. Clarke. New York state museum memoir 6. 1903. p.245, pl.2, fig.21.
Portage (Naples) beds
Seneca point, Canandaigua lake, N. Y.
J. M. Clarke, donor

Lunulicardium sp. nov. ? Clarke

5330 $\frac{9409}{1}$ TYPE Lunulicardium sp. nov. ? Clarke. New York state museum memoir 6. 1903. p.246, pl.4, fig.11.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

Lunulicardium (Prochasma) absegmen Clarke

5331 $\frac{9410}{1}$ TYPE Lunulicardium (Prochasma) absegmen Clarke. New York state museum memoir 6. 1903. p.242, pl.3, fig.15.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

Lunulicardium (Pinnopsis) accola Clarke

5332 $\frac{9411}{1}$ TYPE (original and counterpart) Lunulicardium (Pinnopsis) accola Clarke. New York state museum memoir 6. 1903. p.233, pl.4, fig.12.
Portage (Naples) beds West Falls, Erie co. N. Y.
D. D. Luther, coll. 1897

5333 $\frac{9411}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.13.
Portage (Naples) beds Forestville N. Y.
D. D. Luther, coll. 1902

Lunulicardium acutirostrum *see* Lunulicardium (Pinnopsis) acutirostrum

Lunulicardium (Pinnopsis) acutirostrum Hall

5334 $\frac{9412}{1}$ HYPOTYPE: HYPOPLASTOTYPE Pinnopsis acutirostra Hall. Geology of New York; report on the 4th district. 1843. p.244.

Lunulicardium (Pinnopsis) acutirostrum Clarke. New York state museum memoir 6. 1903. pl.1, fig.1.

Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5335 $\frac{9412}{2}$ HYPOTYPE Lunulicardium acutirostrum Hall. Paleontology of New York. 1883. v.5, pt 1, plates and explanations, pl.71, fig.31.

Lunulicardium ornatum Hall. Paleontology of New York. 1885. v.5, pt 1, pl.71, fig.31.

Lunulicardium (Pinnopsis) acutirostrum Clarke. New York state museum memoir 6. 1903. pl.1, fig.2.

? Chemung beds Elmira, Chemung co. N. Y.
J. W. Hall and C. VanDeloo, coll. 1866

5336 $\frac{9412}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.1, fig.3.

Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5337 $\frac{9412}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.1, fig.4, 5.

Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5338 $\frac{9412}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.1, fig.6.

Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5339 $\frac{9412}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.10.

Portage (Naples) beds Naples N. Y.

Lunulicardium beushauseni Clarke

5340 $\frac{9413}{1}$ TYPE Lunulicardium beushauseni Clarke. New York state museum memoir 6. 1903. pl.3, fig.12.

Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5341 $\frac{9413}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig.13.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5342 $\frac{9413}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.15.
Portage (Naples) beds Fox's point, Lake Erie, N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Lunulicardium bickense *see* Lunulicardium (Prochasma) bickense

Lunulicardium (Prochasma) bickense Holzapfel

5343 $\frac{9414}{1}$ HYPOTYPE Lunulicardium bickense Holzapfel. Die Goniatitenkalke von Adorf; Palaeontographica. 1882. 28:256.
Lunulicardium (Prochasma) bickense Clarke. New York state museum memoir 6. 1903. pl.3, fig.3.
Portage (Naples) beds
Farnham creek, Angola N. Y.
J. M. Clarke, coll. 1898

5344 $\frac{9414}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig.4.
Portage (Naples) beds
Lower Portage falls, Genesee river, N. Y.
D. D. Luther, coll. 1897

5345 $\frac{9414}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig.5.
Portage (Naples) beds
Lower Portage falls, Genesee river, N. Y.
D. D. Luther, coll. 1897

5346 $\frac{9414}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig.11.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
D. D. Luther, coll. 1897

Lunulicardium (Chaenocardiola) clymeniae Clarke

5347 $\frac{9415}{1}$ TYPE Lunulicardium (Chaenocardiola) clymeniae Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1231, fig.1.
Clarke. New York state museum memoir 6. 1903. p.234; p.224, fig. 3.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5348 $\frac{9415}{2}$ TYPE Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1231, fig.2–4.
Clarke. New York state museum memoir 6. 1903. p.224, fig.4–6.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5349 $\frac{9415}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.1–5.
Portage (Naples) beds
Whetstone gully, near Livonia N. Y.
J. M. Clarke, donor

5350 $\frac{9415}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.6 (2 pieces).
Portage (Naples) beds
Brigg's gully, Honeoye lake, N. Y.
J. M. Clarke, donor

Lunulicardium encrinitum Clarke

5351 $\frac{9416}{1}$ TYPE Lunulicardium encrinitum Clarke. New York state museum memoir 6. 1903. p.239, pl.2, fig.20.
Portage (Naples) beds
Blacksmith gully, Bristol N. Y.
J. M. Clarke, donor

Lunulicardium (Prochasma) enode Clarke

5352 $\frac{9417}{1}$ TYPE Lunulicardium (Prochasma) enode Clarke. New York state museum memoir 6. 1903. p.242, pl.3, fig.14.
Portage (Naples) beds
Lower Portage falls, Genesee river, N. Y.
J. M. Clarke, donor

Lunulicardium (Chaenocardiola) eriense Clarke

5353 $\frac{9418}{1}$ TYPE Lunulicardium (Chaenocardiola) eriense Clarke. New York state museum memoir 6. 1903. p.235, pl.4, fig.3.
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
D. D. Luther, coll. 1902

5354 $\frac{9418}{2}$ TYPE Clarke. New York state museum memoir 6. 1903 pl.4, fig.4.
Portage (Naples) beds Forestville N. Y.
D. D. Luther, coll. 1902
On slab with type of pl.4, fig.6.

5355 $\frac{9418}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.5.
Portage (Naples) beds
Correll's point, Lake Erie, N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5356 $\frac{9418}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.6.
Portage (Naples) beds Forestville N. Y.
D. D. Luther, coll. 1902
On slab with type of pl.4, fig.4.

Lunulicardium finitimum Clarke

5357 $\frac{9419}{1}$ TYPE Lunulicardium finitimum Clarke. New York state museum memoir 6. 1903. p.238, pl.2, fig.17.
Portage (Naples) beds Parrish gully, Naples N. Y.
J. M. Clarke, donor

5358 $\frac{9419}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.18.
Portage (Naples) beds Parrish gully, Naples N. Y.
J. M. Clarke, donor

Lunulicardium fragile *see* Pterochaenia fragilis

Lunulicardium (Chaenocardiola) furcatum Clarke

5359 $\frac{9419a}{1}$ TYPE Lunulicardium (Chaenocardiola) furcatum Clarke. New York state museum memoir 6. 1903. p.236, pl 4, fig.7.
Portage (Naples) beds
Correll's point, Lake Erie, N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Lunulicardium (Chaenocardiola) hemicardioides Clarke

5360 $\frac{9419b}{1}$ TYPE Lunulicardium (Chaenocardiola) hemicardioides Clarke. New York state museum memoir 6. 1903. p.235, pl.2, fig.11, 12.
Portage (Naples) beds Parrish gully, Naples N. Y.
J. M. Clarke, donor

5361 $\frac{9419b}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.13, 14.
Portage (Naples) beds Parrish gully, Naples N. Y.
J. M. Clarke, donor

5362 $\frac{9419b}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.15.
Genesee beds (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

5363 $\frac{9419b}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.16.
Genesee beds (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

Lunulicardium *cf.* **inflatum** Holzapfel

5364 $\frac{9419c}{1}$ HYPOTYPE Lunulicardium cf. inflatum Holzapfel. Die Goniatitenkalke von Adorf; Palaeontographica. 1882. 28:33.
Clarke. New York state museum memoir 6. 1903. pl.3, fig.16.
Intumescens zone Martenberg, Westphalia

Lunulicardium (Pinnopsis) libum Clarke

5365 $\frac{9419d}{1}$ TYPE Lunulicardium (Pinnopsis) libum Clarke. New York state museum memoir 6. 1903. p.232, pl.2, fig.10.
Portage (Naples) beds Fox's point, Lake Erie, N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5366 $\frac{9419d}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.1.
Portage (Naples) beds Fox's point, Lake Erie, N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5367 $\frac{9419d}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.2.
Portage (Naples) beds Fox's point, Lake Erie, N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Lunulicardium mülleri Holzapfel

5368 $\frac{9419e}{1}$ HYPOTYPE Lunulicardium mülleri Holzapfel. Die Goniatitenkalke von Adorf; Palaeontographica. 1882. p.32.
Clarke. New York state museum memoir 6. 1903. pl.3, fig.1,2.
Intumescens zone Martenberg, Westphalia
J. M. Clarke, donor

Lunulicardium ornatum *see* Lunulicardium (Pinnopsis) acutirostrum

Lunulicardium (Pinnopsis) ornatum Hall

5369 $\frac{9405}{3}$ HYPOTYPE Pinnopsis ornatus Hall. Geology of New York; report on the 4th district. 1843. p.244.
Lunulicardium (Pinnopsis) ornatum Clarke. New York state museum memoir 6. 1903. pl.1, fig.8.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5370 $\frac{9405}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.1, fig.9.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5371 $\frac{9405}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.1, fig.10.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5372 $\frac{9405}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.1, fig.11.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5373 $\frac{9405}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.1, fig.12,13.
Portage (Naples) beds
Belknap's gully, 2 miles north of Branchport N. Y.
J. M. Clarke, coll. 1895

5374 $\frac{9405}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.1, fig.14.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

Lunulicardium (Prochasma) parunculus Clarke

5375 $\frac{9419f}{1}$ TYPE: PLASTOTYPE Lunulicardium (Prochasma) parunculus Clarke. New York state museum memoir 6. 1903. p.243, pl.3, fig.17.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5376 $\frac{9419f}{2}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig.18.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5377 $\frac{9419f}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig.19.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5378 $\frac{9419f}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.14.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

Lunulicardium pilosum Clarke

5379 $\frac{9419g}{1}$ TYPE Lunulicardium pilosum Clarke. New York state museum memoir 6. 1903. p.239, pl.2, fig.23.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5380 $\frac{9419g}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.24.
Portage (Naples) beds Parrish gully, Naples N. Y.
J. M. Clarke, donor

5381 $\frac{9419g}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.8.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5382 $\frac{9419g}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.9.
Portage (Naples) beds Pike's creek, Erie co. N. Y.
D. D. Luther, coll. 1902

Lunulicardium sodale Clarke

5383 $\frac{9419h}{1}$ TYPE Lunulicardium sodale Clarke. New York state museum memoir 6. 1903. p.238, pl.2, fig. 22.
Portage (Naples) beds
Base of Hatch hill, Naples N. Y.
J. M. Clarke, donor

Lunulicardium suppar Clarke

5384 $\frac{9419i}{1}$ TYPE Lunulicardium suppar Clarke. New York state museum memoir 6. 1903. p. 244, pl.3, fig.6.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
J. M. Clarke, donor

5385 $\frac{9419i}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig.7.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
J. M. Clarke, donor

5386 $\frac{9419i}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig. 8,9.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
D. D. Luther, coll. 1897

5387 $\frac{9419i}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.3, fig.10.
Portage (Naples) beds
Lower Portage falls, Genesee river, N. Y.
J. M. Clarke, donor

Lunulicardium ? (Opisthocoelus ?) transversale Clarke

5388 $\frac{9419j}{1}$ TYPE Lunulicardium? (Opisthocoelus?) transversale Clarke. New York state museum memoir 6. 1903. p.246, pl.4, fig.16.
Portage (Naples) beds Ithaca, Tompkins co. N. Y.
C. Van Deloo, coll. 1874

Lunulicardium velatum Clarke

5389 $\frac{9419k}{1}$ TYPE Lunulicardium velatum Clarke. New York state museum memoir 6. 1903. p.237, pl.2, fig.7.
Portage (Naples) beds
Base of Hatch hill, Naples N. Y.
J. M. Clarke, donor

5390 $\frac{9419k}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.8.
Portage (Naples) beds Parrish gully, Naples N. Y.
J. M. Clarke, donor

5391 $\frac{9419k}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.2, fig.9.
Portage (Naples) beds
Base of Hatch hill, Naples N. Y.
J. M. Clarke, donor

Lunulicardium (Pinnopsis) wiscoyense Clarke

5392 $\frac{9419l}{1}$ TYPE Lunulicardium (Pinnopsis) wiscoyense Clarke. New York state museum memoir 6. 1903. p.233, pl.1, fig.7.
Portage (Naples) beds Wiscoy creek,
Wiscoy above the bridge, Allegany co. N. Y.
D. D. Luther, coll. 1897

MODIELLA Hall

Modiella sp.? Clarke

5393 $\frac{9481}{1}$ TYPE Modiella sp.? Clarke. New York state museum memoir 6. 1903. p.316, pl.12, fig.31.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

NUCULA Lamarck

Nucula corbuliformis Hall *mut.* **pygmaea** Loomis

5394 $\frac{9577}{1}$ TYPE Nucula corbuliformis Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.908, pl.1, fig. 10, 11.
Tully pyrite Livonia salt shaft, Livingston co. N. Y.
D. D. Luther, coll.

Nucula lirata Hall *mut.* **pygmaea** Loomis

5395 $\frac{9578}{1}$ TYPE Nucula lirata Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.908, pl.1, fig.14, 15.
Tully pyrite Livonia salt shaft, Livingston co. N. Y.
D. D. Luther, coll.

Nucula varicosa Hall *mut.* **pygmaea** Loomis

5396 $\frac{9579}{1}$ TYPE Nucula varicosa Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.908, pl.2, fig.3, 4.

Tully pyrite — Greigsville N. Y.

D. D. Luther, coll.

NUCULITES Conrad

Nuculites constricta *see* Palaeoneilo constricta

Nuculites oblongatus Conrad *mut.* **pygmaeus** Loomis

5397 $\frac{9584}{1}$ TYPE Nuculites oblongatus Conrad mut. pygmaeus Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p. 909, pl.1, fig.7.

Tully pyrite — Moscow, Livingston co. N. Y.

D. D. Luther, coll.

Nuculites triqueter Conrad *mut.* **pygmaea** Loomis

5398 $\frac{9585}{1}$ TYPE Nuculites triqueter Conrad mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.909, pl.1, figs.16, 17.

Tully pyrite — Moscow N. Y.

D. D. Luther, coll.

ONTARIA Clarke

Ontaria sp.? Clarke

5399 $\frac{9595}{1}$ TYPE Ontaria sp.? Clarke. New York state museum memoir 6. 1903. pl.8, fig.27.

Portage (Naples) beds — Naples N. Y.

J. M. Clarke, donor

Ontaria accincta Clarke

5400 $\frac{9596}{1}$ TYPE Ontaria accincta Clarke. New York state museum memoir 6. 1903. p.288, pl.8, fig.22.

Portage (Naples) beds

Cashaqua creek, Livingston co. N. Y.

D. D. Luther, coll. 1897

5401 $\frac{9596}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl 8, fig.23.

Portage (Naples) beds — Cashaqua creek N. Y.

D. D. Luther, coll. 1897

5402 $\frac{9596}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.24.
Portage (Naples) beds Cashaqua creek N. Y.
D. D. Luther, coll. 1897

5403 $\frac{9596}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.25.
Portage (Naples) beds Cashaqua creek N. Y.
D. D. Luther, coll. 1897

Ontaria affiliata Clarke

5404 $\frac{9597}{1}$ TYPE Ontaria affiliata Clarke. New York state museum memoir 6. 1903. p.290, pl.7, fig.21, 22.
Portage (Naples) beds Naples, Ontario co. N. Y.
J. M. Clarke, donor

Ontaria clarkei Beushausen (sp.)

5405 $\frac{9598}{1}$ HYPOTYPE Cardiola clarkei Beushausen. Abh. der Königl.-Preuss. Geol. Landesanst. N. F. 1885. Heft 17, p.347.
Ontaria clarkei Clarke. New York state museum memoir 6. 1903. pl.7, fig.10.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5406 $\frac{9598}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.11.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5407 $\frac{9598}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.12.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5408 $\frac{9598}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.13.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5409 $\frac{9598}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.14.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5410 $\frac{9598}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.15.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

On slab with type of pl.7, fig.17.

5411 $\frac{9598}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.16.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5412 $\frac{9598}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.17.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

On slab with type of pl.7, fig.15.

5413 $\frac{9598}{9}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.18.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5414 $\frac{9598}{10}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.19.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5415 $\frac{9598}{11}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.20.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

Ontaria concentrica von Buch (sp.)

5416 $\frac{9599}{1}$ HYPOTYPE *Orbicula concentrica* von Buch. Ueber Goniatiten. 1832. p.50.
Ontaria concentrica Clarke. New York state museum memoir 6. 1903. pl.8, fig.26.
Portage (Naples) beds
Correll's point, Lake Erie, N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Ontaria halli Clarke

5417 $\frac{9599a}{1}$ TYPE *Ontaria halli* Clarke. New York state museum memoir 6. 1903. p.290, pl.7, fig.23.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5418 $\frac{9599a}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl 7, fig.24, 24A.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5419 $\frac{9599a}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.28.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

Ontaria pontiaca Clarke

5420 $\frac{9599b}{1}$ TYPE: PLASTOTYPE O n t a r i a p o n t i a c a Clarke. New York state museum memoir 6. 1903. pl.8, fig. 21.
Portage (Naples) beds — Pontiac, Erie co. N. Y.

Ontaria suborbicularis Hall (sp.)

5421 $\frac{9599c}{1}$ HYPOTYPE U n g u l i n a s u b o r b i c u l a r i s Hall. Geology of New York; report on the 4th district. 1843. p.243.
O n t a r i a s u b o r b i c u l a r i s Clarke. New York state museum memoir 6. 1903. pl.8, fig.1.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5422 $\frac{9599c}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.2.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5423 $\frac{9599c}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.3.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5424 $\frac{9599c}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.4.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5425 $\frac{9599c}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.7.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5426 $\frac{9599c}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.11.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor

5427 $\frac{9599c}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.12.
Portage (Naples) beds Attica, Wyoming co. N. Y.
D. D. Luther, coll. 1897

5428 $\frac{9599c}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.13.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5429 $\frac{9599c}{9}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.14.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5430 $\frac{9599c}{10}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.15.
Portage (Naples) beds Parrish gully, Naples N. Y.
J. M. Clarke, donor

5431 $\frac{9599}{11}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.16.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5432 $\frac{9599c}{12}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.17.
Portage (Naples) beds Naples N. Y.

5433 $\frac{9599c}{13}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.18.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5434 $\frac{9599c}{14}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.19.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5435 $\frac{9599c}{15}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.8, fig.20.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

PALAEONEILO Hall

Palaeoneilo brevicula Clarke

5436 $\frac{9645}{1}$ TYPE Palaeoneilo brevicula Clarke. New York state museum memoir 6. 1903. p.313, pl.15, fig.16.
Portage (Naples) beds Gowanda forks of Cattaraugus creek, Cattaraugus co. N. Y.
D. D. Luther, coll. 1897

Palaeoneilo constricta Conrad (sp.)

5437 $\frac{9634}{6}$ HYPOTYPE Nuculites constricta Conrad. Journal of the Academy of natural sciences of Philadelphia. 1842. 8: 249.

Palaeoneilo constricta Clarke. New York state museum memoir 6. 1903. pl.15, fig.9.

Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5438 $\frac{9634}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.10.

Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5439 $\frac{9634}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.11.

Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5440 $\frac{9634}{9}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.13.

Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

Palaeoneilo constricta Conrad *mut.* **pygmaea** Loomis

5441 $\frac{9646}{1}$ TYPE Palaeoneilo constricta Conrad mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.910, pl.1, fig.12, 13.

Tully pyrite Moscow, Livingston co. N. Y.
D. D. Luther, coll.

Palaeoneilo linguata Clarke

5442 $\frac{9647}{1}$ TYPE Palaeoneilo linguata Clarke. New York state museum memoir 6. 1903. p.314, pl.15, fig.17.

Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5443 $\frac{9647}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.18.

Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5444 $\frac{9647}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.20.

Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5445 $\frac{9647}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.21.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5446 $\frac{9647}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig 22.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Palaeoneilo muricata Clarke

5447 $\frac{9648}{1}$ TYPE Palaeoneilo muricata Clarke. New York state museum memoir 6. 1903. p.312, pl.15, fig.14, 15.
Portage (Naples) beds Honeoye lake N. Y.
J. M. Clarke, donor

Palaeoneilo petila Clarke

5448 $\frac{9649}{1}$ TYPE Palaeoneilo petila Clarke. New York state museum memoir 6. 1903. p.311, pl.15, fig.1.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5449 $\frac{9649}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.2.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5450 $\frac{9649}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.3–5.
Portage (Naples) beds Honeoye lake N. Y.
J. M. Clarke, donor

5451 $\frac{9649}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.6, 7.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5452 $\frac{9549}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.15, fig.8.
Portage (Naples) beds Pontiac, Erie co. N. Y.

Palaeoneilo plana Hall *mut.* **pygmaea** Loomis

5453 $\frac{9649a}{1}$ TYPE Palaeoneilo plana Hall mut. pygmaea Loomis. New York state museum memoir 6. 1903. p.909, pl.1, fig.8, 9.
Tully pyrite Livonia salt shaft, Livingston co. N. Y.
D. D. Luther, coll.

PARACARDIUM Barrande

Paracardium delicatulum Clarke

5454 $\frac{9669}{1}$ TYPE Paracardium delicatulum Clarke. New York state museum memoir 6. 1903. p.304, pl.11, fig.4.
Genesee shales (Genundewa limestone)
Canandaigua lake N. Y.

Paracardium doris Hall

5455 $\frac{9669a}{1}$ HYPOTYPE Cardiola doris Hall. Paleontology of New York. 1883. v.5, pt1, plates and explanations, pl.70, fig.10, 11.
Paracardium doris Clarke. New York state museum memoir 6. 1903. pl.11, fig.5.
Portage (Naples) beds Honeoye lake N. Y.
J. M. Clarke, donor

5456 $\frac{9669a}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.6.
Portage (Naples) beds Honeoye lake N. Y.
J. M. Clarke, donor

5457 $\frac{9669a}{3}$ HYPOTYPE Clarke. New York state museum memoir 6 1903. pl.11, fig.7.
Portage (Naples) beds Rock Stream, Yates co. N. Y.
J. M. Clarke, donor

5458 $\frac{9669a}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.8.
Portage (Naples) beds Rock Stream N. Y.
J. M. Clarke, donor

5459 $\frac{9669a}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.9.
Portage (Naples) beds Rock Stream N. Y.
J. M. Clarke, donor

PARACYCLAS Hall

Paracyclas lirata Conrad *mut.* pygmaea Loomis

5460 $\frac{9676}{1}$ TYPE Paracyclas lirata Conrad mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.910, pl.1, fig.2, 3.
Tully pyrite Livonia salt shaft, Livingston co. N. Y.
D. D. Luther, coll.

PARAPTYX Clarke

Paraptyx ontario Clarke

5461 $\frac{9678}{1}$ TYPE Paraptyx ontario Clarke. New York state museum memoir 6. 1903. p.262, pl.7, fig.1.
Portage (Naples) beds Naples, Ontario co. N. Y.
J. M. Clarke, donor

5462 $\frac{9678}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.2.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5463 $\frac{9678}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.3.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5464 $\frac{9678}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig 4.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5465 $\frac{9678}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.5.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5466 $\frac{9678}{6}$ TYPE Clarke. New York state museum memoir 6. 1903. pl 7, fig.6, 7.
Portage (Naples) beds Honeoye lake N. Y.
J. M. Clarke, donor

5467 $\frac{9678}{7}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.8.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5468 $\frac{9678}{8}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.7, fig.9.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

Pinnopsis acutirostra *see* Lunulicardium (Pinnopsis) acutirostrum

Pinnopsis ornatus *see* Lunulicardium (Pinnopsis) ornatum

POSIDONIA Bronn

Posidonia attica Williams (sp.)

5469 $\frac{9710}{1}$ HYPOTYPE Pterinopecten? atticus Williams. United States geological survey bulletin 41. 1887. p.35. Posidonia attica Clarke. New York state museum memoir 6. 1903. pl.12, fig 10.
Portage (Naples) beds
Pogue's hill, Dansville, Livingston co. N. Y.
J. M. Clarke, donor
On slab with types of pl.12, fig.11, 14.

5470 $\frac{9710}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.11.
Portage (Naples) beds Pogue's hill, Dansville N. Y.
J. M. Clarke, donor
On slab with types of pl. 12, fig. 10, 14.

5471 $\frac{9710}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.12.
Portage (Naples) beds Pogue's hill, Dansville N. Y.
D. D. Luther, coll. 1897

5472 $\frac{9710}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.13.
Portage (Naples) beds
Portage falls, Genesee river N. Y.
D. D. Luther, coll. 1897

5473 $\frac{9710}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.14.
Portage (Naples) beds Pogue's hill, Dansville N. Y.
J. M. Clarke, donor
On slab with types of pl. 12, fig. 10, 11.

5474 $\frac{9710}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.15.
Portage (Naples) beds Pogue's hill, Dansville N. Y.
J. M. Clarke, donor

Posidonia mesacostalis Williams (sp.)

5475 $\frac{9711}{1}$ HYPOTYPE Ptychopteria? mesacostalis Williams. United States geological survey bulletin 41. 1887. p.35.

Posidonia mesacostalis Clarke. New York state museum memoir 6. 1903. pl.12, fig.1.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
D. D. Luther, coll. 1897
On slab with type of pl. 12, fig. 5.

5476 $\frac{9711}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.2.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
D. D. Luther, coll. 1897

5477 $\frac{9711}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.3.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
D. D. Luther, coll. 1897

5478 $\frac{9711}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.4.
Portage (Naples) bed
Johnson's falls, near Strykersville N. Y.
D. D. Luther, coll. 1897

5479 $\frac{9711}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.5.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
D. D. Luther, coll. 1897
On slab with type of pl.12, fig.1.

5480 $\frac{9711}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.6.
Portage (Naples) beds
Varysburg, Wyoming co. N. Y.
D. D. Luther, coll. 1897

5481 $\frac{9711}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.7.
Portage (Naples) beds
Big Sister creek, Angola N. Y.
D. D. Luther, coll. 1902

5482 $\frac{9711}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.8.
Portage (Naples) beds
Big Sister creek, Angola N. Y.
D. D. Luther, coll. 1902

5483 $\frac{9711}{9}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.9.
Portage (Naples) beds
Big Sister creek, Angola N. Y.
D. D. Luther, coll. 1902

Posidonia venusta Münster *var.* **nitidula** Clarke

5484 $\frac{9712}{1}$ TYPE Posidonia venusta Münster *var.* nitidula Clarke. New York state museum memoir 6. 1903. p.268, pl.12, fig.16.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5485 $\frac{9712}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.17.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5486 $\frac{9712}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.18.
Portage (Naples) beds
Gowanda forks, Cattaraugus co. N. Y.
D. D. Luther, coll. 1897

5487 $\frac{9712}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.12, fig.19.
Portage (Naples) beds Correll's point Lake Erie
J. M. Clarke and D. D. Luther coll. 1898

PRAECARDIUM Barrande

Praecardium duplicatum Münster (sp.)

5488 $\frac{9715}{1}$ HYPOTYPE Cardiola duplicata Münster. Beiträge zur Petrefactenkunde. 1840. Heft 3, p.68.
Praecardium duplicatum Clarke. New York state museum memoir 6. 1903. pl.11, fig 25.
Portage (Naples) beds
Johnson's falls, near Strykersville N. Y.
J. M. Clarke, donor

Praecardium melletes Clarke

5489 $\frac{9716}{1}$ TYPE Praecardium melletes Clarke. New York state museum memoir 6. 1903. p.307, pl.11, fig.20.
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Praecardium multicostatum Clarke

5490 $\frac{9717}{1}$ TYPE Praecardium multicostatum Clarke. New York state museum memoir 6. 1903. p.308, pl.11, fig.21.
Portage (Naples) beds Forestville N. Y.
D. D. Luther, coll. 1902

5491 $\frac{9717}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.22.
Portage (Naples) beds Forestville N. Y.
D. D. Luther, coll. 1902

5492 $\frac{9717}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig 23.
Portage (Naples) beds Forestville N. Y.
D. D. Luther, coll. 1902

5493 $\frac{9717}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.24.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke, donor

Praecardium vetustum Hall

5494 $\frac{9718}{1}$ HYPOTYPE Cardium? vetustum Hall. Geology of New York; report on the 4th district. 1843. p.245.
Praecardium vetustum Clarke. New York state museum memoir 6. 1903. pl.11, fig.11.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5495 $\frac{9718}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.12.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

5496 $\frac{9718}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.13.
Portage (Naples) beds
Smith's Mills, Chautauqua co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5497 $\frac{9718}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.14.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke, donor

5498 $\frac{9718}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.16, 17
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5499 $\frac{9718}{6}$ HYPOTYPE: HYPOPLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.18.
Portage (Naples) beds Forestville N. Y.

5500 $\frac{9718}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.19.
Portage (Naples) beds Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

PTERINEA Goldfuss

Pterinea brisa Hall

5501 $\frac{9760}{1}$ HYPOTYPE Pterinea brisa Hall. 20th annual report of the New York state cabinet of natural history. 1867. p.337, pl.14, fig.1.
Hall. 11th annual report of the Indiana state geologist. 1881. pl.27, fig.24.
Niagaran Waldron Ind.

Pterinopecten? atticus *see* Posidonia attica

PTEROCHAENIA Clarke

Pterochaenia cashaquae Clarke

5502 $\frac{9789}{1}$ TYPE: PLASTOTYPE Pterochaenia cashaquae Clarke. New York state museum memoir 6. 1903. p.254, pl.4, fig.20.
Portage (Naples) beds
Cashaqua creek, Livingston co. N. Y.
On slab with types of pl.4, fig.21, 22.

5503 $\frac{9789}{2}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.21, 24.
Portage (Naples) beds
Cashaqua creek, Livingston co. N. Y.
On slab with types of pl 4, fig.20, 22.

5504 $\frac{9789}{3}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.22.
Portage (Naples) beds
Cashaqua creek, Livingston co. N. Y.
On slab with types of pl.4, fig.20, 21.

5505 $\frac{9789}{4}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.23.
Portage (Naples) beds
Bristol hollow, Ontario co. N. Y.

5506 $\frac{9789}{5}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.24.
Portage (Naples) beds
Cashaqua creek, Livingston co. N. Y.

5507 $\frac{9789}{6}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.25.
Portage (Naples) beds
Cashaqua creek, Livingston co. N. Y.

Pterochaenia elmensis Clarke

5508 $\frac{9789a}{1}$ TYPE Pterochaenia elmensis Clarke. New York state museum memoir 6. 1903. p.254, pl.4, fig.26.
Portage (Naples) beds
Big Buffalo creek, East Elma Erie co. N. Y.
D. D. Luther, coll. 1897

5509 $\frac{9789a}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.27.
Portage (Naples) beds
Big Buffalo creek, East Elma N. Y.
D. D. Luther, coll. 1897

Pterochaenia fragilis Hall (sp.)

(see Lunulicardium fragilis Hall)

5510 $\frac{9401}{10}$ HYPOTYPE: HYPOPLASTOTYPE Avicula fragilis Hall. Geology of New York; report on the 4th district. 1843. p.222.
Lunulicardium fragile Hall. Paleontology of New York. 1883. v.5, pt1, plates and explanations.
Pterochaenia fragilis Clarke. New York state museum memoir 6. 1903. pl.5, fig.1.
Portage (Naples) beds Naples, Ontario co. N. Y.
J. M. Clarke, donor

5511 $\frac{9401}{11}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.2.
Genesee shale Bristol, Ontario co. N. Y.
J. M. Clarke, donor

5512 $\frac{9401}{12}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.3.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5513 $\frac{9401}{13}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.4.
Genesee shale Moscow, Livingston co. N. Y.
J. M. Clarke, donor

5514 $\frac{9401}{14}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.5.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5515 $\frac{9401}{15}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.6.
Portage (Naples) shales Naples N. Y.
R. P. Whitfield and C. Van Deloo, coll. 1862

5516 $\frac{9401}{16}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig 7.
Marcellus shale Chapinville, Ontario co. N. Y.
J. M. Clarke, coll. 1888

5517 $\frac{9401}{17}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.8.
Portage (Naples) shale Naples N. Y.
J. M. Clarke, donor

5518 $\frac{9401}{18}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.9, 10.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

Pterochaenia fragilis Hall (sp.) *var.* **orbicularis** Clarke

5519 $\frac{9401a}{1}$ TYPE Pterochaenia fragilis Hall (sp.) var. orbicularis Clarke. New York state museum memoir 6. 1903. p.252, pl.4, fig.17.
Portage (Ithaca) beds
Near Noblesville, Otsego co. N. Y.
D. D. Luther, coll. 1900

5520 $\frac{9401a}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.4, fig.18.
Portage (Ithaca) beds Near Noblesville N. Y.
D. D. Luther, coll. 1900

5521 $\frac{9401a}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.12.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5522 $\frac{9401a}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.13.
Portage (Naples) beds Ithaca, Tompkins co. N. Y.
J. W. Hall and C. Van Deloo, coll. 1866

5523 $\frac{9401a}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.14.
Genesee shale Aurora, Cayuga lake, N. Y.
J. W. Hall and C. Van Deloo, coll. 1867

5524 $\frac{9401a}{6}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.16.
Genesee shale Aurora N. Y.
J. W. Hall and C. Van Deloo, coll. 1867

Pterochaenia perissa Clarke

5525 $\frac{9789b}{1}$ TYPE *Pterochaenia perissa* Clarke. New York state museum memoir 6. 1903. p.253, pl.4, fig.19.
Portage (Naples) beds Parrish gully, Naples N. Y.
J. M. Clarke, donor

Pterochaenia sinuosa Clarke

5526 $\frac{9789c}{1}$ TYPE *Pterochaenia sinuosa* Clarke. New York state museum memoir 6. 1903. pl.5, fig.17.
Genesee shale (Genundewa limestone)
Genundewa, Canandaigua lake, N. Y.
J. M. Clarke, donor

5527 $\frac{9789c}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.18, 19.
Genesee shale (Genundewa limestone)
Genundewa N. Y.
J. M. Clarke, donor

5528 $\frac{9789c}{3}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.20, 21.
Genesee shale (Genundewa limestone)
Genundewa N. Y.
J. M. Clarke, donor

5529 $\frac{9789c}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.5, fig.22.

Genesee shale (Genundewa limestone)

Genundewa N. Y.

J. M. Clarke, donor

Ptychopteria? mesacostalis *see* Posidonia mesacostalis

PUELLA Barrande

Puella sp.?

5530 $\frac{9815}{1}$ TYPE Puella sp.? Clarke. New York state museum memoir 6. 1903. p.309, pl.11, fig.26.

Portage (Naples) beds

Cook's ravine, Canandaigua lake N. Y.

J. M. Clarke, donor

Puella sp.?

5531 $\frac{9816}{1}$ TYPE Puella sp.? Clarke. New York state museum memoir 6, 1903. p.309, pl.11, fig.27.

Genesee shale Seneca point, Canandaigua lake N. Y.

J. M. Clarke, donor

5532 $\frac{9816}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.11, fig.28.

Genesee shale Seneca point, Canandaigua lake, N. Y.

J. M. Clarke, donor

Puella sp.?

5533 $\frac{9817}{1}$ TYPE Puella sp? Clarke. New York state museum memoir 6. 1903. p.309, pl.11, fig.29.

Genesee shale Iron Bridge Mills, Cayuga co. N. Y.

D. D. Luther, coll. 1897

Ungulina suborbicularis *see* Ontario suborbicularis

Venericardium retrostriatum *see* Buchiola retrostriata

GASTROPODA

BELLEROPHON Montfort

Bellerophon denckmanni Clarke

5534 $\frac{10018}{1}$ TYPE Bellerophon denckmanni Clarke. New York state museum memoir 6. 1903. p.321, pl.17, fig.24, 26.

Genesee shale (Genundewa limestone)

Middlesex, Yates co. N. Y.

J. M. Clarke, donor

5535 $\frac{10018}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.25.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5536 $\frac{10018}{3}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.27.
Genesee shale (Genundewa limestone)
Bristol, Ontario co. N. Y.
J. M. Clarke, donor

5537 $\frac{10018}{4}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl 17, fig.28.
Genesee shale (Genundewa limestone) Bristol N. Y.
J. M. Clarke, donor

Bellerophon incisum *see* Phragmostoma incisum

Bellerophon koeneni Clarke

5538 $\frac{10019}{1}$ TYPE Bellerophon koeneni Clarke. New York state museum memoir 6. p.320, pl.17, fig.12-14.
Genesee shale (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

5539 $\frac{10019}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.15.
Portage (Naples) beds
Plum creek, Himrod, Yates co. N. Y.
J. M. Clarke, coll. 1895

5540 $\frac{10019}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.16.
Portage (Naples) beds Middlesex, Yates co. N. Y.
J. M. Clarke, donor

5541 $\frac{10019}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.17, 18.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5542 $\frac{10019}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.19.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5543 $\frac{10019}{6}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.20.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5544 $\frac{10019}{7}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.21, 22.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

CALLONEMA Hall

Callonema filosum Clarke

5545 $\frac{10033}{1}$ TYPE: PLASTOTYPE Callonema filosum Clarke. New York state museum memoir 6. 1903. p.337, pl.18, fig.5.
Portage (Naples) beds
Smith's Mills, Chautauqua co. N. Y.
J. M. Clarke, donor

CARINAROPSIS Hall

Carinaropsis ithagenia Clarke

5546 $\frac{10034}{1}$ TYPE Carinaropsis ithagenia Clarke. New York state museum memoir 6. 1903. p.323, pl.16, fig.18, 20.
Portage (Ithaca) beds
Brookins quarry, near Norwich, Chenango co. N. Y.
D. D. Luther, coll. 1900
2 specimens (external and internal casts)

5547 $\frac{10034}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.19.
Portage (Ithaca) beds
Brookins quarry, near Norwich N. Y.
D. D. Luther, coll. 1900

DIAPHOROSTOMA Fischer

Diaphorostoma (?)

5548 $\frac{10112}{1}$ TYPE Diaphorostoma (?) Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.4, fig.2, 3.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

5549 $\frac{10112}{2}$ TYPE (?) Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.4, fig.7, 8.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

Diaphorostoma lineatum Conrad *mut.* **belial** Clarke (sp.)

5550 $\frac{10113}{1}$ HYPOTYPE Platyostoma belial Clarke. United States geological survey bulletin 16. 1885. p.30.
Diaphorostoma lineatum Conrad mut. belial Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.911, pl.4, fig.9.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

Diaphorostoma lutheri Clarke

5551 $\frac{10114}{1}$ TYPE Diaphorostoma lutheri Clarke. New York state museum memoir 6. 1903. p.337, pl.19, fig.10.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor, 1901

5552 $\frac{10114}{2}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.14.
Portage (Naples) beds — Naples N. Y.
J. M. Clarke, donor, 1901

Diaphorostoma pugnus Clarke

5553 $\frac{10115}{1}$ TYPE Diaphorostoma pugnus Clarke. New York state museum memoir 6. 1903. p.338, pl.19, fig.15.
Portage (Naples) beds
Blacksmith ravine, Bristol N. Y.
J. M. Clarke, donor

5554 $\frac{10115}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.16.
Portage (Naples) beds — Fox's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

Diaphorostoma (Naticopsis) rotundatum Clarke

5555 $\frac{10116}{1}$ TYPE: PLASTOTYPE Diaphorostoma (Naticopsis) rotundatum Clarke. New York state museum memoir 6. 1903. p.337, pl.19, fig.11–13.
Portage (Naples) beds — Angola, Erie co. N. Y.
J. M. Clarke, donor

LOXONEMA Phillips

Loxonema danai Clarke

5556 $\frac{10174}{1}$ TYPE: PLASTOTYPE Loxonema danai Clarke. New York state museum memoir 6. 1903. p.333, pl.18, fig.11.
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
J. M. Clarke, donor

5557 $\frac{10174}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.12.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5558 $\frac{10174}{3}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.13.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke, donor

Loxonema delphicola Hall *mut.* moloch Clarke

5559 $\frac{10175}{1}$ HYPOTYPE Loxonema delphicola Hall mut. moloch Clarke. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.913. pl.4, fig.10.
Tully pyrite Moscow, Livingston co. N. Y.
D. D. Luther, coll.

Loxonema multiplicatum Clarke

5560 $\frac{10176}{1}$ TYPE: PLASTOTYPE Loxonema multiplicatum Clarke. New York state museum memoir 6. 1903. p.333, pl.18, fig.14.
Portage (Naples) beds
Upper Portage falls, Genesee river, N. Y.
D. D. Luther, coll. 1897

Loxonema noe Clarke

5561 $\frac{10177}{1}$ TYPE Loxonema noe Clarke. United States geological survey bulletin 16. 1885. p.55.
Clarke. New York state museum memoir 6. 1903. pl.18, fig.6.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5562 $\frac{10177}{2}$ TYPE Clarke New York state museum memoir 6. 1903. pl.18, fig.7.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5563 $\frac{10177}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.8.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5564 $\frac{10177}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.9
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5565 $\frac{10177}{5}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.10.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

MACROCHILINA Bayle

Macrochilina hamiltoniae Hall *mut.* **pygmaea** Loomis

5566 $\frac{10211}{1}$ TYPE Macrochilina hamiltoniae Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.912, pl.4, fig.1.
Tully pyrite Moscow, Livingston co. N. Y.
D. D. Luther, coll.

Macrochilina hebe Hall *mut.* **pygmaea** Loomis

5567 $\frac{10212}{1}$ TYPE Macrochilina hebe Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.912, pl.4, fig.4.
Tully pyrite Moscow N. Y.
D. D. Luther, coll.

Macrochilina pygmaea Clarke

5568 $\frac{10213}{1}$ TYPE Macrochilina pygmaea Clarke. New York state museum memoir 6. 1903. p.334, pl.18, fig.17.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5569 $\frac{10213}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.18.
Genesee shale (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

5570 $\frac{10213}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. p.18, fig.19.
Genesee shale (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

Macrochilina seneca Clarke

5571 $\frac{10214}{1}$ TYPE Macrochilina seneca Clarke. New York state museum memoir 6. 1903. p.334, pl.18, fig.15.
Genesee shale (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, coll. 1899

5572 $\frac{10214}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.16.
Genesee shale (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, coll. 1899

PALAEOTROCHUS Hall

Palaeotrochus praecursor Clarke

5573 $\frac{10270}{1}$ HYPOTYPE Palaeotrochus praecursor Clarke. United States geological survey bulletin 16. 1886. p 55. Clarke. New York state museum memoir 6. 1903. pl.19, fig.17.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5574 $\frac{10270}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.18.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5575 $\frac{10270}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.19.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5576 $\frac{10270}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.20.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5577 $\frac{10270}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.21.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5578 $\frac{10270}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl 19, fig.22.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5579 $\frac{10270}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.23.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5580 $\frac{10270}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.24.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5581 $\frac{10270}{9}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.25.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5582 $\frac{10270}{10}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.26.
Portage (Naples) beds
Java Village, Wyoming co. N. Y.
D. D. Luther, coll. 1897

PHRAGMOSTOMA Hall

Phragmostoma chautauquae Clarke

5583 $\frac{10290}{1}$ TYPE: PLASTOTYPE Phragmostoma chautauquae Clarke. New York state museum memoir 6. 1903. p.328, pl.17, fig.1.
Portage (Naples) beds
Smith's Mills, Chautauqua co. N. Y.
J. M. Clarke, donor

5584 $\frac{10290}{2}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.2.
Portage (Naples) beds Smith's Mills N. Y.
J. M. Clarke, donor

5585 $\frac{10290}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.3.
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5586 $\frac{10290}{4}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.4.
Portage (Naples) beds Smith's Mills N. Y.
J. M. Clarke, donor

5587 $\frac{10290}{5}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.5.
Portage (Naples) beds Smith's Mills N. Y.
J. M. Clarke, donor

5588 $\frac{10290}{6}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl 17, fig.6.
Portage (Naples) beds Smith's Mills N. Y.
J. M. Clarke, donor

5589 $\frac{10290}{7}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.7.
Portage (Naples) beds Smith's Mills N. Y.

5590 $\frac{10290}{8}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.8.
Portage (Naples) beds Smith's Mills N. Y.

5591 $\frac{10290}{9}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.9.
Portage (Naples) beds Smith's Mills N. Y.

5592 $\frac{10290}{10}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.10.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5593 $\frac{10290}{11}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.17, fig.11.
Portage (Naples) beds Forestville N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Phragmostoma incisum Clarke

5594 $\frac{10291}{1}$ HYPOTYPE Bellerophon incisum Clarke. United States geological survey bulletin 16. 1885. p.53.
Phragmostoma incisum Clarke. New York state museum memoir 6. 1903. pl.16, fig.7.
Portage (Naples) beds Naples, Ontario co. N. Y.
J. M. Clarke donor

5595 $\frac{10291}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.8, 14, 15.
Portage (Naples) beds
Whetstone gully, Honeoye lake, N. Y.
J. M. Clarke, donor

5596 $\frac{10291}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.9, 10.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5597 $\frac{10291}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.11.
Portage (Naples) beds
Whetstone gully, Honeoye lake, N. Y.
J. M. Clarke, donor

5598 $\frac{10291}{5}$ HYPOTYPE: HYPOPLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.12.
Portage (Naples) beds
Whetstone gully, Honeoye lake, N. Y.
J. M. Clarke, donor

5599 $\frac{10291}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.13.
Portage (Naples) beds
Whetstone gully, Honeoye lake, N. Y.
J. M. Clarke, donor

5600 $\frac{10291}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig 16.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5601 $\frac{10291}{8}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.17.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

Phragmostoma natator Hall

5602 $\frac{10292}{1}$ HYPOTYPE Phragmostoma natator Hall. 15th annual report of the New York state cabinet of natural history. 1862. p.60.
Clarke. New York state museum memoir 6. 1903. pl.16, fig.1.
Portage (Naples) beds Naples valley, N. Y.
J. M. Clarke, donor

5603 $\frac{10292}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl 16, fig.2.
Portage (Naples) beds Naples valley, N. Y.
J. M. Clarke, donor

5604 $\frac{10292}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.3.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5605 $\frac{10292}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.4.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5606 $\frac{10292}{5}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.16, fig.5.
Portage (Naples) beds Naples N Y.
J. M. Clarke, donor

Phragmostoma cf. **triliratum** Hall

5607 $\frac{10016}{3}$ HYPOTYPE Phragmostoma cf. triliratum Clarke. New York state museum memoir 6. 1903. pl.16, fig.6.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

Platyostoma belial *see* Diaphorostoma lineatum *mut.* belial

PLEUROTOMARIA Defrance

Pleurotomaria capillaria *mut.* **cognata** *mut. nov.* Clarke

5608 $\frac{10403}{1}$ TYPE Pleurotomaria capillaria mut. cognata mut. nov. Clarke. New York state museum memoir 6. 1903. p.317, pl.19, fig 27.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5609 $\frac{10403}{2}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.28.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5610 $\frac{10403}{3}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.29.
Portage (Naples) beds Naples N. Y.
J. M. Clarke, donor

5611 $\frac{10403}{4}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl 19, fig.30.
Portage (Naples) beds Lodi falls, Seneca co. N. Y.
J. M. Clarke, donor

Pleurotomaria capillaria Conrad *mut.* **pygmaea** Loomis

5612 $\frac{10404}{1}$ TYPE Pleurotomaria capillaria Conrad mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.912, pl.4, fig 6.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

Pleurotomaria ciliata Clarke

5613 $\frac{10405}{1}$ TYPE Pleurotomaria ciliata Clarke. New York state museum memoir 6. 1903. p.318, pl.20, fig.8, 11.
Portage (Naples) beds
Whetstone gully, Conesus lake, N. Y.
J. M. Clarke, donor

5614 $\frac{10405}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.9.
Portage (Naples) beds
Whetstone gully, Conesus lake, N. Y.
J. M. Clarke, donor

5615 $\frac{10405}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.10.
Portage (Naples) beds
Whetstone gully, Conesus lake, N. Y.
J. M. Clarke, donor

5616 $\frac{10405}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.12, 13.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5617 $\frac{10405}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.14.
Portage (Naples) beds
Whetstone gully, Conesus lake, N. Y.
J. M. Clarke, donor

Pleurotomaria genundewa Clarke

5618 $\frac{10406}{1}$ TYPE: PLASTOTYPE Pleurotomaria genundewa Clarke. New York state museum memoir 6. 1903. p.319, pl.19, fig.33.
Genesee shale (Genundewa limestone)
Middlesex, Yates co. N. Y.
J. M. Clarke, donor

5619 $\frac{10406}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.34.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5620 $\frac{10406}{3}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.1, 5.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5621 $\frac{10406}{4}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.2.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5622 $\frac{10406}{5}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.3.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5623 $\frac{10406}{6}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.4.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5624 $\frac{10406}{7}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.6.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

5625 $\frac{10406}{8}$ TYPE: PLASTOTYPE Clarke. New York state museum memoir 6. 1903. pl 20, fig.7.
Genesee shale (Genundewa limestone)
Middlesex N. Y.
J. M. Clarke, donor

Pleurotomaria itylus Clarke

5626 $\frac{10407}{1}$ TYPE Pleurotomaria itylus Clarke. New York state museum memoir 6. 1903. pl.19, fig.31, 32.
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

Pleurotomaria itys Hall *mut.* pygmaea Loomis

5627 $\frac{10408}{1}$ TYPE Pleurotomaria itys Hall mut. pygmaea Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.913, pl.4, fig.5.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

PROTOCALYPTRAEA Clarke

Protocalyptraea marshalli Clarke

5628 $\frac{10430}{1}$ TYPE Protocalyptraea marshalli Clarke. American geologist. 1894. 13:334; p.332, fig.10, 11, p.333, fig.12.
Clarke. New York state museum memoir 6. 1903. pl.19, fig.1–3.
Portage (Naples) beds
Whetstone gully, near Honeoye lake, N. Y.
J. M. Clarke, donor

5629 $\frac{10430}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903 pl.19, fig.4.
Portage (Naples) beds — Honeoye lake, N. Y.
J. M. Clarke, donor

5630 $\frac{10430}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.19, fig.5, 6.
Portage (Naples) beds — Naples, Ontario co. N. Y.
J. M. Clarke, donor

Protocalyptraea styliophila Clarke

5631 $\frac{10431}{1}$ TYPE Protocalyptraea styliophila Clarke. American geologist. 1894. 13:334; p.333, fig.13.
Clarke. New York state museum memoir 6. 1903. pl.19, fig.7–9.
Genesee shale (Genundewa limestone)
Canandaigua lake, N. Y.
J. M. Clarke, donor

PROTOSPIRIALIS Clarke

Protospirialis minutissima Clarke

5632 $\frac{10435}{1}$ TYPE Platyostoma? minutissima Clarke. United States geological survey bulletin 16. 1885. p.55.

Protospirialis minutissima Clarke. New York state museum memoir 6. 1903. pl.20, fig.15.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5633 $\frac{10435}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.16.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5634 $\frac{10435}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.17.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5635 $\frac{10435}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.18.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5636 $\frac{10435}{5}$ TYPE Clarke. New York state museum memoir 6. 1903. pl 20, fig.19.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

TROPIDOCYCLUS Clarke

Tropidocyclus hyalinus Clarke

5637 $\frac{10590}{1}$ TYPE Tropidocyclus hyalinus Clarke. New York state museum memoir 6. 1903. p.331, pl.18, fig.1.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5638 $\frac{10590}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.2.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5639 $\frac{10590}{3}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.3.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5640 $\frac{10590}{4}$ TYPE Clarke. New York state museum memoir 6. 1903. pl.18, fig.4.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

PTEROPODA

HYOLITHELLUS Billings

Hyolithellus micans Billings

5641 $\frac{11015}{1}$ HYPOTYPE Hyolithellus micans Billings. Canadian naturalist, 2d ser. 1871. 4:215.

Ruedemann. New York state museum bulletin 49. 1901. pl.2, fig.11.

Trenton conglomerate

Rysedorph hill, Rensselaer co. N. Y.

Hyolithes neapolis *see* Hyolithus neapolis

HYOLITHUS Eichwald

Hyolithus neapolis Clarke

5642 $\frac{11029}{1}$ PLASTOTYPE Clarke. United States geological survey bulletin 16. 1885. pl 3, fig 4,5.

Clarke. New York state museum memoir 6. 1903. pl.20, fig 23.

Portage (Naples) beds Naples N. Y.

J. M. Clarke, donor

5643 $\frac{11029}{2}$ HYPOTYPE Hyolithes neapolis Clarke. United States geological survey bulletin 16. 1885. p.56.

Hyolithus neapolis Clarke. New York state museum memoir 6. 1903. pl.20, fig.22.

Portage (Naples) beds Naples N. Y.

J. M. Clarke, donor

5644 $\frac{11029}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig 24.

Portage (Naples) beds Naples N. Y.

J. M. Clarke, donor

5645 $\frac{11029}{4}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig 25.

Portage (Naples) beds Naples N. Y.

J. M. Clarke, donor

5646 $\frac{11029}{5}$ HYPOTYPE Clarke. New York state musem memoir 6. 1903. pl.20, fig. 26.

Portage (Naples) beds Naples N. Y.

J. M. Clarke, donor

5647 $\frac{11029}{6}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl 20, fig.27–29.
Portage (Naples) beds Honeoye lake, N. Y.
J. M. Clarke, donor

5648 $\frac{11029}{7}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. pl.20, fig.30.
Portage (Naples) beds Naples N. Y.
D. D. Luther, coll. 1902

CEPHALOPODA

BACTRITES Sandberger

Bactrites (sp. ?) *mut.* **parvus** Loomis

5649 $\frac{12043}{1}$ TYPE Bactrites (sp. ?) mut. parvus Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p 916, pl 5, fig.4, 5.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

Bactrites? sp. *mut.* **pygmaeus** Loomis

5650 $\frac{12044}{1}$ TYPE Bactrites? sp. mut. pygmaeus Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.915, pl.4, fig 12, 13.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

CHILOCERAS Salter

Chiloceras sp. Clarke

5651 $\frac{12095}{1}$ TYPE Chiloceras sp. Clarke. New York state museum memoir 6. 1903. p.344, fig.14.
Portage (Naples) beds
Union Corners, Livingston co. N. Y.
J. M. Clarke, coll.

GEPHYROCERAS Hyatt

Gephyroceras cf. **domanicense** Holzapfel

5652 $\frac{12164}{1}$ HYPOTYPE Gephyroceras domanicense Holzapfel. Mémoires du comité géologique. 1899. v.12, no.3, p.32.
Gephyroceras cf. domanicense Clarke. New York state museum memoir 6. 1903. p.345, fig.15(a).
Portage (Naples) beds
Forestville, Chautauqua co. N. Y.
J. M. Clarke and D. D. Luther, coll. 1898

5653 $\frac{12164}{2}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. p.345, fig.15(b).

Portage (Naples) beds — Forestville N. Y.

D. D. Luther, coll. 1902

5654 $\frac{12164}{3}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. p.345, fig.15(c).

Portage (Naples) beds — Forestville N. Y.

J. M. Clarke and D. D. Luther, coll. 1898

Goniatites astarte *see* Tornoceras uniangulare *mut.* astarte

ORTHOCERAS Breynius

Orthoceras asmodeus *see* Tentaculites gracilistriatus *mut.* asmodeus

Orthoceras mephisto *see* Orthoceras scintilla *mut.* mephisto

Orthoceras nuntium Hall

5655 $\frac{12388}{6}$ HYPOTYPE Orthoceras nuntium Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl 5, fig.9.

Tully pyrite — Canandaigua lake, N. Y.

D. D. Luther, coll.

Orthoceras scintilla Hall (?) *mut.* **mephisto** Clarke

5656 $\frac{12425}{1}$ HYPOTYPE Orthoceras mephitos Clarke. United States geological survey bulletin 16. 1885. p 29.

Orthoceras scintilla Hall (?) mut. mephisto Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.4, fig.14.

Tully pyrite — Canandaigua lake, N. Y.

D. D. Luther, coll.

Orthoceras subulatum Conrad *mut.* **pygmaeum** Loomis

5657 $\frac{12426}{1}$ TYPE Orthoceras subulatum Conrad mut. pygmaeum Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.914, pl.5, fig.6.

Tully pyrite — Canandaigua lake, N. Y.

D. D. Luther, coll.

5658 $\frac{12426}{2}$ TYPE Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.5, fig.7.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

Orthoceras stebos *see* Tentaculites bellulus *mut.* stebos

TORNOCERAS Hyatt

Tornoceras bicostatum Hall (sp.)

5659 $\frac{12540}{10}$ HYPOTYPE Clarke. New York state museum memoir 6. 1903. p 346, fig.16.
Portage (Naples) beds
Correll's point, Lake Erie
J. M. Clarke and D. D. Luther, coll. 1898

Tornoceras uniangulare Conrad (sp.)

5660 $\frac{12544}{6}$ HYPOTYPE Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.5, fig.3.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

Tornoceras uniangulare Conrad *mut.* **astarte** Clarke

5661 $\frac{12547}{1}$ HYPOTYPE Goniatites astarte Clarke. United States geological survey bulletin 16. 1885. p.29.
Tornoceras uniangulare Conrad mut. astarte Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl 5, fig.1.
Tully pyrite Canandaigua lake, N. Y.
D. D. Luther, coll.

5662 $\frac{12547}{2}$ HYPOTYPE Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.5, fig.2.
Tully pyrite
Livonia salt shaft, Livingston co. N. Y.
D. D. Luther, coll.

CRUSTACEA

Acidaspis fimbriata *see* Ceratocephala (Acidaspis) fimbriata

BEYRICHIA McCoy

Beyrichia dagon Clarke

5663 $\frac{13087}{1}$ HYPOTYPE Beyrichia dagon Clarke. United States geological survey bulletin 16. 1885. p.29.

Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.5, fig.12–14.

Tully pyrite Greigsville, Livingston co. N. Y.

D. D. Luther, coll.

CERATOCEPHALA Warder

Ceratocephala (Acidaspis) fimbriata Hall (sp.)

5664 $\frac{13225}{1}$ TYPE Acidaspis fimbriata Hall. Transactions of the Albany institute. 1881. 10:20 (abstract).

Acidaspis fimbriata Hall. 11th annual report of the Indiana state geologist. 1881. pl.33, fig.11.

Niagaran Waldron Ind.

C. D. Walcott and C. Van Deloo, coll. 1878

Cryphaeus boothi var. calliteles *see* Dalmanites (Cryphaeus) boothi *var.* calliteles

Cypridina serratostriata *see* Entomis serratostriata

DALMANITES (Emmrich) Barrande

Dalmanites (Cryphaeus) boothi Green (sp.) *var.* calliteles Green

5665 $\frac{13369}{18}$ HYPOTYPE Cryphaeus boothi var. calliteles Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.5, fig.15.

Tully pyrite Moscow, Livingston co. N. Y.

D. D. Luther, coll.

DOLICHOPTERUS Hall

Dolichopterus ??

5666 $\frac{13430}{1}$ HYPOTYPE Dolichopterus ?? Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1262, pl.12, fig.5.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

ENTOMIS Jones

Entomis prosephina Loomis

5667 $\frac{13510}{1}$ TYPE Entomis prosephina Loomis. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.918, pl.5. fig.10, 11.
Tully pyrite — Canandaigua lake, N. Y.
D. D. Luther, coll.

Entomis serratostriata Sandberger (sp.)

5668 $\frac{13511}{1}$ HYPOTYPE Cypridina serratostriata Sandberger. Leonhardt & Bronn's Jahrb. 1842. p.226.
Entomis serratostriata Clarke. New York state museum memoir 6. 1903. p.344, fig.12.
Portage (Naples) beds
Union Springs, Livingston co. N. Y.
J. M. Clarke, coll. 1890

Entomis variostriata Clarke

5669 $\frac{13512}{1}$ HYPOTYPE Entomis variostriata Clarke. Neues Jahrb. für Mineral. 1884. p.184.
Clarke. New York state museum memoir 6. 1903. p.344, fig.13.
Portage (Naples) beds — Union Springs N. Y.
J. M. Clarke, coll. 1890

EURYPTERUS De Kay

Eurypterus pittsfordensis Sarle

5670 $\frac{13566}{1}$ TYPE Eurypterus pittsfordensis Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1098, pl.10, fig 7.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5671 $\frac{13566}{2}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.15, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase
On slab with types of pl.15, fig. 3; pl.18, fig. 1.

5672 $\frac{13566}{3}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.15, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5673 $\frac{13566}{4}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.15, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

On slab with types of pl.15, fig.1; pl.18, fig. 1.

5674 $\frac{13566}{5}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.16.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5675 $\frac{13566}{6}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.17, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5676 $\frac{13566}{7}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.17, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5677 $\frac{13566}{8}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.18.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

On slab with types of pl.15, fig.1; pl.15, fig.3.

5678 $\frac{13566}{9}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.19.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5679 $\frac{13566}{10}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.20, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5680 $\frac{13566}{11}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.20, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5681 $\frac{13566}{12}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.20, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5682 $\frac{13566}{13}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.20, fig 4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5683 $\frac{13566}{14}$ TYPE Sarle New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.20, fig.5.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5684 $\frac{13566}{15}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.20, fig.6.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5685 $\frac{13566}{16}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.22, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J Sarle purchase

5686 $\frac{13566}{17}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.23, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5687 $\frac{13566}{18}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.23, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5688 $\frac{13566}{19}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.23, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5689 $\frac{13566}{20}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.23, fig.4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5690 $\frac{13566}{21}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.24, fig 2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5691 $\frac{13566}{22}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.24, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5692 $\frac{13566}{23}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.24, fig. 4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5693 $\frac{13566}{24}$ TY Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.24, fig.5.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford, N. Y.
C. J. Sarle purchase

5694 $\frac{13566}{25}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.25, fig.4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5695 $\frac{13566}{26}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.25, fig.5.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5696 $\frac{13566}{27}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.25, fig.6.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

EURYPTERID ?

5697 $\frac{13575}{1}$ TYPE (unknown eurypterid) Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1105, pl.26, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5698 $\frac{13575}{2}$ TYPE (original & counterpart) Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.26, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5699 $\frac{13575}{3}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.26, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

HUGHMILLERIA Sarle

Hughmilleria socialis Sarle

5700 $\frac{13590}{1}$ TYPE Hughmilleria socialis Sarle. New York state bulletin 69; annual report of the state paleontologist. 1903. p.1091, pl.6, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

On slab with types of pl.7, 8.

5701 $\frac{13590}{2}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.7, fig 1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase
On slab with types of pl.6, 8.

5702 $\frac{13590}{3}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.8, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase
On slab with types of pl.6, 7.

5703 $\frac{13590}{4}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.9, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5704 $\frac{13590}{5}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.10, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5705 $\frac{13590}{6}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.10, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5706 $\frac{13590}{7}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.10, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5707 $\frac{13590}{8}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.10, fig.4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5708 $\frac{13590}{9}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.10, fig.5.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5709 $\frac{13590}{10}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.10, fig.6.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5710 $\frac{13590}{11}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.10, fig.8 (2 specimens).
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5711 $\frac{13590}{12}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.10, fig.9.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5712 $\frac{13590}{13}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.11, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5713 $\frac{13590}{14}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.11, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5714 $\frac{13590}{15}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.11, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5715 $\frac{13590}{16}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.11, fig.4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5716 $\frac{13590}{17}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.11, fig.5.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5717 $\frac{13590}{18}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.11, fig.6.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5718 $\frac{13590}{19}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.11, fig.7.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5719 $\frac{13590}{20}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.12, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5720 $\frac{13590}{21}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.12, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5721 $\frac{13590}{22}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.12, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5722 $\frac{13590}{23}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.12, fig.4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5723 $\frac{13590}{24}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.12, fig.6.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5724 $\frac{13590}{25}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.12, fig.7.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5725 $\frac{13590}{26}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.12, fig.8.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5726 $\frac{13590}{27}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.13, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5727 $\frac{13590}{28}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.13, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5728 $\frac{13590}{29}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.13, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.

5729 $\frac{13590}{30}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.13, fig.4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5730 $\frac{13590}{31}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5731 $\frac{13590}{32}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5732 $\frac{13590}{33}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5733 $\frac{13590}{34}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig 4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5734 $\frac{13590}{35}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.5.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5735 $\frac{13590}{36}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.6.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5736 $\frac{13590}{37}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.7
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5737 $\frac{13590}{38}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.8.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5738 $\frac{13590}{39}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.9.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5739 $\frac{13590}{40}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.14, fig.10.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5740 $\frac{13590}{41}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.15, fig.4.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5741 $\frac{13590}{42}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.15, fig 5.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5742 $\frac{13590}{43}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.15, fig.6.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C J. Sarle purchase

5743 $\frac{13590}{44}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.24, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5744 $\frac{13590}{45}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.25, fig.1.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5745 $\frac{13590}{46}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.25, fig.2.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C. J. Sarle purchase

5746 $\frac{13590}{47}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.25, fig.3.
Salina (Pittsford) shale
Erie canal, 2 miles northwest of Pittsford N. Y.
C J. Sarle purchase

5747 $\frac{13590}{48}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.26, fig.4.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

5748 $\frac{13590}{49}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.26, fig.5.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

Hughmilleria socialis Sarle *var.* robusta Sarle

5749 $\frac{13591}{1}$ TYPE Hughmilleria socialis Sarle var. robusta Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1007, pl.21, fig.1.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

5750 $\frac{13591}{2}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.21, fig.2.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

5751 $\frac{13591}{3}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.21, fig.3.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

PTERYGOTUS Agassiz

Pterygotus sp.

5752 $\frac{14081}{1}$ TYPE Pterygotus sp. Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1104, pl.24, fig.6.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

Pterygotus sp.

5753 $\frac{14082}{1}$ TYPE Pterygotus sp. Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p 1104, pl.24, fig.8.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

Pterygotus monroensis Sarle

5754 $\frac{14083}{1}$ TYPE Pterygotus monroensis Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. p.1102, pl.24, fig.7.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

5755 $\frac{14083}{2}$ TYPE Sarle. New York state museum bulletin 69; annual report of the state paleontologist. 1903. pl.24, fig.9.

Salina (Pittsford) shale

Erie canal, 2 miles northwest of Pittsford N. Y.

C. J. Sarle purchase

RIBEIRIA Sharpe

Ribeiria? prosseri Clarke

5756 $\frac{14135}{1}$ TYPE Ribeiria? prosseri Clarke. New York state museum memoir 6. 1903. Explanation of pl.9; pl.9, fig.1.

Portage (Oneonta) sandstone

Near Livingstonville, Schoharie co. N. Y.

C. S. Prosser, coll.

5757 $\frac{14135}{2}$ TYPE Clarke. New York state museum memoir 6. 1903. Explanation of pl.9; pl.9, fig.2.

Portage (Oneonta) sandstone

Near Livingstonville N. Y.

C. S. Prosser, coll.

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PERCÉ

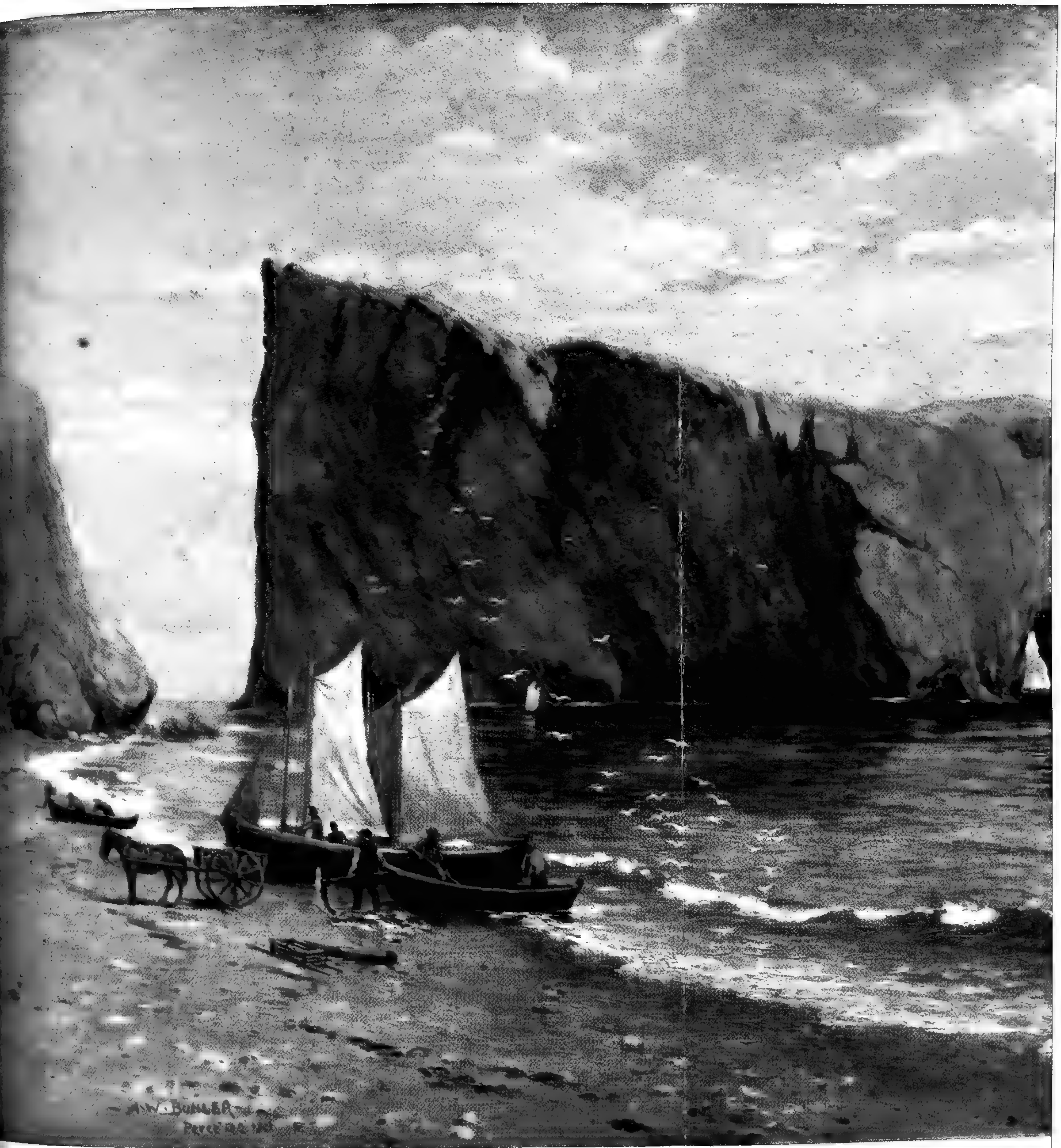
A brief sketch of its geology

BY JOHN M. CLARKE

In seeking the solution of some problems pertaining to the distribution of the ancient faunas of New York, and the nature and extent of the old land barriers and sea channels, one follows only a blind lead if respect is had alone to such evidence as is found within our own political boundaries. In the conservation of the factors necessary to the reconstitution of these early stages in our history, nature has been kind to New York and in the quality of fulness her ancient faunas are not often excelled, but within these confines is but a part of the story; now and again a stage has been skipped here which is recorded elsewhere, or a phase is but obscurely presented in the panorama of New York events which in neighboring territories is portrayed with lucid cogency.

Much of interest lies in the time and mode of introduction into New York of the earliest faunas of the Devonic age. Here they are represented in various degrees of effectiveness and profusion, and for the most part follow with little evidence of interruption on those of the great Siluric age preceding. The pathway of movement of these faunas along the old continental border lies to the northeast and to the southwest, and the labors of our predecessors and colleagues in the latter region have thrown much light on their distribution and travels through what is now the region of the Appalachian mountains but what was then off the coast or along the water ways of the ancient continent termed *Appalachia*.

Seeking such clues to the northeast led us a few years ago into the county of Gaspé, province of Quebec, and the region just north of Gaspé bay, and likewise to the exposures about Dalhousie N. B. at the head of the Bay of Chaleurs, places where unequaled opportunity is afforded for the study of some of the New York faunas



PERCÉ ROCK

under a new aspect and in profuse development. More recently, on a similar errand, the writer has exploited the same factors as developed about the village of Percé on the coast of Gaspé just south of Malbay and about 20 miles due south of the north shore of Gaspé bay. In due time the results of the studies thus made will be presented in some detail for the comparison of these ancient faunas with those of New York, for quite extensive collections have been brought together from all the points mentioned, and we may look for an important elucidation therefrom of some of the problems to which reference has been made.

In this paper, however, it is not so much the purpose to enter on comparisons of results and correlations of faunas as to expound with some brevity the singularly interesting geologic structure prevailing at and about Percé, as derived from observations made in the course of assembling the fossil faunas of the region.

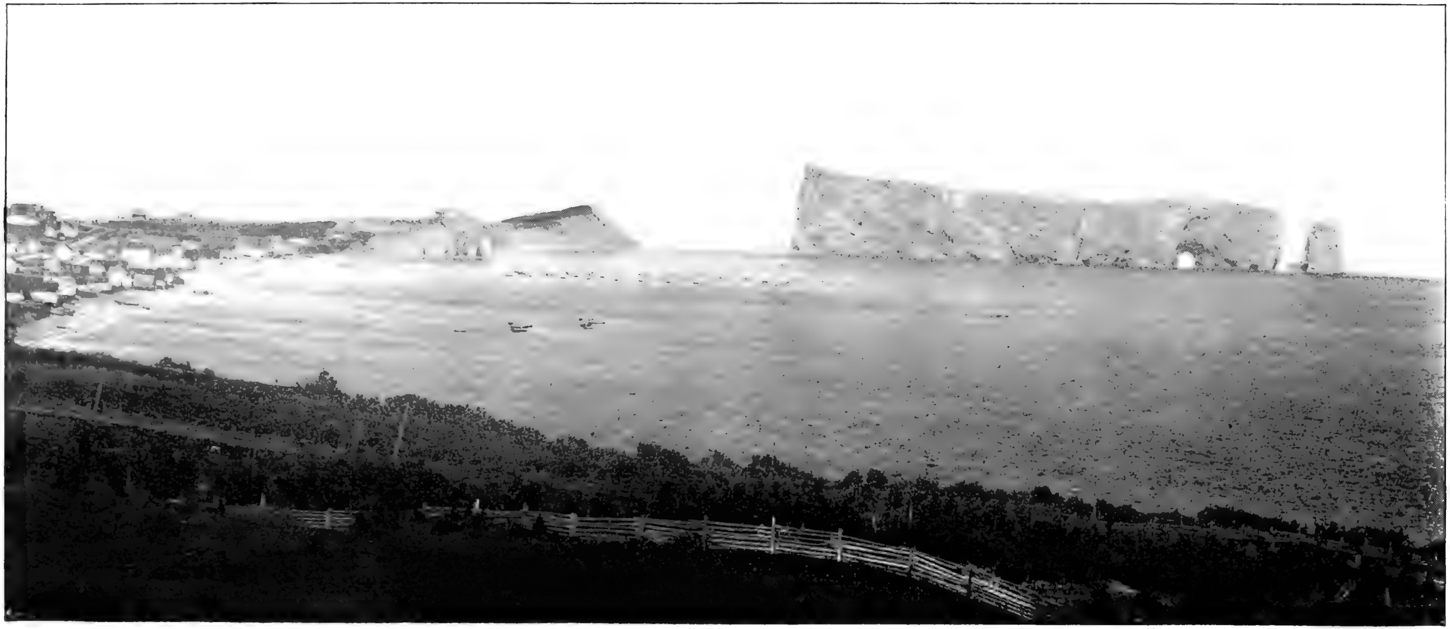
The ancient fishing village of Percé is a spot of extraordinary beauty of situation. It lies exposed to the full force of the sea on the easternmost part of the Gaspé peninsula and no place could display with more potency the tremendous destructive power of the sea than this broken and deeply gnawed coast against which the northeast blasts have beaten ages long. It is an old settlement, one of the oldest in America. Soon after Jacques Cartier in 1535 roasted in the Bay of Chaleurs and planted a cross at Douglastown on Gaspé bay, fisherpeople from the shores of Brittany and the Channel islands settled here under the overshadowing protection of the stupendous and glorious Rocher Percé, from which the place takes name and which today draws the amazed wonder of every passing sea traveler. The narrow beach to the north of the rock and the long beach below afforded a base of operations for the fishing, and here a settlement was made long before Hendrik Hudson had wet keel in the waters of New York.

Isolated and towering stands the Percé rock at the angle between the North and South beaches, cut off from the shore by an interval of 300 feet, over which the waters roll, except at ebb tide, and beneath which lies the zone of a great displacement of the rock masses. All other presentments of the gnawing power of the ocean which the writer has studied on American shores, in northern Scotland at Scrabster and Caithness, in Hoy and the other islands of the Orkneys, are surpassed in magnitude and effect by this leviathan rock. It lies like an immense Atlantic liner, almost at right angles to the course of the South cove, headed inward to the North cove wharf. Its limestone strata, which stand vertical, rise to a hight of 290 feet at its highest landward apex, where today a weathered joint face hangs out a triangular rock mass like a pennant flying at foremast peak.

From the sharp landward bow the massive widens outward to a diameter of about 300 feet and extends in length seaward 1500 feet,

Seaward face of the pillar at outer end of Percé rock; showing the arch

its top sloping with undulating surface rapidly at first and then more gently backward. Sternward stands an isolated rock pillar, remnant of a fallen arch which the seas brought down, as my good friend Philip Le Boutillier tells me, on a rough 17th of June 1845. But the rock is still tunneled aft by a fine arch through which a boat at sail might pass were it not for the breakers. On its rearward sea face is another and smaller arch. The summit of the rock is the breeding-ground of thousands of gulls and cormorants, which make an ever moving halo of white and black about the grassy slopes and jagged asperities of the surface and whose screams and calls are as sempiternal as the breaking of the surf on the fallen rocks. The cliff is virtually inaccessible. Local traditions and Sir Gilbert Parker tell of its having been scaled, but be this as it may, the walls



Percé and rock from the south. At the left Mt Joli, Cap Canon and the South cove

are sheer and would demand surrender of the most daring. Clothed in tints of red and yellow, which are the natural shades of the rock, and veined with streaks of white, the colors of the cliffs change with every passing cloud, alive with bright purples and lustrous bronze as the sun shines full on it, in the cloud filtered light hanging like an oriental tapestry in soft madders and browns, and when the land mist hangs over it or the nor'easter is buffeting it, dark and minatory, all its soft lines lost and its asperities stiffened in resistance.

Turning landward the eye rests first on the topography of the shore line, Mt Joli, a low truncated rock cone connected at low tide with the Pierced rock by a sand bar, and about a hundred yards away, hence extending southward into another small headland, Cap Canon, sometimes Battery point, all a rock escarpment of vertical strata not more than 100 feet high at any point. To the south of this opens the broad Robin fishing beach, which reaches away to the nearly horizontal outcrops of red conglomerate at the opening of Lenfesty's brook and beyond to the headland which bounds the South cove, 2 miles away, Cap Blanc or Whitehead; another vertical mass of limestones lying between and beneath the red rocks. To the north of Mt Joli and the beach of the North cove, begin the Murailles, the high rocky sea wall which fronts the Malbay, rising with a deeply notched sky line in grassy and deeply furrowed slopes and falling off sheer to the water's edge; the tattered remains of a mountain which stretched away into Malbay but has yielded its better part to the restless tooth of the sea. The effect on the landscape of this ragged escarpment is very striking but its impressiveness is appreciated best only from the sea, from which it is alone approachable. At the north end of the North cove the escarpment rises abruptly in the calcareous and arenaceous shales of Cap Barré; thence northward framing the angular recesses beaten out by the sea, the cliff becomes even higher till the line reaches Red peak at the north and falls off abruptly into the gorge of the Grande Coupe. Except for Cap Barré these rocks are brilliantly tinted with reds and yellows and, we shall presently observe, were a part of the tinted strata comprising the Percé rock, though here the angle of their slope is greatly altered and nearly conforms to the slopes of the mountain surface.

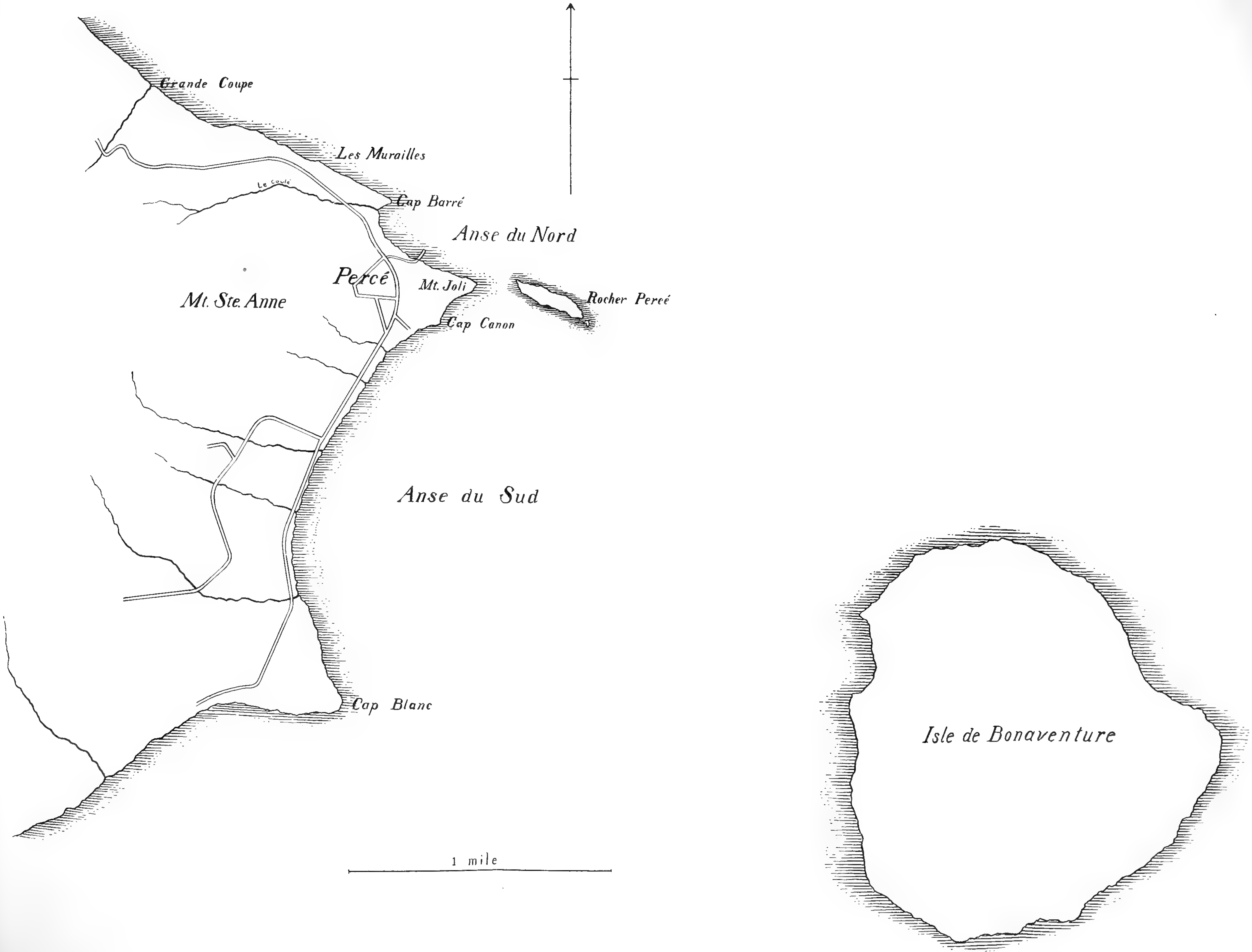
All these bold contours are brought closely together so that in the radius of a mile from the courthouse we embrace the Murailles, cliffs of Joli, Canon, the Percé rock, the broad intervales of the coves and the low south escarpments of the horizontal conglomerate. And behind them all, as a background to the picture, rises Mt Ste Anne, its lofty perpendicular precipices on the eastern face rising to a hight of about 1400 feet. On the slopes of this easternmost member of the cluster of summits known as Percé mountain, pious ardor has cleared a broad way to the shrine at the top whence the eye travels without obstruction to Anse du Cap and Grande Rivière southward, and northward to Pointe St Peter across Malbay and to Shiphead and the shores of Grande Grève across Gaspé bay; inland over the rolling timbered wilderness toward the Shickshock mountains, and seaward beyond the Percé rock to the island of Bonaventure 3 miles away. This mountain is the summit of the great cap of red conglomerate which lies over and against the erect limestones of Percé, Cap Canon and Cap Blanc, extends downward to the sea at the Robin beach and makes the Percé reef, and doubtless continues beneath the water to Bonaventure island where only this rock is found.

From the slopes of Mt Ste Anne flow the little drainage ways of the region, the stream of Le Coulé or Barré brook to the North beach, Robin brook to the South beach and Lenfesty's brook directly through the rising escarpment of the Bonaventure rocks to the south.

This brief sketch of the topography of Percé will serve as the only necessary introduction to the sketch of its geology which, without going far afield from the confines of the settlement, follows.

GEOLOGY

Pretty much all that has been known of the geology of this region we still owe to Sir William Logan, first director of the Geological Survey of Canada. In 1844, the second season of his field work in this capacity, Sir William made it his business to reconnoiter the rocky and wild coasts of the Gaspé country, then and in the season of 1845 making traverses from the Gulf of St Lawrence to the Bay



MAP OF REGION ABOUT PERCÉ

of Chaleurs, "living" as he has said "the life of a savage, sleeping on the beach in a blanket sack with my feet to the fire, seldom taking my clothes off, eating salt pork and ship's biscuit, occasionally tormented with mosquitos." The venerable Mr Philip Le Boutillier tells me of having piloted Sir William about the rocks of Percé and with him scaling the summit of Mt Ste Anne.

In his classical *Geology of Canada* published in 1863 Logan summarized the results of his observations here, and that part of his work in which our interest more specially lies is his detailed account of the limestones, sandstones and conglomerates of the region, enormous series of sediments which he termed the Gaspé limestones, Gaspé sandstones and Bonaventure conglomerates. Several of the Canadian geologists have added much to our knowledge of these formations; Dr Robert Bell, who early explored the region; Sir William Dawson, who studied the plant remains of the Gaspé sandstone; Elkanah Billings, who has made known almost our entire equipment of facts concerning the animal fossils of the rocks; R. W. Ells, who as late as 1882 reviewed the general geologic features of the country and added some important details, while Dr H. M. Ami has contributed a few observations on the faunas.

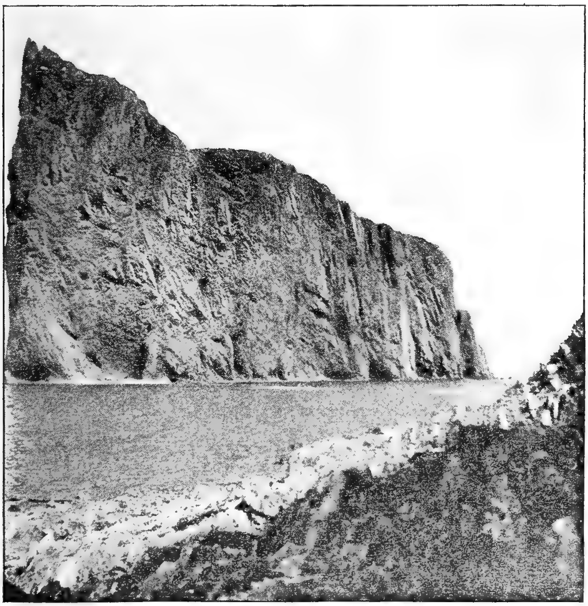
The Gaspé limestones were defined by Logan from their most remarkable development on the narrow tongue of land which constitutes the peninsula of Cape Gaspé eastward of Cape Rozier on the north and Little Gaspé on the south. Here the succession is apparently uninterrupted, the dip estimated at about s.w. 24°, and the series rests unconformably on the shales of Cambric age at Cape Rozier. Through this narrow neck of land not more than a mile across from the Gulf of St Lawrence to Gaspé bay at Grande Grève run two limestone escarpments, the northern terminating in Cape Gaspé, the southern in Shiphead and the two separated by an eroded, not structural, drainage way. Logan estimated the thickness of this continuous mass at about 2000 feet, and divided it into eight parts, divisions 1 to 8, between which was found no evidence of unconformity but some notable distinctions in quality, the strata becoming more highly calcareous with some intermixture of arenaceous matter toward the top. All were regarded by him as of the age of the Lower Helderberg of New York, at a time when the Helderberg fauna was not estimated with precision. Almost all the divisions were found to be fossiliferous, but the uppermost, 7 and 8, specially so.

It became evident from the identification of the fossils of the upper beds by Billings that divisions 7 and 8 correspond more nearly in fauna to the Oriskany of New York than to the Helderberg, and these have been generally conceded to have this equivalence, but of the fauna of the lower beds, its composition and variations, we know only enough to see therein clues to the origin of the later fauna and invaluable lights on the derivation of all early Devonic faunas of the Atlantic and Mississippian provinces. Contrasted with the other beds in profusion of fossils and diversity of species, divisions 7 and 8 have been distinctively designated, Dr Ami having proposed to call these beds the Grande Grève limestones. To them Logan ascribed a thickness of about 800 feet, and in them is a fauna which differs from that of the Oriskany of eastern New York in as many respects as it agrees therewith and yet is bound to it by such striking paleontologic features as the coexistence of Rensselaeria, Megalanteris, Hipparionyx, Chonostrophia, Spirifer murchisoni, S. arenosus and many other organisms.

Over the Grande Grève limestones lie the Gaspé sandstones of Logan, shown in apparently conformable contact with the rocks below at Little Gaspé, and attaining an immense thickness. Sir William estimated them at over 7000 feet and subdivided them largely on lithologic characters, as they vary from drab ferruginous, fine grained quartz and feldspar sandstone to coarse conglomerates and red sandstones, the latter being mostly toward the top. From the lower beds Dawson described many interesting plant remains all presenting the aspect of such sedimentation as characterizes both in New York and Europe the deposits of the Devonic or Old Red lakes or lagoons. The lower beds about Gaspé basin contain a fairly rich marine fauna which has been partly described by Billings and to which we have been able to add evidences of both early and middle Devonic age.

View looking east from the Murailles. Bonaventure Island in the distance, Percé rock and Mt Joli in middle, one of the peaks of the Murailles in the foreground

In the region about Percé the presence of limestones corresponding to those at Gaspé "on the horizon of the Lower Helderberg and Oriskany" [*Geol. Can.* 1863. p.439] was noted by Logan in connection with his rapid but very lucid sketch of the geology of the coast section from Gaspé to the Bay of Chaleurs. Some lists of fossils were given, though these have only in part been verified by subsequent identification, Mr Billings having described a goodly number from the uppermost horizons represented in the Percé rock.



The vertical strata of Percé rock

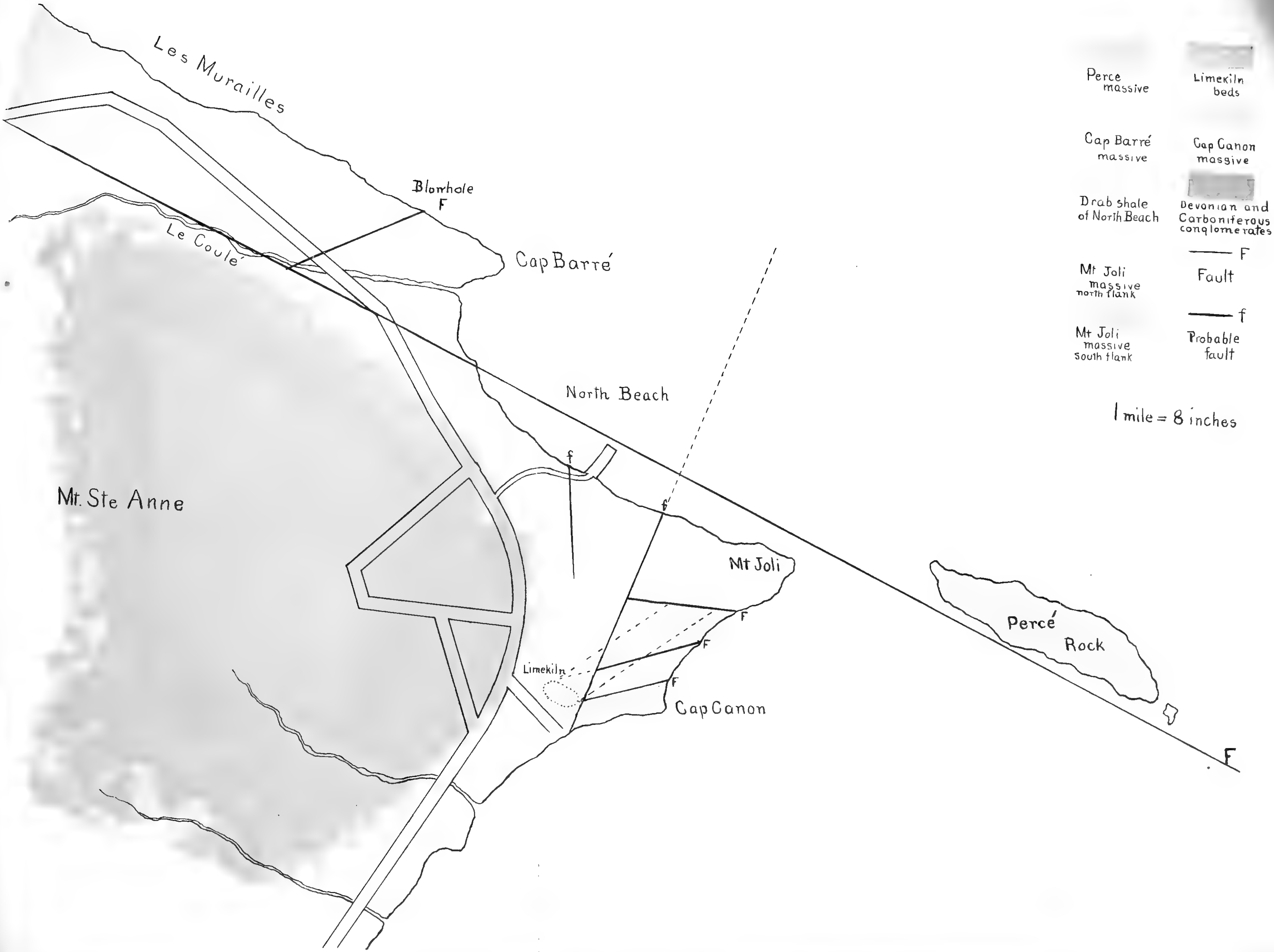
On analyzing the relations of the various limestones and shale masses exposed about Percé, based specially on the character of the fossils, we shall find in the massives now dissevered either by topography or displacement, the key to their geologic structure not in their apparent relations, their attitude one toward another, but here again, as ever, in the nature of their fossil contents, which in themselves afford the solution to the geologic enigma of the region.

Percé rock massive. The tinted strata of Percé rock, standing almost erect, or according to Logan, overhanging the perpendicular

10° northwardly, are the home of a great profusion of fossils many of which are common to the upper or Grande Grève limestones of Cape Gaspé.

As to the essential concurrence of these faunas in a broad sense there can be no question but the careful comparison of them leaves room for doubt whether the actual horizon of the Percé rock is represented in the series at Grande Grève. Inasmuch as the rock succession of Cape Gaspé is constant as far as it extends there is room for the provisional suggestion that the horizon of the Percé rock with the precise expression of its fauna is there modified, but indicates an early stage of the Grande Grève limestones. Percé rock is not divisible faunally and its strata show no persistent differences. They are indifferently yellow and red according to degree of oxidation, and the process of color change, irrespective of sedimentation lines or structural features, is everywhere finely marked. They are highly veined with calcite seams, and the yellows seem, if anything, to predominate on the south, the reds on the north. Mr Ells speaks of their containing interleaved conglomerates but of such we have seen nothing. We may not at this time give a statement of exact or final determinations of its species, but the following suffices to indicate the character of the fauna. To these we shall hope to return in future with the detailed comparisons needful to ascertain the organic and time relations of this fauna to those of the New York series. Such species as are here indicated with unfamiliar names will be fully defined and illustrated hereafter.

Aulopora *sp.*
Lingula rectilatera *Hall.* As in the Helderberg of New York
L. spathata *Hall.* In the New York Helderberg
L. elliptica *nov.*
Orbiculoidea *nov. cf.* grandis *Hall.* New York Oriskany
Pholidops terminalis *Hall.* Also in New York Oriskany
Crania grandegrevensis *nov.*
Leptaena rhomboidalis *Wilckens.* New York Oriskany
Brachyprion majus *Clarke.* Oriskany
Stropheodonta lincklaeni *Hall.* Oriskany
Leptostrophia magnifica *Hall.* As in the Oriskany of New York



GEOLOGICAL MAP OF PERCÉ AND VICINITY

L. irene *Billings*

L. tullia *Billings*

Chonetes antiopia *Billings*

C. canadensis *Billings.* Profusely abundant, much more so than at Grande Grève

C. hudsonicus *Clarke.* New York Oriskany

Chonostrophia complanata *Hall*

Cyrtina affinis *Billings*

Spirifer murchisoni *Castelnau.* This widely distributed Oriskany species is less abundant here than at Grande Grève

S. arenosus *Con.* As S. superbus Billings profusely abundant

S. dolbeli *nov.*

Meristella lata *Hall var.* complector *nov.*

Megalanteris plicata *Hall*

Beachia amplexa *nov.*

Rensselaeria ovoides *Eaton var.* gaspensis *nov. cf.* Oriskany

Leptocoelia flabellites *Conrad.* In enormous masses constituting one of the most abundant of all the fossils. World-wide at this horizon

Actinopteria *cf.* communis *Hall.* In the Helderberg and Oriskany of New York

Megambonia nitidula *nov.* A small form of the type of M. crenistriata (Oriskany)

Trochonema canale *nov.*

Diaphorostoma perceense *nov.* of the type of D. ventricosum (Oriskany) and D. affine (Grande Grève)

Platyceras tortuosum *Hall.* Oriskany species in New York

P. argynus *nov.*

Tentaculites elongatus *Hall.* Also in the Oriskany

T. perceensis *nov.*

Dalmanites (Probolium) perceensis *nov.* This is a really remarkable species both in structure and size. Outside of the Helderberg fauna of New York, it is the only American trilobite having the long and forked cephalic snout characterizing the subgenus Probolium (D. nasutus, D. tridens) but instead of having the pygidium of those species, which is believed to be marked with a long terminal spine and irregularly pustulose surface, its caudal plate approaches more nearly that of D. micrurus of the same fauna. Fragments of this species are very abundant and some indicate a size greater than that attained by any known species of the genus and indeed by any known trilobite except the colossal Uralichas ribeiroi from the Silurian of Portugal. Restorations from these fragments show that D. perceensis attained a length of 25 inches. It is the only species of the genus present in the fauna.

Phacops logani *Hall.* A Helderberg and Oriskany species in New York

To indicate our present knowledge of the distribution of this fauna, its relation to that of the Grande Grève limestones and the composition of the latter I subjoin the following tabulation to which have also been added the species of the marine fauna of the Gaspé sandstones as developed about Gaspé Basin.

List of Gaspé Devonic fossils

	GRANDE GRÈVE LIMESTONES All localities on north shore of Gaspé bay from Little Gaspé (contact with Gaspé sandstone) to Shiphead	PERCÉ ROCK	GASPÉ SANDSTONE
Glossina acer *nov*	×	....	....
Lingula elliptica *nov*	×	×	....
L. spathata *Hall*	....	×	....
L. rectilatera *Hall*	....	×	....
Orbiculoidea *cf.* grandis *Hall*	×	×	....
O. *sp*	×	....	....
Pholidops terminalis *Hall*	×	×	....
P. *cf.* ovata *Hall*	×	....	....
Crania pulchella *Hall & Clarke*	×	....	....
C. grandegrevensis *nov*	×	×	....
Dalmanella lucia *Billings*	×	....	....
Rhipidomella lehuquetiana *nov*	×	....	....
R. logani *nov*	×	....	....
R. musculosa *Hall*	×	....	....
R. *sp.*	×	....	....
Schizophoria amii *nov*	×	....	....

Photo by L'Esperance

Percé village and rock from the summit of Mt Ste Anne. The headlands of Mt Joli and Cap Canon in the middle distance and the Bonaventure conglomerate of Ste Anne in the foreground

List of Gaspé Devonic fossils (*continued*)

	GRANDE GRÈVE LIMESTONES All localities on north shore of Gaspé bay from Little Gaspé (contact with Gaspé sandstone) to Shiphead	PERCÉ ROCK	GASPÉ SANDSTONE
Hipparionyx proximus *Vanuxem*......	×	....	....
Orthothetes woolworthanus *Hall mut.* gaspensis	×	....	....
O. becraftensis *Clarke*..........	×	....	....
Leptaena rhomboidalis *Wilckens*......	×	×	....
Stropheodonta parva *Hall mut.* avita *nov.*	×	....	....
S. crebristriata *Hall mut.* simplex *nov.*	×	....	....
S. patersoni *Hall mut.* praecedens *nov.*	×	....	....
S. galatea *Billings*..........	×	....	....
S. hunti *nov*..........	×	....	....
S. lincklaeni *Hall*..........	×	×	....
S. magniventer *Hall*..........	×	....	....
Brachyprion majus *Clarke*..........	×	×	....
Leptostrophia magnifica *Hall*..........	×	×	....
L. blainvillii *Billings*..........	....	....	×
L. irene *Billings*..........	×	×	....
L. oriskania *Clarke*..........	×	....	....
L. tullia *Billings*..........	....	×	....
Strophonella continens *nov*..........	×	....	....
equiplicata *nov*..........	×	....	....
senilis *nov*..........	×	....	....
equalis *nov*..........	×	....	....
ampla *Hall*..........	×	....	....
Chonetes canadensis *Billings*..........	×	×	....
C. melonicus *Billings*..........	×	....	....
C. antiopia *Billings*..........	×	×	....
C. hudsonicus *Clarke*..........	×	×	....
mut. gaspensis *nov*..........	....	....	×
C. billingsi *nov*..........	×	....	×
C. *sp.*	×	....	....
Chonostrophia complanata *Hall*..........	×	×	×
C. dawsoni *Billings*..........	....	....	×
Anoplia nucleata *Hall*..........	×	....	....
Spirifer arenosus *Conrad*..........	×	×	....
S. murchisoni *Castelnau*..........	×	×	....
S. gaspensis *Billings*..........	....	×?	×
S. dolbeli *nov*..........	×	×	....
S. modestus *var.* nitidulus *nov*..........	×	....	....
S. fimbriatus *Conrad*..........	×	....	....
S. ? hera *nov*..........	....	....	×
S. *sp.*	×	....	....
Cyrtina rostrata *Hall*..........	×	....	....
C. affinis *Billings*..........	×	×	....
Meristella lata *Hall var.* complector *nov.*	×	×	....
M. acerra *nov*..........	×	....	....

List of Gaspé Devonic fossils (*continued*)

	GRANDE GRÈVE LIMESTONES All localities on north shore of Gaspé bay from Little Gaspé (contact with Gaspé sandstone) to Shiphead	PERCÉ ROCK	GASPÉ SANDSTONE
Rhynchospira	×	....	....
Coelospira concava *Hall*	×	....	....
Nucleospira *cf.* ventricosa *Hall*	×	....	....
Camarotoechia dryope *Billings*	×	....	....
C. excellens *Billings*	×	....	....
C. ramsayi *Hall*	×	....	....
Plethorhyncha barrandei *Hall*	×	....	....
P. pleiopleura *Conrad*	×	....	....
Uncinulus mutabilis *Hall*	×	....	....
Eatonia peculiaris *Conrad*	×	....	....
Beachia amplexa *nov*	×	×	....
Megalanteris plicata *nov*	×	×	....
Rensselaeria ovoides *Eaton var.* gaspensis *nov*	×	×	×
R. *sp*	×	....	....
Cryptonella ? capsa *nov*	×	....	....
C. ? fausta *Clarke*	×	....	....
Leptocoelia flabellites *Conrad*	×	×	×
Centronella glansfagea *Hall*	×	....	....
Aviculopecten perceus *nov*	....	×	....
A. ? incrassatus *nov*	×	....	....
Pterinopecten proteus *Clarke mut*	×	....	....
Actinopteria communis *Hall*	×	×?	....
A. textilis *Hall*	×?	....	....
Megambonia crenistriata *Clarke*	×	....	....
M. nitidula *nov*	....	×	....
Palaeopinna flabellum *Hall*	×	....	....
Modiella modiola *nov*	....	....	×
M. pygmaea *Conrad*	....	....	×
Goniophora mediocris *Billings*	×	....	....
Leptodomus canadensis *Billings*	×	....	....
Modiomorpha gaspesia *nov*	×	....	....
Mytilarca nitida *Billings*	×	....	....
M. canadensis *Billings*	×	....	....
Cypricardinia distincta *Billings*	×	....	....
Phthonia cylindrica *Hall*	....	....	×
Nuculites gaspensis *nov*	....	....	×
Conocardium cuneus *Conrad*	×	....	....
Schizodus ventricosus *Billings*	×	....	....
Bellerophon plenus *Billings*	×	....	....
B. gaspensis *nov*	×	....	....
Tropidodiscus wakehami *nov*	....	....	×
T. pelicea *nov*	....	....	×
Pleurotomaria delia *Billings*	×	....	....
P. voltumna *Billings*	×	....	....
P. lydia *Billings*	×	....	....
P. ? rotula *nov*	×	....	....
Trochonema canale *nov*	....	×	....
Loxonema ? hebe *Billings*	×	....	....

List of Gaspé Devonic fossils (*concluded*)

	GRANDE GRÈVE LIMESTONES All localities on north shore of Gaspé bay from Little Gaspé (contact with Gaspé sandstone) to Shiphead	PERCÉ ROCK	GASPÉ SANDSTONE
Euphemus ? quebecensis *nov*	....	....	×
Holopea gaspesia *nov*	....	....	×
H. depressa *nov*	×	....	....
H. *cf.* antiqua *Hall*	×	....	....
Diaphorostoma affine *Billings*	×	....	....
D. desmatum *Clarke*	×	....	....
D. perceense *nov*	....	×	....
D. *sp*	×	....	....
Strophostylus expansus *Hall var*	×	....	....
Platyceras gaspense *nov*	....	....	×
P. argynus *nov*	×	×	....
P. eucerus *nov*	×	....	....
P. laciniatum *nov*	....	....	×
P. tortuosum *Hall*	×	×	....
P. conulus *nov*	×	....	....
P. paxillatum *nov*	×	....	....
P. *cf.* nodosum *Conrad*	×	....	....
P. *cf.* fornicatum *Hall*	×	....	....
P. *sp.*	×	×	....
Hyolithus oxys *nov*	×	....	....
H. encentris *nov*	×	....	....
H. *cf.* aclis *Hall*	....	....	×
Conularia lata *Hall mut*	×	....	....
C. desiderata *Hall*	×	....	....
Orthoceras *sp*	×	....	....
Cyrtoceras *sp*	×	....	....
Kionoceras rhysum *nov*	×	....	....
Dalmanites micrurus *Green*	×	....	....
D. phacoptychoides *nov*	×	....	....
D. pyrene *nov*	×	....	....
D. vatinius *nov*	×	....	....
D. goniaea *nov*	×?	....	....
D. foederatus *nov*	×	....	....
D. (Probolium) perceensis *nov*	....	×	....
Phacops bombifrons *Hall*	×	....	....
P. logani *Hall*	....	×	....
P. correlator *Clarke*	....	....	×
Proetus phocion *Billings*	×	....	....
Cordania	×	....	....
Ceratocephala gaspesia *nov*	×	....	....
Lichas (Terataspis) grandegrevensis *nov*	×	....	....
Tentaculites elongatus *Hall*	×	×	....
T. cartieri *nov*	....	....	×
T. perceensis *nov*	....	×	....
Spirorbis latissimus *nov*	×	....	....

It will be seen from the foregoing that the Percé fauna is more sparse than that of Grande Grève and that some of the species extremely abundant there, e. g. Eatonia peculiaris, Hipparionyx proximus are absent here, while here Chonetes canadensis, Leptocoelia flabellites are profusely developed. Again striking species in each fauna are absent in the other, while there remains a number of most characteristic species common: Rensselaeria ovoides var., Megalanteris plicata, Beachia, Spirifer arenosus, S. murchisoni, etc.

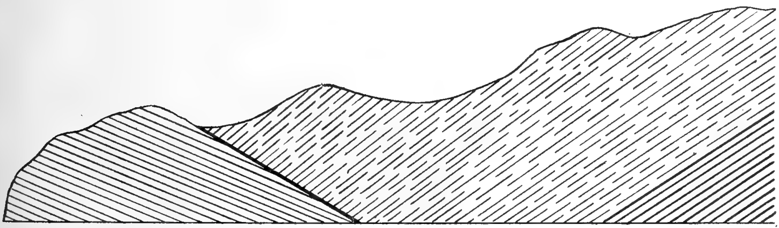
The ragged sky line of the Murailles

There is thus a difference in the relation of the elements of the faunas to each other and also to those of New York. Hence there may be in these faunal characters a reason for regarding these limestones as the expression of a distinct substage in the deposition period of the Grande Grève beds.

On the Murailles or the high rock wall above the North cove we find Percé strata again. Rounding Cap Barré where the dip of the gray limestones and shales is to the north, beyond the first point to

On the slope of the Murailles. The Percé rock strata in the cliff

the Blowhole, a sea cavern gnawed out by the waves, the tinted Percé strata again appear, but here lying at a steep angle, 20° to 40° to the southeast and abutting palpably against the thrust plane of a fault which is well marked in the face of the cliff, sloping obliquely downward and to the north. The line of displacement is well enforced by the contrast in color between the downthrown yellow and red strata and the more somber grays of the Cap Barré massive. Logan noted the fact that these downthrown strata were of equivalent age and probably a part of the Percé rock, and Ells cites the occur-



Section at Blowhole. Cap Barré beds at left, downthrown Percé beds at right

rence in the rocks at the Blowhole of the fossils Spirifer arenosus and S. cyclopterus (probably S. murchisoni); we have also found

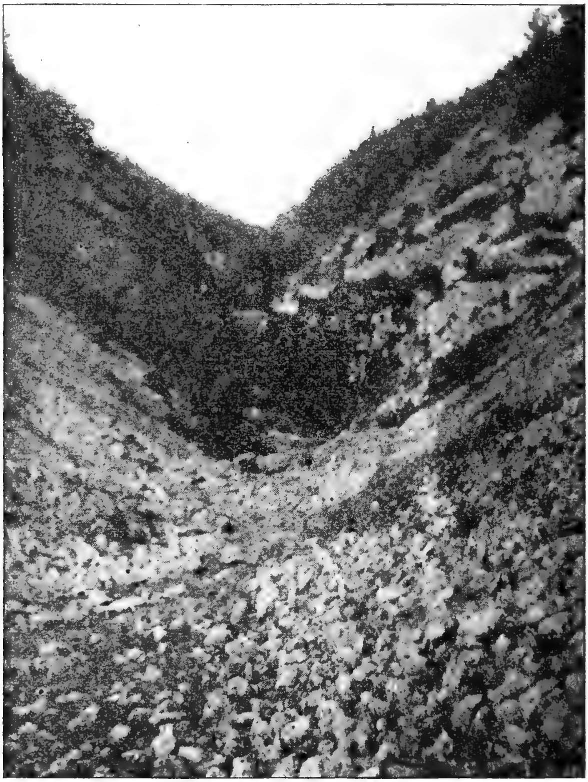
Dalmanites perceensis	Leptocoelia flabellites
Phacops logani	Leptostrophia irene
Acidaspis *sp.*	Chonetes hudsonicus
Megalanteris plicata	Spirifer arenosus
Chonetes canadensis	S. murchisoni

and a few others, but the specimens are not very well preserved nor are they in any wise so abundant as at Percé rock.

These Percé beds about the Blowhole are probably again downthrown in themselves in their further extension along the Murailles but without essential change of dip, for this same southward dip is well expressed in the angle of the landward slope of the cliff and is apparent as far as Le Coulé on Barré brook where Percé fossils were also found. The latter seem to be the summit beds of the limestones and from them the following species were obtained.

Spirifer arenosus	Megalanteris plicata
S. murchisoni	Leptostrophia irene
Chonetes canadensis	Coelospira
C. hudsonicus	

The beds are gray and nodular with redder strata. The outcrop is in the strike and the beds apparently rise uniformly into the Murailles. A displacement is evident along the bed of the brook but its amount was not estimated. Red peak, which is the highest and easternmost of the Murailles, is said by Logan to



Le Coulé. Nodular limestones and limestone conglomerate

be capped by horizontal beds of "the conglomerate" which I take to mean the conglomerate of Mt Ste Anne (Bonaventure) but I was not able to verify the observation, the beds here being apparently conformable in dip to those below. The displacement of the tinted Percé strata (the term Percé is here used as indicative of the horizon of the Percé rock) against the Cap Barré beds is evident on the south road leading up the mountain side to the Grand Coupe, as well as in Le Coulé as just stated. In the great sea front of Red peak, the high face rising 660 feet over the water is believed to bring up the lower gray limestones in conformity and, though these beds are difficult of access and have not been properly studied, it is likely that here are the strata which fill the broken interval between the Percé beds and those beneath, the rocks of Cap Barré and perhaps also in part those of Cap Blanc.

As a whole, we may say of the Percé beds that though they are now but remnants left by recent rapid and profound changes in topography, due to the tremendous destructive energy of the sea, and their surfaces, both on the Percé rock and in the Murailles, are the slopes of lost mountains, yet they have been subjected to disturbances in themselves much greater and much more ancient, witnessed by their difference in inclination and their tremendous displacements. These displacements we shall endeavor to portray more particularly in summing up the evidence relating to the geologic structure of the region.

There is little evidence yet on which to base any kind of subdivision of the Percé rock mass, either from its fossils or its rocks. The yellow beds seem to bear in greater abundance the prolific species Chonetes canadensis, Leptostrophia irene, Chonostrophia etc., and the red layers the trilobite remains, Spirifer arenosus, S. murchisoni, etc., but this occurrence is open to constant exception.[1]

Cap Barré beds. In first considering the limestones of Percé rock we have started with the latest of the limestone deposits. In close if not immediate succession beneath them seem to follow the gray schists exposed only at Cap Barré, the southernmost and lowest point of the Murailles.

These beds consist of thin, sandy, blue gray limestones with intercalated shale, the rock becoming reddish at the top beneath the soil cap. They dip northeast 30° to 40°, which is an angle not repro-

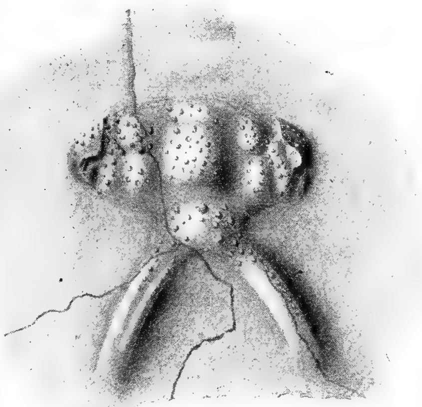
[1]Most of the fossils from the Percé rock described by Billings were evidently picked up loose at the foot of Mt Joli whither they are washed in great quantity from the rock itself. Hence Billings, not personally acquainted with the situation, frequently cites Mt Joli as a locality of these fossils which is misleading for the Joli mass is of very different age.

duced in any of the strata elsewhere exposed, and their attitude toward the Percé strata farther north has just been expounded, from which we may infer that these rocks are normally subjacent to the latter and have been separated therefrom by the downthrow of the superjacent mass. These Cap Barré beds, so far as exposed, may attain a thickness of 75 to 100 feet. Their relations with the strata at Mt Joli are determinable from no structural relation exhibited, for they are separated from the latter by the long interval of the

Cap Barré from North cove

North cove. These beds contain fossils, but very sparsely. I have found a few Lingulas and an Ambocoelia-like brachiopod probably allied to Spirifer modestus Hall, which is a Helderberg species, also a small corrugated Leptostrophia like L. oriskania Clarke, but the age and position of the strata are decisively indicated by the presence of a species of the trilobite *Dicranurus*.

This fossil is of more than ordinary interest. The genus Dicranurus has been described heretofore only from two geologic formations, the Helderberg (New Scotland beds and Coeymans limestone) of eastern New York (D. hamatus Conrad) and from the equivalent horizon Etage G, of Bohemia (D. monstrosus Barrande sp.). The species from Cap Barré (D. limenarcha) is represented only by an incomplete cephalon but it is rarely that any other part of the genus has been observed in any of its occurrences. It was a species larger than the New York form and perhaps even larger than the Bohemian. Its elongate, subconate middle lobe is well delimited by a deep nuchal furrow, the lateral lobes are separated by a shallow transverse or oblique groove, while the axial diameter of the occipital ring from the base of the



Dicranurus limenarcha

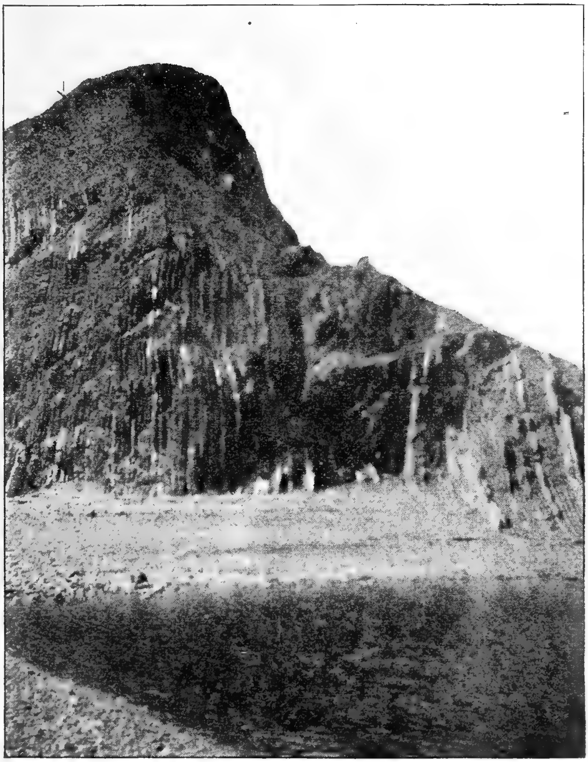
central lobe to the fork of the spine is relatively less than in D. hamatus. The free cheeks were attached to this specimen, but they have not been preserved except along the sutures. The great neck spines are highly divergent and very heavy. Barrande gave the angle of divergence in D. monstrosus as 60°, in D. hamatus it is 45°, in D. limenarcha it is 80°, measured from the central occipital tubercle as apex, axially for one third of the length of the spines. These spines are curved outward, downward and back, and probably made a deep recurvature as in the other species, though they are not preserved at the tips. On their proximal extent is a low median depression. The surface of the head is covered with acute pustules scattered sparsely with very much finer ones between. On the occipital ring the central pustule, which is more conspicuous than the rest as in other species, is punctuated at the top by a circle of depressions. The head had an original length to the point of recurvature of the neck spines of about 40mm, the greatest divergence of the spines is 29mm, the axial length to the angle of the spines, 23mm, of which 9mm belong to the occipital ring; width between the eyes, 25mm.

From no other evidence have we so satisfactory a basis for the conclusion that the Cap Barré beds follow close below the beds of Percé rock and above those of Mt Joli. We may therefore conclude that either these strata lie buried in the tide-swept interval between the Percé rock and the outermost vertical strata belonging to the Mt Joli massive, or that, originally in place here, they have been pinched out by faulting.

The space between these two massives not in the line of the connecting sand spit but rather in the line of vertical thickness of the strata, at right angles to their present position, is barely enough to admit the beds of Cap Barré. Doubtless they have been largely squeezed out in faulting and pitched over on their side where they now lie, though some part of them may remain in the interval, to be exposed by some favoring neap tide to the eye of the trained observer.

Shales of the North beach. Faintly exposed at spots in the bank along the North beach, in the dugway road to the wharf and at points from there toward Mt Joli are beds of soft shale usually gray, sometimes black, blue black and green black, lying under the reddish soil cap. These are slightly inclined away from the vertical and it is not in my present judgment at all certain that they are continuous with the Joli escarpment which we are about to consider. They have furnished no fossils and outside of them, beneath the water not far from the wharf, is a vertical reef in which cyathophylloid and favosite corals occur and these are doubtless the latest and uppermost beds of the Joli series. Soft drab shales similar to those on the North beach appear also in the roadway between the Cap Canon cliff and the escarpment at Lamb's limekiln, and I have inferred therefrom the presence of an infaulting through which this mass of shales has been displaced from its proper position.

Mt Joli massive. The erect strata of gray thin limestones and calcareous shales which constitute the low headland at Mt Joli begin not at the scarp itself, but at low water may be seen extending well out from the shore. Along the North beach these outlying strata form little reefs, but the intervals between them and the wall of the promontory is concealed by the beach. Taking the Mt Joli massive



East face of Mt Joli

as a whole, it has an approximate length along the sea front of 700 feet, the highest point being at the north, the upper slope declining southerly, ending rather abruptly, and the rock mass being separated from that of Cap Canon by an unexposed and probably entirely interrupted area of about 350 feet. There is little change in the lithologic composition of the strata composing Mt Joli, but there is definite evidence of displacement in the mass itself. For the greater part of the length of the sea wall the strata are essentially vertical with slight undulations; but at a distance of about 250 feet from the south end of the cliff the strata become much more irregular, maintaining their essentially vertical attitude but are folded and slightly displaced among themselves and faulted against the more erect strata of the main part of the mountain. The southern part of the mass is composed of strata similar to those of the northern but increasingly slaty in composition. In both parts of this Mt Joli massive fossils were found, but they are by no means of common occurrence; moreover they are wedged in the vertical strata so that their extraction is not easily accomplished. From their calcareous layers, which with the eroded interleaved shales form the outermost northern reach of the strata and are exposed only at low tide as reefs, were obtained a few fossils: Platyceras, large species of Helderberg type; Zaphrentis corticata Billings; Z. cingulosa Billings.

The shaly layers on the high vertical north face of the scarp have afforded species provisionally identified as follows:

1 Hindia *sp.*
2 Monograptus *cf.* clintonensis *Hall*
3 Duncanella *cf.* borealis *Nich.*
4 Streptelasma *cf.* caliculus *Hall*
5 Michelinia *cf.* lenticularis *Hall*
6 Dalmanella *cf.* perelegans *Hall*
7 Leptaena rhomboidalis *Wilckens*
8 Stropheodonta *cf.* varistriata *Conrad*
9 Spirifer *cf.* niagarensis *Conrad*
10 Spirifer modestus *Hall*?
11 Cypricardinia *aff.* sublamellosa *Hall*
12 Phacops *sp.*

Giving special attention to the trilobite in which lies the clearest indication of geologic age, we find it to be a fully developed Phacops such as nowhere occurs in the typical Siluric deposits of the Mississippian sea or Appalachian gulf. Its glabella is large, rotund and coarsely pustulose, the glabellar furrows obsolete, eyes large and the genal angles have minute spinules. The pygidium is broad, the axis having six to eight well defined rings, the first bearing a prominent tubercle, the pleurae having five to six ribs all grooved and separated by deep furrows. These structural points indicate an early period in the history of the genus, hence if Siluric, a final stage. The species is equivalent to Phacops logani of the Helderberg and Oriskany of New York, of the Percé rock and the Grande Grève limestones.

The Murailles and North cove, looking toward Malbay

The construction of this assemblage as a whole as indicative of a very late upper Siluric marine fauna is justified and we would therefore put together the entire mass of the strata 550 to 600 feet thick, as appertaining to this horizon, that is the series of limestones and shales extending from the reefs bordering the north flank of Mt Joli, southward almost to the first palpable shear zone.

In the layers of the south flank of the mountain which strike n. 30° w., are essentially vertical but with many undulations and irregular inclinations toward the north, and are thin, fairly pure limestone strata from 2 to 5 inches in thickness separated by sandy shale masses, fossils have been found:

Hindia (apparently identical with foregoing)
Subretepora
Dalmanella testudinaria *Dalman*
Rafinesquina *sp.*
Strophomena *sp.* strongly geniculate form (very common)
Parastrophia hemiplicata *Hall* small form
Zygospira *cf.* uphami *Winchell & Schuchert*
Ortonia *sp.*
Ampyx hastatus *Ruedemann*
Tretaspis reticulatus *Ruedemann* (very common)
Calymmene callicephala *Green*
Pterygometopus *cf.* intermedius *Walcott*
Ptychopyge ulrichi *Clarke* (common)
Illaenus americanus *Billings*

This very striking though small array of species is emphatically indicative of early Siluric age, we might say in a general sense equivalent to the Trenton, but can not escape the inference that it is early Trenton with suggestions of Pretrenton age. The trilobites are specially noteworthy, for Ampyx hastatus and Tretaspis reticulatus have been found before only in the lower Trenton conglomerate of Rysedorph hill near Albany and definitely indicate not the Trenton fauna normal to the Mississippian province of that time, but the invading fauna from the Atlantic province whose closer affiliations are with European species.

Two spots in the sea wall have afforded these fossils, one not far from the south end of the cliff where were taken

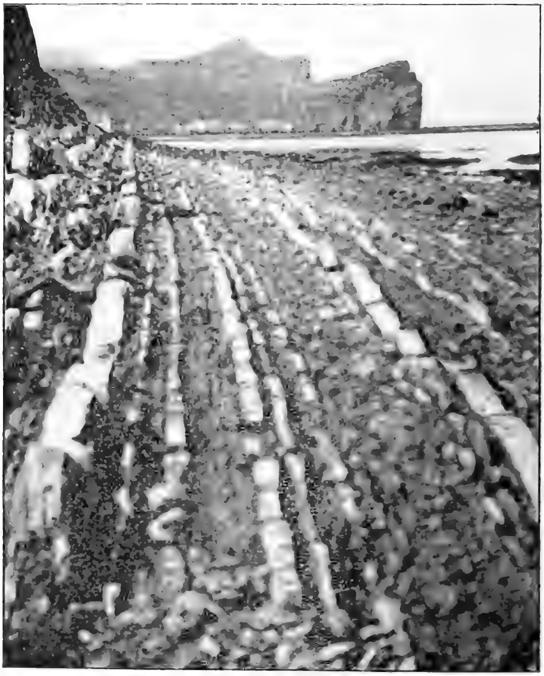
Calymmene callicephala
Dalmanella testudinaria
Rafinesquina
Parastrophia hemiplicata
Zygospira

These were from calcareous nodules embedded in the shales.

The other locality lies just north of the most apparent line of displacement where the strata have lost their contortions. Here were obtained

Tretaspis reticulatus
Ampyx hastatus
Ptychopyge ulrichi
Illaenus americanus
Pterygometopus *cf.* intermedius

It is not safe to infer great difference in age of these associations.

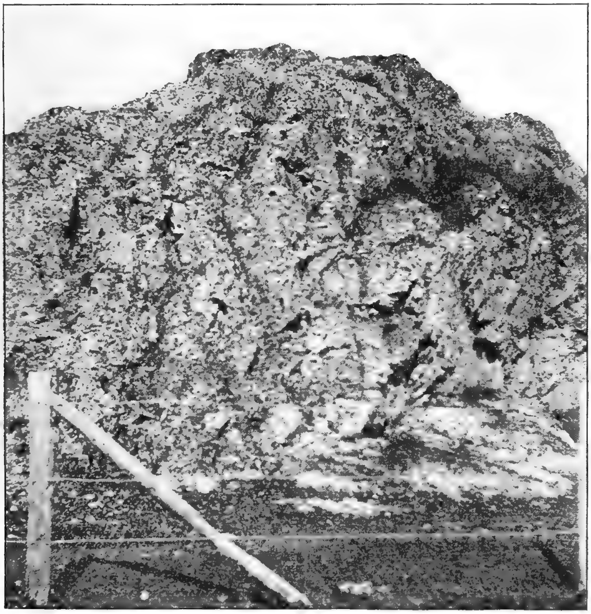


Vertical strata on north face of Mt Joli. The Murailles in the distance

Mt Joli then with its 700 feet of calcareous strata represents a long stretch of Siluric time, and it would appear that the apparent line of main faulting of the southern or lower against the northern or upper mass, marks the disappearance of some interval in the lower elements of the series as indicated. Such departure as there has been from the vertical position of the strata is in the direction of overthrow so that the lower lean up against the higher strata.

We shall presently note the paleontologic evidence indicating displacement in the vertical mass itself.

Cap Canon massive. Directly south or below the abrupt termination of Mt Joli is a beach interval where no rock exposure is seen for a length of 345 feet. The grass grown bank shows a red soil cap and in it here and there are blocks of red conglomerate, as though (and to such evidence we may return) deposition of the red conglomerates was over a rough bottom wherein this clay-banked beach was a deeply gullied line of disturbance. The rocks of Cap Canon are calcareous shales and black argillaceous slates, greatly



The Limekiln massive

disturbed internally by folds and undulations, thrusts of slight measure which have produced glistening shear faces, veined in all directions, richly jointed and cleaved, but in spite of these internal displacements the vertical attitude of the mass is still apparent with a slight general inclination toward the north.

This mass, irrespective of its undulations has a sea front 630 feet long and this is approximately a measure of its actual thickness. In lithologic character there is a marked difference between it and that of Joli, chiefly expressed in its slatiness. It has, after repeated search, revealed no fossils.

On the summit of Cap Canon is the summer home of Mr Frederick James. From this spot the well grassed rock surface slopes deeply landward, then abruptly rises at a distance of about 400 feet from the edge of the cliff and the strata stand upright again in a bare dome of rock at which is a now abandoned limekiln. The rock here was burned by Mr Philip Le Boutillier and from him I learn that the burning has been only partly successful but at times a purer limestone has been brought to the kiln from the outcrops at Cap Blanc, 2 miles south.

Limekiln massive. The rocks at the Limekiln are as a whole notably distinct in character from those constituting Cap Canon though they stand vertical and hold the attitude characterizing the rest of the strata.

These beds are limestones much seamed with calcite veinules and heavy bedded, largely a limestone conglomerate but with no jasper pebbles as in the limestone conglomerate of Mt Ste Anne to which reference will be made. They have a thickness of 200 feet. A single bed of a similar conglomerate was observed infolded in the schists of Cap Canon.

Just beneath these on the south slope are even bedded impure gray limestones and from these latter only have fossils been obtained. There is to my mind a reasonable security in regarding these fossil-bearing rocks here in place, though blocks have been found only in displaced condition. Concerning this point, however, I would not venture to be unqualified in my statement. These fossils are:

Plectambonites sericeus *Sow.* (very common)
Rafinesquina, a geniculated species
Leptaena rhomboidalis *Wilckens*
Protozyga exigua *Hall*
Ambonychia *sp.*
Ceraurus pleurexanthemus *Green*

Though few in number, the species abound in individuals and the assemblage clearly indicates a later stage of Lower Siluric than the fauna in the south flank of Mt Joli, somewhere equivalent to middle or upper Trenton age. The road in front of Mr James's house, as it rises from the depression between the escarpment and Cap Canon, shows trace of an infaulted mass of soft, brown shale elsewhere referred to as occurring on the North beach near the wharf. If we

SECTION ALONG THE COAST FROM ROBIN BEACH TO PERCÉ ROCK

have construed the fauna correctly, the place of the Limekiln rocks is between the south and north flanks of Joli or is a corresponding portion in the series. We may find no clear evidence of the necessary fault plane in that escarpment, but this cliff at the Limekiln is evidently cut off by faults both therefrom and from the Cap Canon mass.

Cap Blanc massive. From Cap Canon southward for a distance of 2 miles sweeps, first, the broad Robin fishing beach or South cove buttressed at the south by horizontal or slightly dipping beds of red sandstone and conglomerates rising into a constantly more elevated sea wall till Cap Blanc is reached. Here as one turns the point of the headland and rounds the light, vertical limestone strata are once more exposed and their contrast in color to the horizontal or slightly northeast dipping red strata which overlie them and abut against their slopes, gives name to the place. The sea wall is sheer and the foot of the cliff accessible with risk, even by water.

The vertical thickness of these rocks measuring from the point of the cape southward is estimated at 700 to 1000 feet. They are light gray in general effect and the succession of the strata is obscurely presented in the highway and field outcrops. With the slight inclination of the strata away from the vertical toward the north as seen in the Mt Joli massive, we first find in t e highway cut ascending the cliff from the north a red limestone, suggesting in tint the Percé rock and carrying

Halysites catenulatus *Linné*
Heliolites or Lyellia
Ortonia
Anodontopsis
Trochonema
Bellerophon
Lichas (fragment)
Trematopora (very slender branches)
Callopora
Small Whitfieldella-like brachiopods

but principally and oftenest a large and heavy shelled pelecypod having a broad cardinal plate extending inward from the hinge line, not attached to the bottom of the valves nor thickened at its junction therewith. This rock is of such character that it breaks in almost any direction except along the surface of these fossils but one example of this species has the valves together and this, sectioned vertically shows these projecting plates not in apposition as though connected with the articulation of the valves, but standing apart with a well defined space between, indicating that they are a broad chondrophore. Further material will be necessary to elucidate the nature of this shell.

It is clear however, from the list given, even though generic determinations only seem safe at present, that this congeries represents a stage of late Siluric, clearly older than the fauna of the Percé rock, probably older than the beds of Cap Barré, but not necessarily older than the north flank of the Mt Joli massive. These beds, the highest in the series, lie lowest as the entire mass is slightly overturned. Working southward over the remaining exposures in exceedingly rainy and cheerless weather, it is probable that we have overlooked much that will throw light on the relations of the series.

Beyond the light, seaward of the road, on the edges of the escarpment in the field whence the purer layers of limestone have been removed for burning, and which appertain to the lower and southernmost part of the series here represented, after careful search fossils were found, not in the blue and more abundant limestone, but in thin clinking limestone plates.

The mode of preservation here is singularly favorable were the material sufficiently abundant, the fossils being weathered out on the surfaces of the plates and doubtless the fauna will prove an interesting and instructive one under more favorable opportunities for exploration. These slabs have afforded:

Spicules of hexactinellid sponges	Whitfieldella *cf.* bisulcata
Platyostoma	Orthothetes (small)

Many crinoid stems and an occasional crushed head with ornamented plates resembling Glyptocrinus.

Calymmene (small species)	Phacops of P. logani type
Bumastus (small species)	Phacops *sp.*

Taking up for more minute consideration the trilobites, the time values of whose structure is best understood, we may note

1 The common species of Phacops is fully developed, with glabellar lobes fused by almost entire disappearance of the furrows, eyes rather small, cheeks rounded with the faintest trace, if any, of the genal spinules indicating early age, and the doublure of the cephalon

crenulated to a degree shown only in pronounced development in this genus.

The pygidium is short and stout with a short blunt axis bearing four defined rings but eight axial sulci can be counted. Of the pleural ribs but two can be counted and these are flat and sulcate.

This completely developed Phacops is in itself indication of either Devonic age or a very late stage of Siluric. In the Mississippian Siluric no such form presenting fully matured cephalic features is known. The species, however, shows in the sulcate pygidial ribs index of early phylogenetic stage. It can not be identified with the Helderbergian and Oriskany P. logani which is found in the Percé rock and at Joli, but approaches thereto.

2 The second species of Phacops is known only from its cephalon which is of a singular and unusual type. In this the first furrows of the glabella are faint without entering the dorsal furrows and are like a pair of eyebrows, defining obscure round lobes, behind which the second lobes are also round and better defined, while the third lobes are obscure. The eyes are small and with few lenses, the cheeks broad, flat and dalmanitiform, running out into short flat spines at the angles.

The aspect of the species is that of immaturity with reference to the development of the genus Phacops and presents the combination with features pertaining to Dalmanites which is indicial of the passage forms from the latter to the former. The aspect of this cranidium is shown in some early Devonic forms such as P. (D.) tumilobus Clarke from the Amazonas but without association with cheeks of notable Dalmanites type.

One of these forms of Phacops indicating late age is counterbalanced by the somewhat earlier expression of the other and this combination is verified by the presence of Bumastus and Calymmene.

We must call the horizon late Siluric but are disposed to make it so late as to be an almost final stage in the passage from the lower limestones into those of the Percé massive or lowest lower Devonic.

The Cap Blanc limestones appear then from the evidence before us to be a downthrown mass representing a part of the series shown more continuously in the sea wall at Percé, and indeed such part as is either not there clearly presented or is presented here with some change of faunal association. It is not, in our view, a section of the series there lost by faulting out, but the expression of the later Siluric beds there, with a variant geographic association of species.

Relations of limestone masses about Percé. We have estimated roughly the thickness of the masses here discussed as follows:

Percé beds, 250 feet at Percé rock but probably rising in red peak to	400 feet
Lost interval between Percé rock and Mt Joli (Cap Barré beds)	100-200 feet
Mt Joli massive	700 feet
Cap Canon massive	630 feet
Limekiln massive	200 feet
	2030-2130 feet

Thus there is a development of approximately 2000 feet of limestones representing the geologic series from early Siluric (Black River-Trenton) to well into the early Devonic or Oriskany. The Cap Blanc massive with a thickness of 700 to 1000 feet is not in our judgment an addition to, but a repetition of a part of the series. The rocks on the Murailles are likewise regarded as not adding to, but repeating the series in part, with the exception of the Cap Barré beds which are partially provided for in the rock interval between Mt Joli and the Percé rock. In order of succession from the top downward, we should, from present evidence arrange the masses thus:

Percé beds
Cap Barré beds
Mt Joli (north flank)
(?) Limekiln beds
Mt Joli (south flank)
Cap Canon

Some doubt will attach to the proper position of the strata of the Limekiln for the reasons already stated.

With the foregoing succession we deduce a profound displacement between the Percé rock and the north face of Mt Joli by which the beds of Cap Barré for a thickness of 100 or more feet were squeezed out, and their remnant overturned to their present place and attitude, a quarter mile away, and their dip reversed.

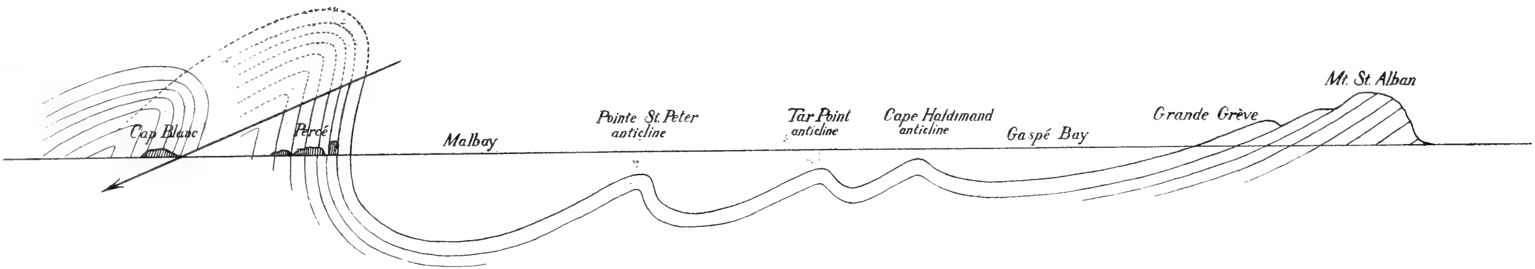
Looking south from Mt Joli, Cap Canon in left foreground, Mt Ste Anne at the right

On the face of Mt Joli among the vertical strata we believe it probable that a displacement has taken place by a downthrow which has squeezed out the rocks represented by the fauna found in the beds at the Limekiln. This is inferred wholly from the nature of the fossils of the latter. Their place is here in the succession of the faunas, but should subsequent developments tend to show that the fossils there found were derived from another source, either from the rocks of Cap Blanc or the limestones northward toward the Barachois, we need not open the cliff to admit this mass. On the other hand, were such the evidence, it would seem to be the remnant infaulted by a displacement whose zone rests where now is the short beach between Joli and Cap Canon.

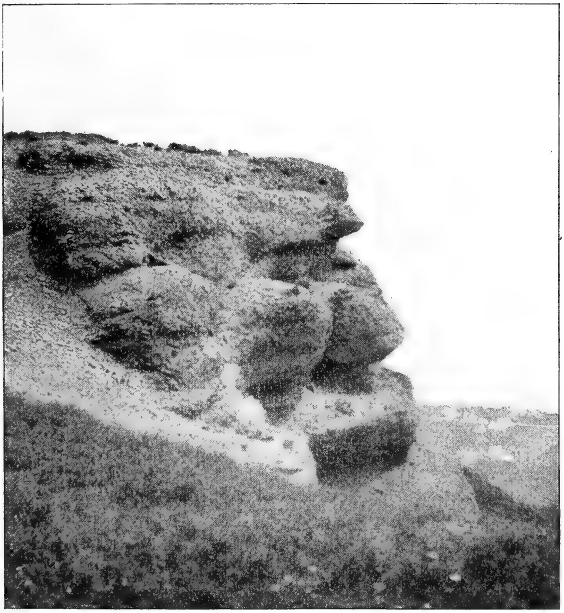
The displacement we have already noted in the south flank of Mt Joli and shown in the rock wall is within the succession of lower Siluric faunas, these fossils occurring on both sides, and we hence infer it not to have been of great depth.

On the Murailles we find the clearly defined line of displacement along which the Percé beds have slipped down over the Barré beds inverting their dip, and this entire mass of Barré and Percé beds was evidently cut off by the longer line of faulting from the Percé rock. These lines of probable displacement of the limestone masses we have expressed on the map adjoining.

Surface conditions preceding deposition of red sandstone and conglomerates. Strip off the mantle of red, almost horizontal conglomerate through which the limestone cliffs project their heads and the country would present an irregular series of jagged limestone bluffs, the remnants of broken and eroded folds, which the tooth of subaerial weathering, of stream erosion and the endless gnawing of the ocean, left standing. The vertical position of most of those once horizontal rocks is in itself an indication of the immense proportions attained by the primary folding of the strata. The presence of an anticline at Percé was recognized by Logan, and without venturing to go so far afield as to connect the structures here with those beyond the scope of this sketch, it may be said that the simplest explanation of the relation of the Percé limestones with the series as exhibited from Little Gaspé to Shiphead is a great syncline beneath the sea, of



Restoration of the syncline in Devonic and Siluric limestones along coast line from Percé at the south to Grande Grève at the north and showing the downthrow at Cap Blanc; also the anticlines riding on this depression and more clearly expressed farther inland which the Grande Grève limestones lie on the northern more gradually sloping arm and the Percé rock on the southern erect arm. With this reconstruction, the massive of Cap Blanc represents the faulted downthrown crest of the Percé fold, while lesser anticlines indicated by the government geologists as those of Pointe St Peter, Tar point, Cape Haldimand, developed further back from the coast, ride on the surface of this synclinorium.



Bonaventure conglomerate at summit of Mt Ste Anne

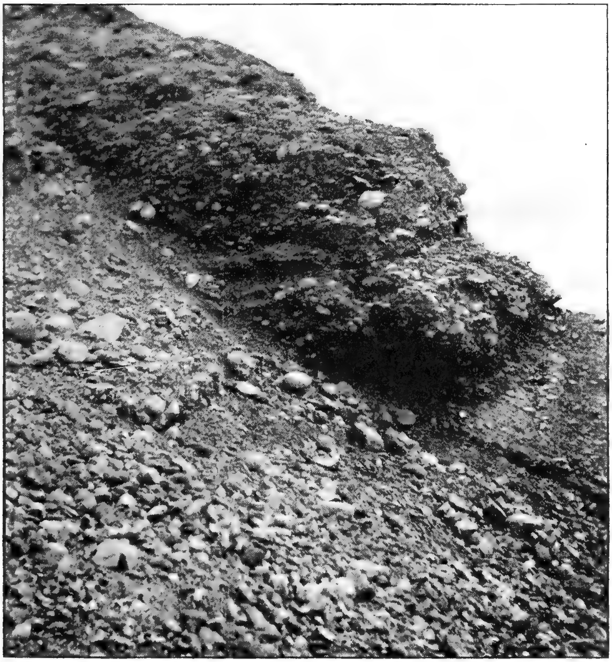
Immense time was necessary for the destruction of these old folds before the ragged country was carried down beneath the water level for the deposition of the red conglomerates and sandstones.

Red sandstones, conglomerates and limestones

The country is so completely sheeted with these horizontal deposits that they may be studied at numerous places away from the limestone cliffs, but nowhere in their continuity so well as along the slopes of Mt Ste Anne. Let us however, first take note of the opinions which have been expressed by Logan and Ells concerning these deposits. We have remarked that while almost horizontal, there is a definite dip in the strata to the northeast which is conspicuously displayed in the precipitous eastern face of Mt Ste Anne, and in the western wall of the distant Bonaventure island, 3 miles out to sea. From Bonaventure island, which is wholly composed of these strata, Logan derived the term Bonaventure which he originally applied to the entire series of these rocks, chiefly conglomerates, and these he regarded as of Carbonic age. Ells, approaching the region from a study of the conglomerates of the Bay of Chaleurs interstratified in which have been found Devonic fossils (chiefly fishes of Old Red sandstone type) recognizes differences in the conglomerate mass and assigns to the Bonaventure the upper beds of Mt Ste Anne and all those covering Bonaventure island with which they were continuous, believes an unconformity to exist between the upper and lower conglomerates of Mt Ste Anne and assigns the latter including the sandstones and interbedded limestones, to the Upper Devonic age. Of such interruptions of deposition in the conglomerates we could find no evidence in the Percé region but if we interpret these interesting sediments aright, it is quite in accordance with the judgment we have been able to form, that they do actually represent a period of time partly Devonic but transcending that era into the next succeeding. We may note the character of these strata in some detail, beginning at the lowest accessible exposures.

Shore between Robin beach and Cap Blanc. Near the mouth of Lenfesty's brook we find in the shore wall an exposure about 25 feet in hight, at the base of which are red shales overlain by red and white sandstones and conglomerates, then red shales followed by conglomerates and above these are gray hydraulic limestones. The conglomerates are variable in lateral extent, passing into sandstones but reappearing in great force to the south, the limestones disappearing. The pebbles of the conglomerate are at this horizon, largely of jasper and with a very small percentage of limestone of the character of the higher beds. On Bonaventure island the conglomerates also contain much jasper but the limestone pebbles predominate.

Mt Ste Anne. The sandstones and limestones of the lower beds are also seen in climbing Mt Ste Anne and in the vicinity of Irishtown. All the higher beds of Mt Ste Anne are composed of limestone conglomerates with very little jasper and as the cement is calcareous it falls away freely. It was noted by Ells that these pebbles and boulders of the conglomerate contain Siluric fossils. We have found in them Chonetes canadensis, Spirifer murchisoni, Megalanteris plicata, Meristella arcuata and Dalmanites perceensis, all fossils of the



Limestone conglomerate, Mt Ste Anne

Percé rock; also Halysites catenularia, Heliolites, and in some sandstone pebbles a small Spirifer like S. vanuxemi. These fossil-bearing pebbles were found to the summit of the mountain even in the platform on which rests the shrine of Ste Anne. As this point is nearly 1400 feet above tide, the thickness of these red beds can not be less than 1200 feet and down along the shore land it seems to fill or to have stained all the depressions between the scarps of vertical limestone so that even on the shore when the soil is opened, blocks of the conglomerate are set free.

General remarks on the conglomerates

One is struck with the absence in the Percé region of the great thickness of the rusty brown Gaspé sandstones which at Little Gaspé rest conformably on the limestones and at Gaspé Basin carry marine fossils. Doubtless we are to find the contemporary of these deposits in the red and white sandstones of Percé, but they are only feebly developed and to them as an equivalent of the work elsewhere done, we must add some part of the conglomerate series. We follow ideas before expressed in regard to the tremendous deposits of the Gaspé sandstone, as sediments laid down first along an embayed coast and eventually in a deep coastal estuary which received heavy drainage from an elevated and rapidly decaying land surface. That estuary may have extended far to the southeast and at times it appears to have been shut off from the ocean entirely by the upbuilding of bars across its mouth but it was virtually and for long periods a coastal lagoon subject to inroads from without in times of stress.

Then was the period of Old Red lakes in New York, in Scotland, Orkney and Russia. They did not all begin at the same period of time nor continue their existence for equal times; some began in the late Siluric, others in middle Devonic, several are known to have continued their existence beyond the Devonic and into the Carbonic. So here, we are disposed to believe, this peculiar mode of sedimentation has transcended the limits of Devonic time and entered the Carbonic, though we have no traces of marine life of either period after the deposition was once established. The conglomerates of eastern Gaspé are contrasted with the sandstones of the more westerly parts of the county, and we may interpret them as the deposits of the seaward ends of the long estuary where for countless time the waters of the sea beat, as today, on the upturned edges of the ancient limestone cliffs and rolled their fragments up along the margin of an ever sinking continent.

Conclusion

From the future detailed study of the faunas preserved in this series of Siluric and Devonic limestones, we may expect a flood of light on the significance of contemporaneous faunas in the northern

Appalachian basin. In the Percé rock and its more northerly development in the limestones of Grande Grève, we confidently look for a solution of the questions of origin and derivation of the faunas which represent the earliest Devonic life of the Appalachian basin, and their path of migration once determined, evidence to infer the outline of the continental borders and the definition of the waterways.

In this brief sketch we have omitted from consideration through lack of personal acquaintance, reference to the Siluric limestones which occur in detached masses along the Malbay to the north, and at spots remote from Percé, along the southern coast. When these have been studied in detail, the entire series will be found to present an important supplement to our present knowledge of the factors of that ancient time.

UPPER SILURIC AND LOWER DEVONIC FAUNAS OF TRILOBITE MOUNTAIN, ORANGE COUNTY, NEW YORK

BY HERVEY WOODBURN SHIMER

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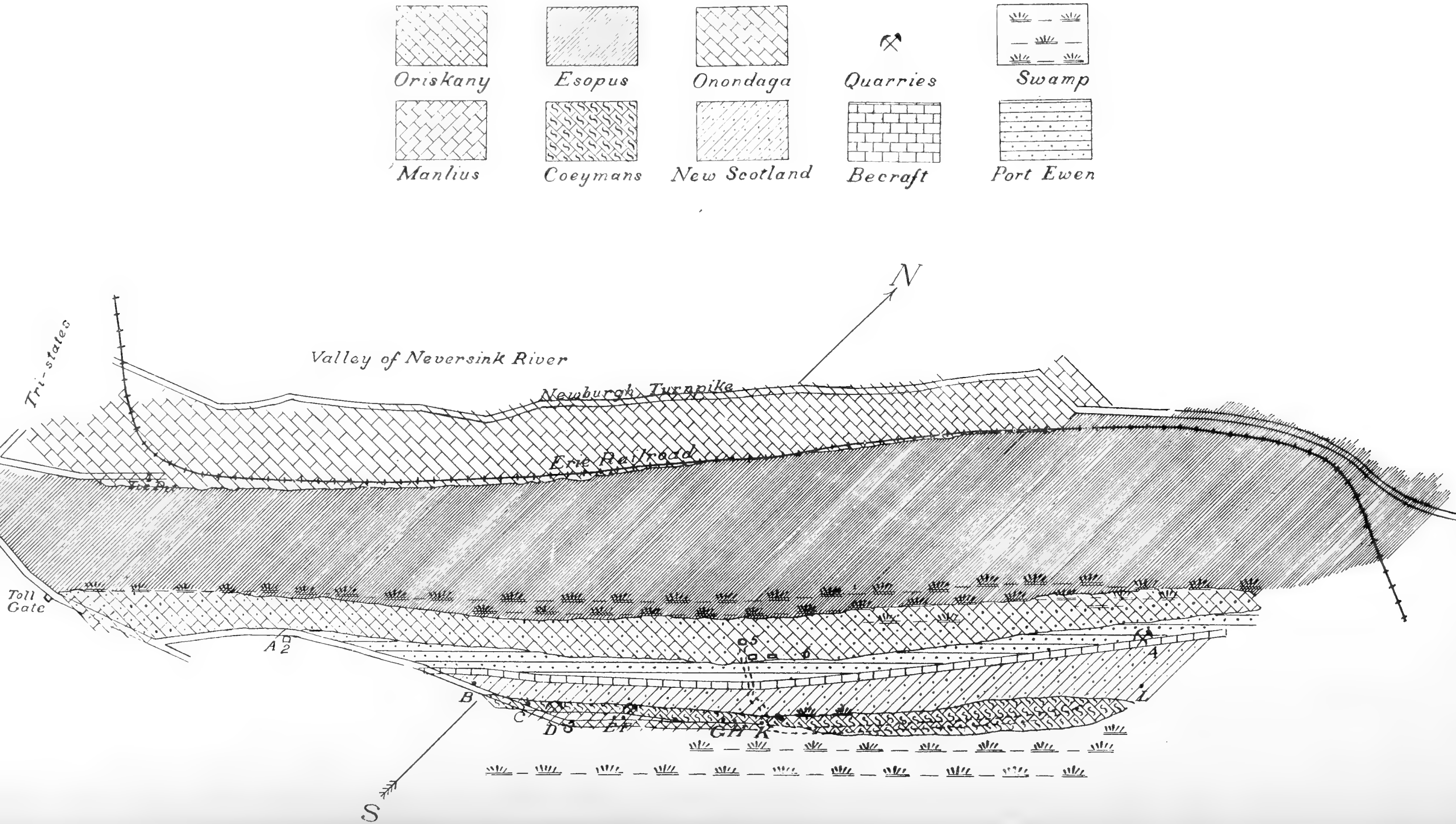

Geologic map of Trilobite Mountain

INTRODUCTION

Trilobite mountain, which is situated 3 miles southeast of Port Jervis, Orange co. N. Y., is a ridge with a maximum hight of about 750 feet, trending in a northeast-southwest direction. The ridge is about 2 miles long by 1 mile wide and is bounded on the northwest by the Neversink river and on the southeast by the marsh separating this ridge from Shawangunk mountain, which like all other of the Blue Ridge ranges trends from the northeast to the southwest.

Both the valley of the Neversink and that containing the marsh between the Shawangunk and Trilobite mountains are simple mon-

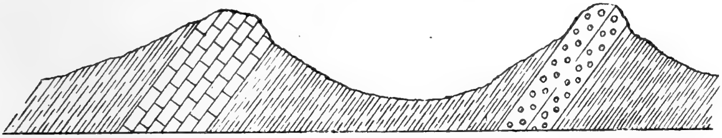

Fig. 1 Simple monoclinal valley (Rogers)

oclinal valleys [fig. 1][1]. The Onondaga and Marcellus formations underlie the former, the upper Medina to Manlius the latter valley.

Trilobite mountain, as noted by Dr Barrett[2], constitutes one of a series of anticlines extending in a northeast-southwest direction. In other words, this monocline is crossed by a " secondary system of flexures which cause the Helderberg Ridge to rise and sink in a succession of anticlinal and synclinal folds . . . The roads are in the synclinals and the limestone quarries are in the southeast fronts of the anticlinals . . . Bennett's quarry is in one of these; Nearpass's and Buckley's quarries lie south and north of it respectively." To the central one of these ridges Mather and Horton gave (about 1840) the name Trilobite mountain, from the great abundance of trilobites found here in the rocks of the Lower Oriskany.[3]

The first paper published in reference to the geology of this region was by Dr William Horton on the geology of Orange county. Dr Horton, who was a resident of Craigville, Orange co. and a well

[1] Rogers, H. D. Geol. of Pa. 1858. v. 2, pt 2, p. 921.

[2] Am. Jour. Sci. Ser. 3. 1877. 13:385.

[3] Mather. Geol. N. Y. 1st dist. p. 333.

known local geologist, was made one of the assistant geologists of the first geological district of this State.[1] Dr Horton encountered the same difficulty in determining the dip of the Trilobite mountain beds that all later observers have had, namely a tendency to confound cleavage and bedding. He says that the Trilobite mountain strata " repose unconformably upon the Millstone grit (Shawangunk grit) at the western base of Shawangunk mountain."[2] On the next page, however, he hesitates and says that this southeast dip is " far from certain. The stratification is to me still uncertain."

Several years later, W. W. Mather, geologist in charge of the first district, published his report where we find that he reached more definite conclusions. Speaking of the Manlius and Helderbergian series, he says " These limestones dip in a west to northwest direction, lying upon the subjacent Shawangunk rocks conformably; but some of the strata are rather enigmatical and appear to dip to the east-southeast in consequence of the cleavage or shivering of the strata since their deposition. In some of the strata the real dip is evident, but in others it is not, and it was only after minute examination that the real direction was with certainty determined."[3]

Dr S. T. Barrett of Port Jervis gave in 1876[4] the result of many years detailed work on the rocks of this region. He correlated the strata with those farther north and west in New York State, giving the horizons and thicknesses from bottom to top as follows:

		Feet
1	Tentaculite limestone	20
2	Favosites limestone	2–5
3	Lower Pentamerus and Cherty	40
4	Delthyris shale	120
5	Upper quarry	10
6	Upper shale	150
7	Trilobite layers	5–10
8	Oriskany and Cauda Galli	500–800

[1] N. Y. Geol. Rep't 1st dist. 1839. p. 135.
[2] N. Y. Geol. Rep't 1st dist. 1839. p. 150.
[3] Geol. N. Y. 1st dist. 1842. p. 332.
[4] N. Y. Lyc. Nat. Hist. 11:290.

Heinrich Ries in his report on the geology of Orange county, N. Y.,[1] gives a concise description of the successive horizons with a few fossils from each. He notes the greater prominence of the cleavage in the higher beds, so that the "bedding is often totally obliterated."[2]

Besides the above, Beecher, Darton and Schuchert have done more or less work in reference to this region.

This mountain[3] which represents one limb of an anticline, is a typical monoclinal ridge of the Appalachian type. It is, however, not a simple ridge but is made up of many minor ridges, as the

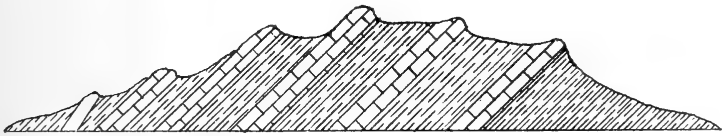

Fig. 2 Complex monoclinal ridge (Rogers)

accompanying ideal figure will show [fig.2].[4] All those dipping in the same direction contribute to the making of the mountain. We have here, then, what Rogers called a complex monoclinal ridge.[4]

These minor ridges, locally termed hogbacks, are usually, if not always, capped by a harder or more resistant stratum than that immediately beneath and are the result of normal erosion. Attacked by atmospheric agencies and in certain instances at least aided during present and past times by running water, the weaker stratum is disintegrated and washed away. The upper resistant stratum, thus undermined, breaks off by its own weight and falling, lies as talus covering the southeast slope of the hogback. The angle of slope of this talus depends on the size of the fragments. The northwest slope conforms in a greater or less degree to the dip of the beds.

There is evidence, in a slight development of slickensides etc., of more or less disturbance in the region, which leads one to suspect the presence of faults. The great development of hogbacks, which

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[1] N. Y. State Geol. 15th An. Rep't 1895. p.395-475.

[2] ——— p. 429.

[3] In altitude it is only a hill as the highest elevation is only about 750 feet.

[4] Rogers, H. D. Geol. of Pa. 1858. v. 2, pt 2, p. 920.

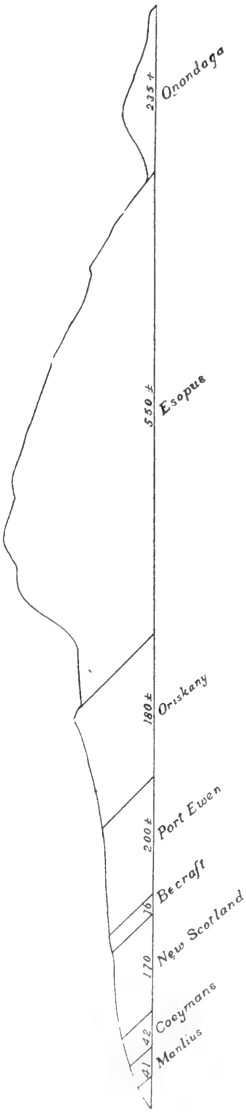

Fig. 3 Generalized section across Trilobite mountain

occur in all horizons but are specially characteristic of the Esopus, lends color to this supposition. These hogbacks, however, appear to be better explained as the result of differential erosion, as noted above. The more or less sudden rise and dying away of such a ridge in its northeast-southwest trend is apparently due to the greater or less development of certain cleavages; that is, where one of the characteristic cleavages at an angle to the bedding plane is well developed, erosion can most advantageously attack it.

The present paper gives a report on the succession of faunas in the strata of Trilobite mountain, from the Manlius to the Onondaga formation inclusive. Most of the field work was done during the summer of 1902, while the work on the collections was carried on during the summer and fall of 1903 in the laboratory of Columbia University. In the field work, great care was taken to distinguish between beds of varying lithic or faunal characters, by keeping separate the fossils collected from each, even though such differences were noted in a bed of less than an inch thick.

The accompanying map and sections were measured by pacing, and are subject to correction but in the acquisition of the fossils great precaution was taken against mixing the collections from higher or lower beds.

GENERALIZED SECTION AT TRILOBITE MOUNTAIN[1]

	Feet	Feet
Onondaga limestone (max. exposure)	235±	
Esopus grit	550±	
Oriskany limestone	180±	
Upper or Spirifer muchisoni zone		150±
Lower or Dalmanites dentatus zone		30±
Port Ewen beds	200±	
Becraft limestone	16	
New Scotland beds	170±	
Upper or Spirifer cyclopterus zone		125±
Lower		45±
Coeymans limestone	42	
Upper or Cherty		11
Middle or Chert free		28
Lower or Favosites bed		3
Manlius limestone (max. exposure)	41	

GENERAL DESCRIPTION OF HORIZONS

Manlius limestone

The Manlius limestone is exposed in six of the sections. It is a very compact, dark blue or almost black rock, containing many black shale seams. All the beds give evidence of more or less disturbance, the thin shale layers being at times minutely and irregularly crumpled, while the thicker beds, incapable of this minute displacement, present rather the appearance of little hillocks. Many calcite veins penetrate the rock mass, specially separating shale seams from the limestone. Chert occurs as scattered nodules but is not nearly as abundant as in the higher formations; it seldom gives any evidence of the presence of fossils, and even when deeply weathered it shows little else than a few crinoid joints.

The greatest thickness, 41 feet, is exposed in section F. The other sections give exposures varying in thickness from 2 to 31 feet.

Fossils are comparatively rare except in very restricted beds. The most characteristic and abundant species are Spirifer vanux-

[1] *See* fig. 3.

emi, Stropheodonta varistriata, Tentaculites gyracanthus and Whitfieldella? nucleolata; the latter species is, however, confined to the upper 24 feet. Principally because of the restriction of this fossil to the upper beds, the Manlius has been separated into an upper and lower portion. The lower Manlius is exposed in the lower portions of sections E and F; it contains no fossils that are not likewise found in the upper Manlius. The upper Manlius is characterized by the first appearance of such Helderbergian species as Favosites helderbergiae and F. sphaericus.

Favosites bed[1] (Lower Coeymans, transitional)

The lithic character of the lower portion of this bed is similar to that of the Manlius, being a compact, dark blue limestone. The upper portion, however, is more coarsely crystalline through the presence of many crinoid joints, being a typical calcarenite.[2] The lower surface of the Favosites bed is, in places, very wavy and uneven, as though deposited upon an old, water-worn surface. The bed is composed almost entirely of heads of Stromatopora and Favosites. Where weathered, it is specially recognizable by the concentrically wrinkled laminae of the hydrozoon. At times these heads seem to have been deposited upon a yielding sediment which in places appears to be a continuation upwards of the Manlius and extends between and even partially covers these heads.

The fossils are most abundant by far in the lower third of this 3 foot bed. The most characteristic are Stromatopora concentrica?, Favosites helderbergiae, F. sphaericus and Zaphrentis roemeri. There are also found such characteristic Manlius forms as Whitfieldella? nucleolata, ostracods (probably Beyrichia) and Stropheodonta varistriata; the last, however, occurs also in the Coeymans proper. With these occur such Helderbergian forms as Lichenalia torta and Rensselaeria cf. aequiradiata. No Gypidula galeata occurs in the Favosites bed but immediately above it is exceedingly abundant.

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[1] This name was proposed by Barrett, N. Y. Lyc. Nat. Hist. v. 11.
[2] Grabau. Geol. Soc. Am. Bul. 14:349.

HELDERBERGIAN SPECIES

Favosites helderbergiae	Zaphrentis roemeri
F. sphaericus	Rensselaeria cf. aequiradiata

MANLIUS SPECIES

Whitfieldella ? nucleolata	Stropheodonta varistriata
Beyrichia ?	

Notwithstanding the absence of Gypidula galeata I have no hesitancy from the above fauna in placing the Favosites bed in the Coeymans limestone group. For detailed discussion of this bed see C 2, F 2 and H 2.

Coeymans (proper) middle and upper

The Coeymans (proper) is a heavy bedded, dark gray limestone, about 40 feet thick. It is usually very coarsely crystalline, being a typical calcarenite. The lower portion is chert free but in the upper part occur thin chert bands, ⅛ of an inch to 1 inch thick. It is characterized throughout its whole thickness by an abundance of specimens of Gypidula galeata.

The chert free beds contain in abundance Uncinulus nucleolatus, U. pyramidatus, Rhynchospira formosa, Spirifer cyclopterus, Atrypa reticularis, Favosites helderbergiae and F. sphaericus, while in the chert-bearing beds we meet such typical New Scotland forms occurring very abundantly as Meristella laevis, Streptelasma strictum, Leptaena rhomboidalis, Dalmanella subcarinata and Delthyris perlamellosa. Some of the chert bands contain very many bryozoa; specially abundant are Orthopora rhombifera, O. regularis, Unitrypa praecursa and Lioclema cellulosum. Lichenalia torta is found abundantly in both the upper and lower parts of the Coeymans. The Coeymans or pre-New Scotland species found here are Rhynchonella semiplicata ?, Stropheodonta varistriata and Gypidula galeata. Thus it is seen that the chert-bearing beds form a transition from the Coeymans to the New Scotland. But principally on the ground that no specimen of the characteristic and abundant New Scotland fossil, Spirifer macropleura, was found in these chert-bearing beds and that Gypidula galeata continues very abundant, it was thought better to place this in the Coeymans than in the New Scotland division.

For detailed discussion of this horizon, see sections C, D and F.

New Scotland beds

The New Scotland beds represent an alternation of dense, dark blue, compact limestone with dark gray shales and thin-bedded sandstones. The limestone is at times very full of chert bands which in places make up almost half of the rock mass. These chert bands, like many of those in the upper Coeymans are, when weathered, one mass of fossils. This is a specially good place for the collection of the more delicate organisms. The arenaceous limestone beds at times exhibit a succession of light and dark laminae of paperlike thickness, as at K 15, L 2, and L 3. These thin beds contain either very few or no fossils except in the very lowest band. An exceedingly rapid change from a comparatively clear to a very black muddy water condition appears to have made it impossible for life to exist. Changes of current are also indicated by the appearance of pockets of coarsely grained limestone in the finely grained at L 3.

This formation is divided into an upper and a lower horizon. The division is based primarily on the great abundance of Spirifer cyclopterus in the upper 125 feet; this is exceedingly rare in the lower 45 feet. Spirifer macropleura is the diagnostic fossil of the New Scotland and is abundant throughout its whole extent. To the lower New Scotland are apparently confined such forms as Favosites sphaericus and many bryozoa, e. g. Orthopora rhombifera, O. regularis and Monotrypella? abrupta. Fragments of Lingula and Orbiculoidea occur frequently in calcareous, phosphatic, clay nodules; no manganese could be detected in these nodules.[1]

[1] In the upper New Scotland of western Maryland, Schuchert notes the occurrence of manganese-phosphatic nodules similar to those dredged from the present deep seas, but he does not think these indicate a deep water condition here, for the "stratigraphic evidence denotes a shallow sea before and after New Scotland times." U. S. Nat. Mus. Proc. 26:420.

Streptelasma strictum is also apparently more abundant in the lower than in the upper division. The upper beds are characterized by the great abundance of Coelospira concava. Common also in the upper beds are Atrypina imbricata, Stropheodonta becki, Trematospira multistriata and Cyrtolites expansus. Such forms as Stropheodonta becki and Strophonella headleyana are found much more frequently in shale than in limestone. This is also true of Spirifer macropleura but does not hold apparently for such species as Delthyris perlamellosa and Coelospira concava which are found with equal frequency in shale and in limestone.

Becraft limestone

This is a very dark gray, heavy bedded limestone. The lower portion is coarsely crystalline, a coarse calcarenite. Most of the formation, however, is finely crystalline, even at times rather shaly. A thickness of 16 feet is included in this formation. The lower 2½ feet are characterized by a great abundance of Gypidula pseudogaleata, the typical Becraft fossil. In this bed are also numerous specimens of Edriocrinus pocilliformis and Leptaena rhomboidalis. The great abundance of the latter and several other New Scotland species in the Becraft of northern New Jersey is considered by Weller to be the chief difference which distinguishes its fauna from that of the preceding and succeeding beds.[1] Gypidula pseudogaleata was not found in the rest of the formation but owing to the great abundance of Spirifer concinnus which in great numbers usually characterizes the Becraft, and also of Leptaena rhomboidalis and Atrypa reticularis, these 14 feet are included. Spirifer concinnus is at times so abundant in these upper beds as to practically make up the entire rock mass. The other fossils also are those which are specially noticeable in the Gypidula pseudogaleata beds; yet the entire Becraft here represents a temporary invasion of a few typical Becraft species into the very slightly changing New Scotland seas, so that the mass

[1] Weller. Sur. N. J. 3:93.

of the New Scotland fauna continues through the Becraft into the Port Ewen. Only a few forms, such as Spirifer macropleura, unable apparently to live in the slightly purer waters, disappeared.

Port Ewen beds

The 200 feet included in this formation are mostly concealed. The few exposures are lithologically very similar to the New Scotland, varying from a dark blue limestone to a silicious shale. The fossils are likewise very similar to those of the New Scotland, including such typical forms as Stropheodonta becki, Strophonella punctulifera, Streptelasma strictum, Lichenalia torta and an abundance of Coelospira concava and Eatonia singularis. But the transitional character of the Port Ewen to the Oriskany is indicated by the presence of Meristella lata and Spirifer murchisoni. With the exception of these two fossils, all the species found in these beds are Helderbergian.

From the close of the Becraft to the uppermost Dalmanites dentatus beds the fauna is transitional from the typical Helderbergian to the Oriskanian. The fauna acquires more and more an Oriskanian aspect as the beds are ascended. Yet the lower beds contain so many very typical Helderbergian species that there is no hesitancy in placing these beds in the lower Helderberg. From the upper 30 feet of these transition beds, however, the above mentioned Helderbergian species are absent and there is a great increase of the Oriskanian element. It was thought well, therefore, on account of the very decided faunal change, to place these upper (D. dentatus) beds in the Oriskany.[1] The evidence for this is taken up in detail under the lower Oriskany.

Oriskany

The Oriskany is mainly a silicious limestone with the silicious content increasing perceptibly from the base upward. At times it is

[1] Barrett likewise noted the close relationship of the fauna of the Trilobite bed to that in the rocks above: "The relations of the Dalmanites dentatus layer seem to be more with the rocks above than those below it." Am. Jour. Sci. ser. 3. 45:72.

quite heavily bedded; in other places it becomes very shaly; this latter condition is specially noticeable near the middle of the formation. It is divided into an upper (150 feet) and a lower (30 feet) division on faunal grounds entirely.

Lower Oriskany (Dalmanites dentatus zone)

FAUNA OF THE LOWER ORISKANY

Vermipora serpuloides *Hall* (H) c[1]
Beachia suessana *Hall* (O) R-c
Chonostrophia jervisensis *Schuch.* r-C[2]
Cyrtina rostrata *Hall* (O and On) r
Dalmanella subcarinata *Hall* (H) R-C
Leptaena rhomboidalis (*Wilck.*) (Trenton-Waverly) R-c
Leptostrophia oriskania *Clarke* (O) R
Meristella lata *Hall* (O) r
Nucleospira elegans *Hall* (Niagara-H) c
Orbiculoidea ampla *Hall* (O) r
Orthothetes woolworthanus *Hall* (H) c
Rensselaeria aequiradiata (*Con.*) (H) R
R. subglobosa *Weller* c-C
Rhipidomella oblata *Hall* (H) r
Spirifer murchisoni *Castel.* (O) r-c
Stenochisma formosa *Hall* (H) r
Strophonella? conradi *Hall* (H) r
Uncinulus vellicatus *Hall* (H) R
Actinopteria textilis (*Hall*) (H) R-C
A. textilis arenaria (*Hall*) (O) R
Diaphorostoma nearpassi (*Weller*) R
D. ventricosum (*Con.*) (H and O) R
Loxonema jerseyense *Weller* ?-c
Platyceras platystoma *Hall* (H) r
P. ventricosum *Con.* (H and O) R
Tentaculites acula *Hall* (H) r-c
T. elongatus *Hall* (H and O) r
Dalmanites dentatus *Barr.* R-C
D. dolphi *Clarke* R[3]
Homalonotus vanuxemi *Hall* (H) c

Out of the above fauna of 30 species, 6 have so far been found only in these beds, 4 occur in both Helderbergian and Oriskanian, 13 are Helderbergian and 7 are Oriskanian species. Omitting from the consideration all that are very rare (R), there are present 11 Helderbergian and 5 Oriskanian species, which vary in number

[1] R=very rare; r=rare; c=common; C=very common. H=Helderbergian; O=Oriskanian; On=Onondagan species. ?=species doubtful. When no horizon is given, the species has been found in the beds of this region only (i. e. northwestern New Jersey and southern New York).

[2] Schuchert notes the occurrence of the species in the Becraft of the Port Jervis region. Am. Geol. 27:250.

[3] Described from these beds but not seen by me.

from rare (r) to very common (C). The Helderbergian species outnumber the Oriskanian two to one; but this predominant Helderbergian aspect disappears when the individual species are examined. The Helderbergian species, Vermipora serpuloides, Dalmanella subcarinata, Rhipidomella oblata, Nucleospira elegans and Stenochisma formosa are also found in the calcareous Oriskany of other regions associated with the large normal Oriskany shells.[1] Tentaculites elongatus is much more characteristic of the uppermost calcareous Oriskany than of the lower Helderberg, but it is specially the very typical Oriskany species, Beachia suessana, Meristella lata and Spirifer murchisoni which give the distinct Oriskanian aspect to these beds; these are abundant and normal in their development, and occur from the base to the top of these beds. Besides these, Rensselaeria subglobosa, Dalmanites dentatus and D. dolphi, though at present hardly known outside the beds of this region, are more Oriskanian in appearance than Helderbergian.

The development of marginal crenulations and spines on the cephalon and pygidium is characteristic of many Devonic trilobites.[2] In the genus Dalmanites this is scarcely noticeable in the Helderbergian but becomes exceedingly conspicuous in the Oriskany, Schoharie and Onondaga. It is first noticed as slight crenulations on the anterior portion of the cephalic margin of the species pleuroptyx Green of the Lower Helderberg; in stemmatus Clarke of the calcareous Oriskany this crenulation is extended back along the margin of the cephalon; while in dentatus Barrett it is greatly accentuated into denticulations. This reaches its maximum development in the regalis Hall of the Schoharie and Onondaga. The appearance of such a highly ornamented Dalmanites as dentatus Barrett would on *a priori* grounds be placed *above* the Helderbergian. All the above named species considered as a whole are so characteristically Oriskanian that it is believed

[1] van Ingen & Clark, P. E. N. Y. State Paleontol. An. Rep't. 1902. p.1203-4; and Clarke N. Y. State Mus. Mem. 3, p.65-67.

[2] *See also* Clarke. N. Y. State Mus. Mem. 3, p. 87.

they far outweigh the greater number of Helderbergian species. It is on this account that these beds have been included in the Oriskany.

With the inclusion of these beds in the Oriskany the question of correlation with the Oriskany of other regions at once arises. Are these lower as well as the upper beds the time equivalent of the arenaceous Oriskany as developed at Oriskany Falls, New York, or do they represent in time a part of the unconformity beneath the normal Oriskany and would, therefore, be an older or lower Oriskany?

Large Rensselaerias are characteristic of the typical Oriskany. Beachia suessana is a small and earlier form of this same type; it is one of the most abundant shells of these beds and is practically absent from the upper beds and from the Helderbergian below. Rensselaeria subglobosa is another small and very abundant non-Helderbergian species confined to these lower beds. The following species occurring here are quite typical of the lower Helderberberg: Rensselaeria aequiradiata, Nucleospira elegans, Stenochisma formosa, Uncinulus vellicatus, Actinopteria textilis and Homalonotus vanuxemi. None of the following normal Oriskany species were found here: Rensselaeria ovoides, Megalanteris ovalis, Camarotoechia barrandei, Leptocoelia flabellites, Spirifer arenosus, Chonostrophia complanata and Hipparionyx proximus.

With the presence of the forms noticed above which foreshadow the normal Oriskanian fauna, the presence of a very decided Helderbergian element and the absence of so many typical Oriskanian species, an earlier fauna than the normal Oriskanian appears to be indicated. They have, therefore, been called Lower Oriskany.[1]

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[1]Of the 30 species cited by Schuchert from the Camden (Tenn.) Lower Oriskany, 22 species are typical Oriskanian or later, 6 are Helderbergian, Eatonia peculiaris occurs in both and Atrypa reticularis ranges through the Siluric and Devonic; Hipparionyx proximus and Rensselaeria ovoides are questionably present. The typical Helderbergian Meristella laevis and Pterinea? cf. textilis

The Trilobite bed for which the Lower Oriskany here is specially noted is a dense, dark blue limestone containing many trilobite fragments, specially of Dalmanites dentatus and Homalonotus vanuxemi. The former species is specially abundant, whence the name "dentatus fauna" for the Lower Oriskany. It likewise contains a great abundance of Rensselaeria subglobosa, Chonostrophia jervisensis, Actinopteria textilis and Loxonema jerseyense. It is bounded above and below by an inch of silicious limestone. This bed maintains a uniform thickness of from 4 to 6 inches.

Upper Oriskany (Spirifer murchisoni zone)

The upper Oriskany is characterized by dark blue silicious limestone and shale, and has an approximate thickness of 150 feet. Chert bands occur more or less frequently throughout the entire formation, but specially in the upper portion. At times these show no traces of any fossils even when weathered; at other times they are one mass of fossils. Unlike the chert bands of the upper Coeymans and Lower New Scotland, these fossiliferous bands apparently contain no bryozoa.

This formation is specially characterized by Spirifer murchisoni, Meristella lata, Leptocoelia flabellites, Coelospira dichotoma, Actinopteria textilis arenaria, Diaphorostoma ventricosum and Tentaculites elongatus. The lower portion contains an abundance of Orbiculoidea jervisensis. This large brachiopod is very noticeable, even at quite a distance from the exposure, as it occurs frequently at right angles to the bedding. The most characteristic fossil is Spirifer murchisoni, and hence the name "murchisoni zone."

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are present. Omitting from the above all species marked questionable, there remain 15 characteristic of the Oriskany or later (Onondaga) and 5 of the Helderbergian. [Safford, J. M. & Schuchert, Charles. The Camden (Tenn.) Lower Oriskany. Am. Jour. Sci. ser. 4? 7:429-32]

This Camden Oriskany is developed at least as far north as western Maryland where, according to Schuchert, the lower portion of the Oriskany "recalls the Oriskany of Camden, Tennessee, and points to an older stage than the Oriskany as usually known." [Schuchert. On the Lower Devonic and Ontaric Formations of Maryland. U. S. Nat. Mus. Proc. 26:420]

FAUNA OF THE UPPER ORISKANY

Coelospira dichotoma *Hall* (O) r-c
Leptocoelia flabellites (*Con.*) (O and On) r-c
Beachia suessana *Hall* (O) R
Chonostrophia complanata *Hall* (O) r
Dalmanella subcarinata *Hall* (H) r
Megalanteris ovalis *Hall* (O) ?
Meristella lata *Hall* (O) r-C
Orthothetes woolworthanus *Hall* (H) C
Reticularia modesta (*Hall*) (H) r
Spirifer arenosus (*Con.*) (O and On) ?
S. cyclopterus *Hall* (H and O) R
S. murchisoni *Castel.* (O) r-C
Stropheodonta becki *Hall* (H) r
Actinopteria textilis arenaria (*Hall*) (O) c
Pterinea? gebhardi (*Con.*) (O) r
Diaphorostoma desmatum *Clarke* (O) r
D. ventricosum (*Con.*) (H and O) r-C
Platyceras lamellosum *Hall* (H) R
P. reflexum *Hall* (O) ?
Conularia pyramidalis jervisensis *Shimer* r
Tentaculites elongatus *Hall* (H) r-C

Out of a fauna of 21 species, one was found in the beds of this region only, two are equally characteristic of the Helderbergian and Oriskanian, six are Helderbergian and 12 Oriskanian. Omitting from consideration all questionable and very rare species, there remain 5 Helderbergian and 8 Oriskanian species.

From the abundance of such typical Oriskany species as Leptocoelia flabellites, Coelospira dichotoma, Chonostrophia complanata, Meristella lata, Spirifer murchisoni and Actinopteria textilis arenaria there is no doubt that these beds should be placed in the Oriskany. Although the Helderbergian forms occurring here are not very typically such, yet they indicate a persistence of Helderbergian species in this region to the beginning of the Esopus, for in the uppermost Oriskany beds occur such Helderbergian forms as Stropheodonta becki, Reticularia modesta and Tentaculites elongatus side by side with Spirifer murchisoni, Meristella lata and Leptocoelia flabellites. Yet the larger and specially characteristic fossils of the typical Oriskany as developed at Oriskany Falls, are mostly wanting in these beds. Rensselaeria ovoides, Hipparionyx proximus and Camarotoechia barrandei were not found, while Megalanteris ovalis and Spirifer arenosus were questionably identified from a few fragments. In northwestern New Jersey Weller[1] notes the presence of Hipparionyx proximus but it is exceedingly rare and abnormal in its small size; Spirifer arenosus is one of the rarest shells of the New Jersey Oriskany of that region, while Camarotoechia barrandei is questionably present.

Instead of deriving an argument in favor of Helderberg-Oriskany transition beds from the practical nonoccurrence of the very typical larger shells of the normal Oriskany, and from the commingling of Helderbergian and Oriskanian species, it is believed with Clarke[2] that these beds which are stratigraphically the equivalent of the Oriskany, represent the calcareous (deep water) facies of the shallow water original Oriskany. Just as at present much of the older life, geologically considered, is found in the deeper portions of the sea,[3] so here the Helderbergian types persisted in the deeper water; not being able, evidently, to compete with the newer Oriskany fauna, they found safety in the less favorable localities, just as the Insectivores among mammals have persisted to the present, notwithstanding their low development, because, added to a maintenance of small size, they have become nocturnal in habit and in many ways have adapted themselves to the less desirable localities.

Large size is usually correlated with an abundance of food. In the sea the more abundant food supply is in comparatively shallow waters. It is here that marine vegetation flourishes, on which all sea animals primarily depend for food; it is here also that river-borne detritus, which contains a greater or less amount of food, is

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[1] Geol. Sur. N. J. 1902. 3:341–64.

[2] Oriskany Fauna of Becraft Mountain. N. Y. State Mus. Mem. 3, p. 72.

[3] Alexander Agassiz discusses this point quite thoroughly in his work, the *Three Cruises of the U. S. Coast and Geodetic Survey Steamer Blake,* v. 1, from which the following conclusions are quoted:

"The abyssal fauna has descended from the littoral and other shallow regions, to be acclimatized at great depths." [p. 155]

"All the evidence thus far tends to show that the deep sea fauna originated at the close of the Paleozoic times." [p.151]

After noting that a large number of antique types occur everywhere, he continues, "We can only say that in the deep water fauna a relatively larger number of such antique forms have been found than elsewhere." [p.156]

Plate 1

Oriskany-Esopus swamp, looking southwest; from near the residence of William Balmos

Plate 2

Oriskany-Esopus swamp, looking southwest. The Oriskany ridge is at the right of the picture; the Oriskany-Esopus swamp at the left.

mostly deposited. It would, therefore, be expected that the larger shells would not be found in the very deep waters i. e. below the depths at which marine algae flourish. This theory is supported by the work of Agassiz while associated with the dredging steamer Blake.[1] In discussing Gastropods and Pelecypods, he thus concludes, "Deep sea dredging has thus afforded few specimens of even moderately large size, judged by the standard of shallow water or littoral shells."

It thus seems well to look on the fauna of these upper Oriskany beds as existing in deeper portions of the sea at the same time that the typical Oriskany Falls fauna lived in comparatively shallow waters. Yet this deeper portion was not removed beyond the reach of land-derived sediment for the beds are more or less argillaceous and silicious limestones.

All the large fossils of the original Oriskany noted above as practically absent from the Port Jervis region, are very abundant at Becraft mountain[2] and also, with the exception of Camarotoechia barrandei, near Rondout N. Y.[3] But they are likewise associated in these regions with many Helderbergian forms. The practical absence of these fossils from the Port Jervis region can not be due to insufficient time for the migration of the species into this region, as they occur both south in Maryland, with also many in Pennsylvania, as well as north in New York State. Nor can it be due to some barrier since many typical Oriskany forms occur here. It may possibly be due to a greater depth of water.

Oriskany-Esopus swamp

This swamp probably rests on the upper beds of the Oriskany, being worn out of the more easily disintegrated Esopus. The preglacial drainage having been obstructed, this has been filled in to a depth of probably 20 or 30 feet in places. It is interesting to note that on Becraft mountain, also, "the contact between the Oriskany

[1] Agassiz, Alexander. Three Cruises of the U. S. Steamer Blake, 2:62.

[2] Clarke, J. M. Oriskany Fauna of Becraft Mountain. N. Y. State Mus. Mem. 3, p.67.

[3] van Ingen & Clark, P. E. Disturbed Fossiliferous Rocks in the Vicinity of Rondout, N. Y. N. Y. State Paleontol. An. Rep't. 1902. p. 1203.

and Esopus is everywhere marked by low, swampy ground and by the existence of stream beds."[1]

Esopus

The Esopus is a dark gray silicious shale. It has an approximate maximum thickness of 550 feet. The very strong cleavage which has been induced in it has given rise to very thin, platelike pieces. The entire Esopus is a continuous succession of hogbacks, giving an appearance very similar to a series of step faults. Yet this appearance may be due merely to differential weathering on account of the greater development of certain cleavages over others. This latter theory is partially borne out by the fact that the valleys between the hogbacks run parallel to the strike of the beds.

No fossils were found in the Esopus though prolonged search was made for them. Irregular pyrite nodules are very abundant in all parts of the Esopus and Lower Onondaga. For 50 or more feet up into the Onondaga, probably a fourth of the many fossils found are pyritized. This suggests that perhaps each of the Esopus nodules also represents what is left of one or more fossils after the wonderful cleavage to which it has been subjected.

The Schoharie grit is here included in the Esopus on account of the absence of fossils and the lithic similarity of the two formations.

Onondaga

The transition from the Esopus to the Onondaga is very gradual. The lowest, much cleaved beds are arenaceous shales and except for the fossils would be placed in the Esopus. The beds become more calcareous till 30 feet above the base, a typical calcareous shale is developed. Here the fossils are quite numerous though few in species. The most abundant species are Coelospira acutiplicata and C. grabaui. The strata continue principally as calcareous shales for over a hundred feet but with the occurrence of thin bands of limestone more and more frequently toward the top. For the next 40 or 50 feet the limestone and calcareous shale beds are about equal in number and thickness. Here

[1] Grabau, A. W. Stratigraphy of Becraft Mountain, Columbia County, N. Y. N. Y. State Paleontol. An. Rep't. 1902. p. 1069.

Plate 3

View from the Esopus ridge looking northeast across the Oriskany-Esopus swamp and Oriskany ridge to Shawangunk mountain. The low ridge at the right of the picture is Trilobite ridge.

the most abundant fossils are Atrypa reticularis, Spirifer macrus, Reticularia fimbriata, Phacops rana and Chonetes hemisphericus. Above this the rock becomes a heavy limestone with thin shale seams at intervals. There are thus over 200 feet of the Onondaga laid down before the formation becomes the typical heavy bedded limestone usually associated with this formation. In the uppermost portion chert bands make their appearance. This chert is so thoroughly mixed through the limestone that it has when weathered an exceedingly rough appearance. Two hundred and thirty-five feet of the Onondaga is estimated to be here exposed. White[1] gives a thickness of 250 feet for Port Jervis. For a detailed discussion see K 14 to K 23.

REFERENCES TO DETAILED DISCUSSION

Those underscored are represented by fossils

Lower Manlius—E 1a-f, F 1a-n

Upper Manlius—D 1, E 1g-m, F 1p, F 1q, G 1, H 1, K 1

Favosites bed—D 2, F 2, H 2, Lower K 2

Coeymans—C 1, C 2, C 3, D 3, D 4, D 5, D 6, D 7, F 3, F 4, F 5, F 6, F 7a-c, Middle K 2

Lower New Scotland—C 4, Lower C 5, D 8, Lower D 9, F 7d, Lower F 8, Upper K 2, K 3, K 4, K 5, K 6, K 7, K 8, K 9, K 10, K 11, Lower L 1.

Upper New Scotland—Lower B 1, Upper C 5, C 6, Upper D 9, D 10, Lower D 11, Upper F 8, F 9, Lower F 10, K 12, K 13, K 14, K 15, K 16, K 17, K 18, Upper L 1, L 2, L 3

Becraft—Middle B 1, Lower D 11, Lower F 10, Lower K 19, L 4, L 5, L 6

Port Ewen—Lower A 1, Upper B 1, Lower B 2, Upper D 11, D 12, D 13, Lower D 14, Middle F 10, Upper K 19, K 20, K 21, L 7, Lower L 8

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[1] 2d Geol. Sur. of Pa. G6, p.119.

Lower Oriskany—Upper A 1, Lower A 2, Upper B 2, Upper D 14, Lower D 15, Upper F 10, F 11, K 22, K 23, K 24, K 25, K 26, K 27, K 28, Lower K 29, Upper L 8, L 9, Lower L 10

Lower Oriskany (Trilobite bed)—Top of B 2, Top of D 14, F 11, K 27

Upper Oriskany—Upper A 2, A 3, A 4, A 5, A 6, Upper D 15, F 12, Upper K 29, K 30, K 31, K 32, K 33, K 34, K 35, K 36, K 37, K 38, K 39, K 40, K 41, Upper L 10, L 11, L 12, L 13, Lower L 14

Esopus—K 41, Upper L 14, L 15

Onondaga—K 42, K 43, K 44, K 45, K 46, K 47, K 48, K 49, K 50, K 51

COMPARISON WITH SIMILAR HORIZONS IN OTHER REGIONS

Becraft mt e. N. Y.	Rondout e. N. Y.	Trilobite mt s. e. N. Y.	Nearpass quarries n. w. N. J.	W. Md. and n. e. W. Va.	
1	2	3	4	5	
300± ft	300–325	550±	375	Land cond.	Esopus
1–several	20–70	180±	170	348	Oriskany
25	110–200	200±	80	Not recog.	Port Ewen
40–45	40	16	20	85	Becraft
68	100±	170±	160	64	New Scotland
45	50	40	40	110	Coeymans
55	45	41±	35	110 (6)	Manlius
240	365–505	647	505	717	Manlius-Oriskany inclusive

A short description of each section follows.

1 Grabau. Stratigraphy of Becraft Mountain, Columbia Co., N. Y. N. Y. State Paleontol. An. Rep't 1902. p.1030-79.

2 van Ingen & Clark, P. E. Disturbed Fossiliferous Rocks in the Vicinity of Rondout N. Y. N. Y. State Paleontol. An. Rep't 1902. p.1176-1227.

3 The present paper.

4 Weller. Rep. on Pal. Geol. Sur. of N. J. 3: 56-102.

5 Schuchert. On the Lower Devonic and Ontario Formations of Maryland. U. S. Nat. Mus. Proc. 26: 413-24.

6 This includes all of the strata from the Salina to the Coeymans.

1 At Becraft mountain, Columbia county, N. Y., Grabau gives the following lithic and faunal characters for these formations.[1] In

[1] Stratigraphy of Becraft Mountain, Columbia County, N. Y. N. Y. State Paleontol. An. Rep't. 1902. p. 1030–79.

comparing 1, 2 and 3 it should be noted that the distance between Becraft and Rondout is not nearly so great as it is between Rondout and Port Jervis.

Manlius .... 55 feet

Three Stromatopora beds occur, 0, 2 and 12 feet respectively below the top of the Manlius. Besides the Stromatopora, the most characteristic fossils are Spirifer vanuxemi, S. corallinensis, S. eriensis var., Whitfieldella cf. nitida, etc.

Coeymans .... 45 feet

Layers of chert are not infrequent in this limestone, an argillaceous calcarenite.[1] The lowest bed of this, resting immediately on the uppermost Stromatopora bed, contains some specimens of Favosites helderbergiae and many of Gypidula galeata. In the Coeymans were also found Delthyris perlamellosa, Spirifer cyclopterus, S. macropleura (one specimen), Leptaena rhomboidalis, Pterinea? textilis (one specimen), etc.

New Scotland .... 68 feet

Thin bedded, argillaceous to silicious rocks with a variable amount of lime carbonate present. Orthothetes woolworthanus, Stropheodonta becki, Spirifer macropleura, Delthyris perlamellosa, Eatonia peculiaris, E. medialis, Diaphorostoma ventricosum, etc.

Becraft .... 40-45 feet

Coarsely crystalline limestone (calcarenite). The most abundant and characteristic species are Spirifer concinnus, Gypidula galeata (usually small), Atrypa reticularis and Uncinulus campbellanus.

Port Ewen.. 25 feet

A dark crystalline limestone, very similar to the Coeymans. Monotrypella tabulata specially characterizes this horizon; this is, however, also found in the Coeymans. Other fossils are Spirifer concinnus, S. cyclopterus, Del-

[1] Grabau. Science. Feb. 20, 1903. p. 297.

thyris perlamellosa, Rhynchospira formosa, Eatonia peculiaris, etc.

Oriskany .... 1-several feet

A silicious limestone. The following are a few of the fossils found here by Clarke,[1]—Chonetes hudsonicus, Tentaculites elongatus, Cyrtolites expansus, Diaphorostoma ventricosum, Eatonia medialis, Coelospira concava, Leptocoelia flabellites, Meristella lata, Spirifer murchisoni, Chonostrophia complanata, Edriocrinus becraftensis, etc.

Esopus and Schoharie.............................. 300 ± feet

2 At Rondout east of Kingston, van Ingen and P. E. Clark have worked up the following section.[2] This is the northeast continuation of the same ridge in northern New Jersey and at Port Jervis. Its further continuation is seen in Becraft mountain.

Manlius .... 45 feet

The lower and upper divisions contain many specimens of Leperditia alta, Spirifer vanuxemi, and Stropheodonta varistriata. The middle part contains an abundance of Stromatopora, "a veritable coral reef."

Coeymans .... 50 feet

The basal bed of 5 feet contains many specimens of Gypidula galeata, Spirifer cyclopterus, S. concinnus, Lichenalia torta and Stropheodonta varistriata (both flat and highly convex varieties). The middle beds are cherty limestones with no Stropheodonta varistriata noted. The upper beds are shaly limestones with an abundance of Uncinulus nucleolatus, Atrypina imbricata, Bilobites varicus, etc. Gypidula galeata is abundant in all the beds.

New Scotland.. 100± feet

Shaly limestone alternating with thin bands of semicrystalline

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[1] N. Y. State Mus. Mem. 3, p.65-71.

[2] van Ingen, Gilbert & Clark, P. E. Disturbed Fossiliferous Rocks in the Vicinity of Rondout N. Y. N. Y. State Paleontol. An. Rep't. 1903. p.1176-1227.

limestone. The lower portion has considerable chert; it is characterized by an abundance of Orthothetes woolworthanus, Stropheodonta becki, Spirifer cyclopterus, S. macropleura, Delthyris perlamellosa, etc. The most abundant species in the middle beds are Orthothetes woolworthanus, Strophonella radiata, Delthyris perlamellosa; no other Spirifers are noted. The upper beds contain many specimens of Spirifer cyclopterus, S. concinnus, Uncinulus campbellanus and Aspidocrinus scutelliformis, and numerous specimens of Gypidula pseudogaleata. A few of Delthyris perlamellosa are here noted but none of Spirifer macropleura.

Becraft .... 40 feet

A coarsely crystalline limestone. The fauna of this is identical with that of the upper New Scotland with the exception of a relatively greater abundance of the species above noted and the nonoccurrence of Spirifer cyclopterus.

Port Ewen.................................... 110-200 feet

Silicio-argillaceous limestone. The lowermost beds gave the following abundant species: Leptaena rhomboidalis, Orthothetes woolworthanus, Dalmanella perelegans, Delthyris perlamellosa, Spirifer concinnus, Rhipidomella oblata, Meristella laevis, etc. In the upper beds were noted[1]: Pholidops ovata, Rhipidomella oblata, Stropheodonta becki, Coelospira concava, Spirifer modestus, Cypricardinia lamellosa, Tentaculites elongatus, Homalonotus vanuxemi, Phacops logani, Dalmanites pleuroptyx, etc.

Oriskany .... 30-70 feet

The lower portion is a pebble bed..................... 6-18 feet

The upper portion consists of alternating sandy and cherty limestones .... 20-50 feet

[1]Clarke. Oriskany Fauna of Becraft Mountain. N. Y. State Mus. Mem. 3. 1900. p.73.

North of Rondout at Glenerie, the entire Oriskany has a thickness of but 20 feet.

Here the Oriskany contains the following mixture of New Scotland and Oriskany species as noted by van Ingen. Common ones only will be noted.

New Scotland species
- Chaetetes sphaericus
- Dalmanella perelegans
- Eatonia medialis
- E. singularis
- Orthothetes woolworthanus
- Rhipidomella oblata
- Spirifer cyclopterus

Oriskany species
- Actinopteria arenaria
- Anoplotheca dichotoma
- Leptocoelia flabellites
- Beachia suessana
- Chonostrophia complanata
- Cyrtina rostrata
- Edriocrinus sacculus
- Hipparionyx proximus
- Meristella lata
- Spirifer arenosus
- S. modestus
- S. murchisoni
- Tentaculites elongatus

Esopus .... 300-325 feet

4 Nearpass quarry in northwestern New Jersey. Weller.

About 3 or 4 miles to the southwest in the continuation of Trilobite mountain, occurs an excellent exposure, specially of the lower beds, in the limestone quarry of William Nearpass. This section was studied by Stuart Weller[1] and the following measurements given.[2]

Manlius .... 35 feet

The most characteristic fossils are Spirifer vanuxemi (only in the upper portion), Stropheodonta varistriata, Leperditia alta and Tentaculites gyracanthus. Stromatoporoid masses are abundant in the lowest part.

Coeymans .... 40 ± feet

A more or less cherty limestone. In the basal portion is an abundance of Favosites helderbergiae and Stromatopora. The most characteristic fossils of this formation are Gypidula galeata, Spirifer cyclopterus, Uncinulus mutabilis, etc.

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[1] 1902. Geol. Sur. N. J. Paleontology, 3:56-102.

[2] —— p. 58-60.

New Scotland .... 180 ± feet

The lowest part of 20 ± feet is a cherty limestone, containing no Spirifer macropleura but many specimens of Enterolasma strictum, Delthyris perlamellosa, Spirifer cyclopterus, etc.

The middle 140 ± feet are calcareous shales specially characterized by an abundance of Spirifer macropleura. Other fossils are Coelospira concava, Atrypina imbricata, Trematospira multistriata, etc.

The upper 20 ± feet are a hard, cherty limestone and correspond in stratigraphic position to the *Becraft*. They contain no Gypidula pseudogaleata or Spirifer concinnus. Leptaena rhomboidalis is specially abundant.

Port Ewen (estimated) .... 80 ± feet

Not exposed.

Oriskany .... 170 ± feet

Silicious limestone.

The lower 30 ± feet, Dalmanites dentatus zone, is specially characterized by an abundance of Chonostrophia jervisensis, Rensselaeria subglobosa, Dalmanites dentatus, etc.

The next 20 ± feet, Orbiculoidea jervisensis zone, is very similar to the Oriskany of Becraft mountain.

The upper 120 ± feet, Spirifer murchisoni zone, contains an abundance of Spirifer murchisoni, Leptocoelia flabellites, Meristella lata, Diaphorostoma ventricosum, Tentaculites elongatus, etc.

Esopus .... 400 ± feet

5 In western Maryland at Cumberland, Keyser, etc., the following composite section has been given by Schuchert.[1]

Manlius .... 110 feet

In the lower part, Favosites helderbergiae praecedens, Rhynchonellas like Uncinulus campbellanus and also Nucleospira are abundant.

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[1]On the Lower Devonic and Ontaric Formations of Maryland. U. S. Nat. Mus. Proc. 1903. 26:413–24.

In the middle occur in great numbers, Sphaerocystites multifasciatus, Spirifer modestus and Rhynchonella formosa.

In the upper portion, the most abundant species are, Tentaculites gyracanthus, Calymmene camerata, a small form of Gypidula near G. galeata, Orthopora, Lioclema, etc.

Coeymans .... 110 feet

In the lower part fossils are rare; Atrypa reticularis and Leptaena rhomboidalis occur.

The middle portion specially abounds in Stromatopora and at intervals Tentaculites gyracanthus. Layers of chert are more or less prominent.

The upper part contains typical Gypidula galeata and Spirifer cyclopterus.

New Scotland.. 64 feet

The lower two thirds is a cherty limestone and is characterized by Spirifer macropleura. There also occur here Edriocrinus pociliformis, Eatonia medialis, E. singularis, Coelospira concava, Trematospira multistriata, Delthyris perlamellosa, Spirifer cyclopterus, Phacops logani, etc.

The upper one third consists of argillaceous shales with occasional manganese-phosphatic nodules. Spirifer macropleura, Orthothetes woolworthanus, Stropheodonta becki, etc. occur here.

Becraft .... 85 feet

"The fauna is most abundant in the upper half, where Rensselaeria aequiradiata is the most characteristic fossil. No Spirifer macropleura occurs here. Other fossils are a small Leptocoelia flabellites, Spirifer cyclopterus, S. concinnus, Cyrtina, etc."

Port Ewen. Not recognized as such in Maryland.

Oriskany .... 348 feet

The lower 90 feet, which are silicious shales, contain near the base Leptocoelia flabellites; just below the middle, Leptocoelia flabellites, Spirifer tribulis, Beachia suessana immatura, Tentaculites acula, Diaphorostoma desmatum, etc. and, near the top, there are many specimens of Chonetes hudsonicus.

The upper 258 feet of calcareous sandstone contain in the lowest beds, Spirifer cumberlandiae, S. concinnoides, etc. but fossils are rare in the lower 100 feet; the upper 158 feet contain the typical Hipparionyx fauna.

Esopus, Schoharie and Onondaga are wanting in Maryland and farther south, the Marcellus being deposited on the eroded Oriskany.

Conclusions

From the above it is seen that the Manlius is faunally very similar in the New York and New Jersey sections but differs in the Maryland section in that the latter contains many such Coeymans fossils as the bryozoan Orthopora and brachiopods closely resembling Uncinulus campbellanus (Hall) and Gypidula galeata (Dalman). The latter also contains such Cobleskill species as Calymmene camerata Conrad.

The Coeymans of all the sections is similar in the development of chert in the middle beds. Sections 1, 3 and 4 agree in having a basal coral zone while 1, 2, 3 and 4 agree in having the upper beds shaly in character, with Gypidula galeata (Dalman) abundant in the whole of the formation. In Maryland (section 5) the Stromatopora horizon is at the middle of the Coeymans while the typical Gypidula galeata does not occur below the upper beds.

The New Scotland of all the sections is very similar, lithically and faunally. Spirifer macropleura (Conrad) is found in the whole formation in all the regions with the possible exception of the lower 20 feet of section 4 and the upper portion of section 2; in the latter, Gypidula pseudogaleata (Hall) is also present, thus closely resembling the Becraft. Edriocrinus pociliiformis Hall occurs in the lower beds of section 5 while it was not found earlier than the Becraft at Trilobite mountain.

The Becraft is a coarsely crystalline limestone (calcarenite) in sections 1, 2 and 3, containing many specimens of Gypidula pseudogaleata (Hall) and Spirifer concinnus Hall. In section 4 these beds will probably be found in the lower portion of the covered strata called Port Ewen, as the upper 20 feet of that section, correlated with the Becraft on stratigraphic grounds, are very similar both lithically and faunally to the uppermost New Scotland of section 3. No Gypidula pseudogaleata occurs in the Maryland section but Spirifer concinnus does; the latter species is thus found in all the sections, omitting section 4. Spirifer macropleura (Conrad) does not occur in the Becraft in any section.

The Port Ewen is not recognized in section 5, and is covered in section 4. In section 1 it is very similar lithically and faunally to the Coeymans, while in sections 2 and 3 it quite closely resembles in like characters the New Scotland.

The Oriskany of all the sections is more or less silicious. Some beds of section 2 and the upper Oriskany of section 5 are more distinctly sandstones. The fauna of sections 1 and 2 and the upper beds of 3 and 4 represent the calcareous facies of the normal Oriskany.[1] Sections 1 and 2 contain many more of the typical shallow water forms than do sections 3 and 4. The lower beds of sections 3, 4 and 5 contain an older Oriskany fauna. In the shallowing waters of the upper portion of the Oriskany of section 5 there was developed the normal Oriskany fauna.

As seen from the above sections, there is an increase in thickness of the upper Siluric and the lower Devonic strata from the north to the south, indicating a greater subsidence in the latter than in the former regions. These strata thin out westward in New York State, disappearing, with the exception of 7 feet of Manlius[2] and several inches of doubtful Oriskany sandstone, before Buffalo is reached. This is shown in the accompanying diagram [fig.4] taken from Hartnagel's report on the Cobleskill limestone of New York.[3]

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[1] See Oriskany under "General description of each horizon."

[2] Grabau, A. W. Siluro-Devonic Contact in N. Y. Geol. Soc. Am. Bul. 1900. p.347-76.

[3] Hartnagel, C. A. Preliminary Observations on the Cobleskill ("Coralline") Limestone of New York. N. Y. State Paleontol. An. Rep't. 1902. p.1109-75.

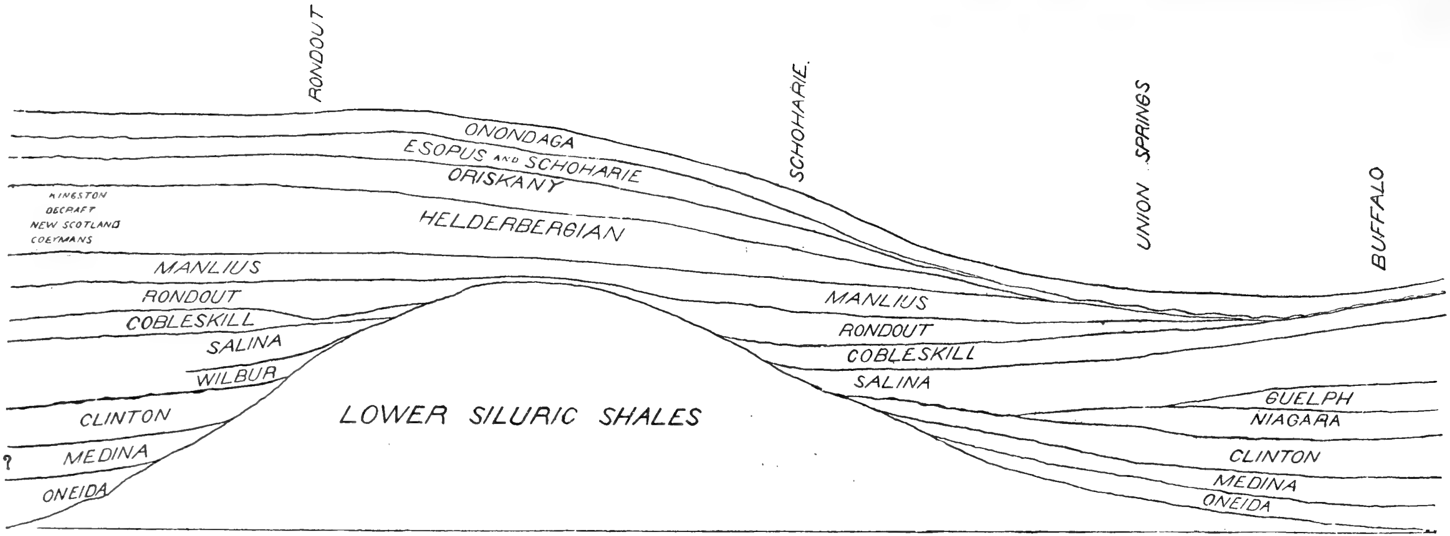

Fig. 4 Diagram showing overlaps and succession of formations of the Mississippian sea and an early stage of the Cumberland basin (After Hartnagel)

One of the most noticeable differences between the upper Siluric and lower Devonic formations of New York and Maryland is the greater development of limestones with the corresponding less development of shales in the latter region. In Maryland the clear water condition allowing the deposition of limestone began in the Salina and was continued almost without interruption to the Oriskany.[1] The Manlius fauna entered at the close of the Salina and continued during a deposit of over a hundred feet of strata; the land was, as during the Coeymans, at a considerable distance from the present exposed strata. During at least the upper New Scotland times, land was not far distant from any of the five sections, but it either soon sank again or a deflection of currents carried the muddy waters in another direction, allowing the deposition of the Becraft. In northwestern New Jersey and eastern New York, this was followed by a return of the New Scotland conditions, during which the Port Ewen was laid down.

During the Oriskany the shore line was again nearer, so that the deposit throughout the whole extent from Becraft mountain to western Maryland is a silicious limestone. At the close of this period the land rose both to the south and north. From the middle of Pennsylvania southward through western Maryland, land conditions existed, for the Marcellus rests on the eroded Oriskany;[2] but in New Jersey and New York the shore line after remaining near during a deposition of from 300 to 500 feet of the arenaceous shales of the Esopus, again retired to some distance, producing clear water, during which the heavily bedded Onondaga limestones were deposited. That this submergence took place slowly is indicated by the very gradual change from the Esopus to the Onondaga.

It is interesting to note that chert is prominently developed in the Coeymans and New Scotland in each of the five sections, i. e. from Becraft mountain in eastern New York to western Maryland.

Evidence of migration of faunas

Favosites helderbergiae praecedens occurs in the lowest Manlius of western Maryland. In New York and New

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[1] Schuchert. On the Lower Devonic and Ontaric Formations of Maryland. U. S. Nat. Mus. Proc. 26:413-24.

[2] —— 1903. p.414.

Jersey F. helderbergiae is very abundant in the lowest Coeymans. In southern New York a few specimens have been noted in the upper Manlius.

Among bryozoa the genus Orthopora is recorded by Schuchert from the upper Manlius of Maryland. This is, according to Nickles and Bassler [1900] its earliest appearance. It is next found in the Helderbergian, where it is abundantly represented in the upper Coeymans and lower New Scotland of Trilobite mountain.

Gypidula galeata makes its first appearance in the upper Manlius of western Maryland as a small variety. This is here exceedingly abundant. It has not been found in the New York or New Jersey Manlius but the normal form appears in great numbers in the lower Coeymans; it is not present, however, in the Manlius-Coeymans transition (Favosites bed).

Leptocoelia flabellites occurs as a small variety in the Becraft of Maryland but not below the upper division of the Oriskany at Trilobite mountain.

Beachia suessana appears in the lower Oriskany of western Maryland as the variety immatura. These basal beds are probably contemporaneous with part of the Port Ewen of New York, since the latter are not recognized in Maryland and there was a continuous deposition. The first appearance of this species in New Jersey and New York was in the lower Oriskany.

These species appear to indicate a northward migration.

DETAILED DISCUSSION OF THE STRATA AND FAUNAS OF THE VARIOUS FORMATIONS AT TRILOBITE MOUNTAIN

Less than one eighth of a mile east of the tollgate which is at the southwest terminus of Trilobite mountain, is the road leading along the southeastern foot of the mountain. This may be called for convenience the Bennett road from the Bennett's limestone quarries which are situated by its side, and is, as noted on the sketch map, a public road for about one half the distance. Beyond this it is either a rough wood road or a mere foot path. It is along this road that the following sections begin, passing northwestward across the strike of the beds. The mountain, with the slight exception of a few cleared fields, is covered with so dense a growth of shrubs and small trees that not only is traveling very difficult, but the rock outcrops are often concealed from view even at the distance of a few feet. This, together with the fact that most of the strata are covered with talus or drift, renders impossible the careful notation of successive beds and their fossil contents which one could wish. Another peculiarity of the region and one which makes the correlation of beds still more difficult, is the numerous hogbacks for which the mountain is justly noted. These as already noted are probably due to the greater or less development of certain cleavages over others, rendering the rock more susceptible to the disintegrating influences of the weather along the lines of the more pronounced cleavage. The length of the hogbacks is in the direction of the strike of the beds. At times when the hogback is very short, a well developed cleavage may obscure the strike.

The following sections are numbered from southwest to northeast along the Bennett road, beginning always on the northwest side of the road.[1]

Section A

This begins in a small quarry situated about 35 rods northeast of the junction of the Bennett road with the turnpike. This quarry was opened in the lower Oriskany since the sandy nature of the weathered rock renders it available for road material, though not eminently so.

A1 A dense, blue, very silicious limestone in coarsely shaly beds, weathering into a brown sandstone. Upper Port Ewen and Lower Oriskany .... 30 feet

The following fossils were found in the upper part:[2]

C=very common; c=common; r=rare; R=very rare.

85 Spirifer murchisoni *Castelnau*
104 Actinopteria *cf.* communis
137 Dalmanites *cf.* pleuroptyx
Crinoid joints

A2 Strata concealed by talus. Lower and Upper Oriskany. 125 feet

A3 Dark blue, thin bedded limestone. Upper Oriskany... 8 feet

[1]See local map.

[2]The numbering refers to the table at the end of the paper.

A4 Dark blue limestone in one bed. In the middle of this is a 3 inch, exceedingly fossiliferous band from which the following fossils were identified. Upper Oriskany............. 1 foot

47 Coelospira dichotoma *Hall* c
48 Leptocoelia flabellites (*Conrad*) c
53 Meristella lata *Hall*
61 Orbiculoidea jervisensis (*Barrett*) ?
85 Spirifer murchisoni *Castelnau*
127 Tentaculites elongatus *Hall*

A5 Dense blue limestone containing many specimens of Tentaculites elongatus. In the basal portion of this is a chert band very similar to K33. Upper Oriskany.......... 10 feet
In the lower half of this outcrop were collected:

53 Meristella lata *Hall* ?
85 Spirifer murchisoni *Castelnau*
127 Tentaculites elongatus *Hall*

In the upper half:

30 Chonostrophia complanata *Hall*
34 Coelospira dichotoma (*Hall*)
85 Spirifer murchisoni *Castelnau* C

A6 Dense blue, upper Oriskany limestone extending to a band exceedingly full of large individuals of Tentaculites elongatus. This takes the section to the top of the hill bordering the Bennett road .... 10 feet

Section B

Section B begins about 95 rods northeast of section A, in a cleared field, or 8 rods southwest of an excellent spring (Pflaum's), which is easily noticed at the very edge of the western side of the road.

B1 Concealed strata. Upper New Scotland to Lower Port Ewen.. 210 feet

B2 Strata covered. Upper Port Ewen to Lower Oriskany. The last talus of the Trilobite bed was found at the top of this locality .... 100 feet
Few specimens of Dalmanites dentatus were found but many of the characteristic shells.

Section C

Section C begins about 30 rods northeast of section B, or 18 rods northeast of Pflaum's spring.

C1 Very finely grained, dark gray limestone; wherever it is weathered it is quite friable. This bed is very fossiliferous. Coeymans .... 6 feet

8 Favosites *sp.*
13 Lichenalia torta *Hall*
23 Atrypa reticularis (*Linnaeus*)
33 Coelospira concava (*Hall*)
40 Dalmanella subcarinata *Hall*
42 Eatonia medialis (*Vanuxem*)
44 Gypidula angulata *Weller* R
45 G. galeata (*Dalman*) C
57 Nucleospira elegans *Hall* ?
58 N. ventricosa *Hall* r
75 Rhynchonella semiplicata (*Conrad*) ?
76 Rhynchospira formosa *Hall* c
78 Schizophoria bisinuata *Weller* ?
79 S. multistriata *Hall* ?
82 Spirifer cyclopterus *Hall* C
88 Stropheodonta becki *Hall*
89 S. varistriata (*Conrad*) r
94 Strophonella punctulifera (*Conrad*)
98 Uncinulus mutabilis *Hall* c
99 U. nucleolatus *Hall* c
100 U. pyramidatus *Hall* c
110 Pterinea? naviformis *Conrad* R
123 Platyceras *sp.* R
129 Tentaculites *sp.*
137 Dalmanites pleuroptyx (*Green*) R
143 Proetus protuberans *Hall* R

C2 Rather coarsely grained limestone, usually in beds 1 to 3 feet thick. This extends up to the first chert band. Coeymans .... 15 feet

The most abundant fossils were:

8 Favosites *sp.*
45 Gypidula galeata (*Dalman*) C
52 Meristella laevis (*Vanuxem*) C
137 Dalmanites pleuroptyx (*Green*)

C3 A finer grained limestone than the preceding. The chert bands vary from ⅛ to 1 inch in thickness. Coeymans........ 9 feet

23 Atrypa reticularis (*Linnaeus*) c
45 Gypidula galeata (*Dalman*) c
52 Meristella laevis (*Vanuxem*) c
131 Orthoceras helderbergiae? *Hall* R
140 Phacops logani *Hall* R

C4 This limestone is similar to the preceding but contains more chert. The chert bands here vary from ½ inch to 2 inches in thickness and are from 1 to 2 inches apart. After weathering the chert is about as light as pumice stone. On the surfaces of partially weathered chert is an excellent place to note bryozoa. Lower New Scotland .... 11 feet

1 Hindia fibrosa? (*Roemer*)
5 Enterolasma strictum *Hall* c
8 Favosites *sp.*
13 Lioclema cellulosum? (*Hall*)
14 L. ponderosum (*Hall*) r
17 Orthopora regularis (*Hall*) c
18 O. rhombifera (*Hall*) C
20 Unitrypa praecursa (*Hall*)?
26 Bilobites varicus (*Conrad*) r
41 Delthyris perlamellosa *Hall* c
42 Eatonia medialis (*Vanuxem*) r

C5 Strata covered with talus. Lower New Scotland and Upper New Scotland .... 140 feet

C6 An outcrop of dark blue limestone is exposed on the brow of the hill. Upper New Scotland......................... 5 feet

5 Enterolasma strictum *Hall* r
40 Dalmanella subcarinata *Hall*
47 Leptaena rhomboidalis (*Wilckens*)
52 Meristella laevis (*Vanuxem*) r
62 Orthothetes woolworthanus *Hall*
71 Rhipidomella oblata *Hall*
82 Spirifer cyclopterus *Hall* C
88 Stropheodonta becki *Hall*
90 S. varistriata *var.* arata *Hall*

Section D

This section begins 15 rods northeast of section C, or 34 rods northeast of Pflaum's spring in the large Bennett quarry.

D1 Dense, compact, dark blue almost black limestone. A finely grained variety alternates with one rather coarsely grained in beds

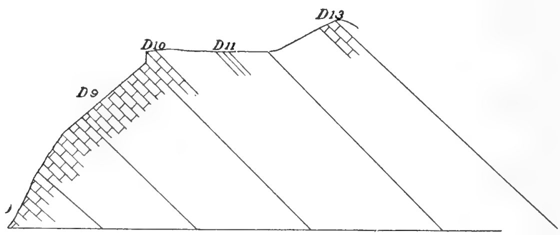

Fig. 5 Section D

from 1 to 6 inches thick, separated by almost black shale seams; these latter vary in thickness from a fraction of an inch to an inch and are very irregular; the thinner ones at times even present an appearance similar to cranial sutures. The thicker ones are not so irregular but are rather as though molded over little hillocks. These shale seams are often separated from the rock above and below by calcite seams, the crystallization of which is vertical to the bedding plane; at times even the laminae of the shale are farther separated thus. There are quite coarsely grained layers, specially toward the upper part of this locality; these are usually only 1 to 3 inches in thickness; the last one of these occurs about 2 feet below the base of the Favosites bed.................................... 20 feet

The following is a more detailed subdivision of the above from the base upward.

D1a Alternately fine and medium grained limestone with many irregular shale seams. It contains many minute crystals of iron pyrites. Upper Manlius . . . . 5 feet

These fossils were found here,—

7 Favosites sphaericus *Hall*
Sphaerocystites multifasciatus? *Hall* c
16 Monotrypella? abrupta? (*Hall*)
Atrypa *sp.*
86 Spirifer vanuxemi *Hall*
89 Stropheodonta varistriata (*Conrad*) r
103 Whitfieldella? nucleolata (*Hall*)
Euomphalus? R
116 Loxonema *sp.*
124 Pleurotomaria *sp.*
128 Tentaculites gyracanthus (*Eaton*) c
135 Dalmanites micrurus (*Green*)
144 Beyrichia manliusensis *Weller* r
145 B. *sp.* c

D1b Rather coarse grained with small and scattered particles of chert; at times the chert is absent for several horizontal feet . . . . 6 inches

D1c Alternating fine and medium grained limestone . . . . . 6 feet

86 Spirifer vanuxemi *Hall* c
89 Stropheodonta varistriata (*Conrad*) C
103 Whitfieldella? nucleolata (*Hall*) c
128 Tentaculites gyracanthus (*Eaton*) r
145 Beyrichia *sp.*

D1d Medium grained with very small particles of chert scattered through the bed . . . . 6 inches

86 Spirifer vanuxemi *Hall*
89 Stropheodonta varistriata (*Conrad*)
108 Megambonia aviculoidea *Hall* r

D1e Alternately fine and rather coarse grained limestone . . . . 2 feet, 4 inches

86 Spirifer vanuxemi *Hall*
89 Stropheodonta varistriata (*Conrad*)
103 Whitfieldella? nucleolata (*Hall*)

D1f Fine grained limestone which shows good sub-bedding; specially is this seen where the rock has been exposed to atmospheric agencies since glacial times. Here the laminae stand out with tissue paperlike thinness. A corresponding development of sub-bedding was not noticed in any of the other beds, perhaps because none of them had apparently been weathered for the same length of time . . . . 3 feet

86 Spirifer vanuxemi *Hall*
89 Stropheodonta varistriata (*Conrad*)
102 Uncinulus *sp.*

D1g Alternating coarse and fine grained limestone.... 32 inches

6 Favosites helderbergiae *Hall* r
86 Spirifer vanuxemi *Hall* r
89 Stropheodonta varistriata (*Conrad*) r
103 Whitfieldella? nucleolata (*Hall*)
146 Leperditia alta (*Conrad*) c

D2 Favosites bed. From one to several inches below the base of this bed is a shale seam from ⅛ to ¾ inch in thickness; but above the seam the lithic character of the rock is the same as beneath it, that is, a fine grained dark blue limestone similar to the lower portion of D1a. This extends up between the heads of the Stromatopora and Favosites which suddenly become very numerous.. 3 feet

This bed is subdivided as follows:

D2a This is made up almost entirely of masses of Stromatopora and Favosites; the interspaces between these are filled with a fine grained, dark blue limestone. Stromatopora individuals are greatly in excess of all other fossils. Specimens of Favosites partially surrounded by Stromatoporoid growths and vice versa are quite common. This layer is specially noticeable when weathered; the concentrically wrinkled laminae of the hydrozoon stand out then very conspicuously. The Stromatoporoid masses vary in diameter from 2 to 9 inches.................................. 9-10 inches

The following fossils were found:

2 Stromatopora concentrica? *Goldfuss* C
6 Favosites helderbergiae *Hall* C
7 F. sphaericus *Hall* C
9 Zaphrentis roemeri *Edwards & Haime* r

D2b First crinoidal bed. The rock is coarse grained through the presence of very many crinoid joints. No Stromatoporas were noticed here, but Favosites is still present, though in greatly diminished numbers .... 1+ foot

7 Favosites sphaericus *Hall* C
89 Stropheodonta varistriata (*Conrad*) r

D2c A fine grained limestone very similar to D2a. Where this layer is absent it is represented by a weathered line of separation.

No fossils were noticed . . . . 1-2 inches

D2d Second crinoidal bed. Same character of limestone as D2b. The only fossils seen here were Favosites sphaericus Hall which was very abundant, and F. helderbergiae Hall which was rare . . . . 1 foot

D2e Iron stain . . . . a line

The entire Favosites bed is always closed by a line of iron stain. This is not a perfectly straight line but will at times rise a half foot above a Favosites head. The succeeding bed is very full of specimens of Gypidula galeata resting often immediately on the iron stain but never, as far as noticed, occurring below this. Specimens of Favosites occur in the higher beds, but very rarely as compared with their abundance in the Favosites bed. The line where the iron stain occurs weathers into an open seam.

D3 This bed succeeds the iron stain and but for the very great number of individuals of Gypidula galeata present would have been placed in the upper band of the Favosites bed. This stratum becomes gradually more finely crystalline till the characteristic rock of bed D4 occurs. Coeymans . . . . 1-6 inches

6 Favosites helderbergiae *Hall* c
23 Atrypa reticularis (*Linnaeus*) r
45 Gypidula galeata (*Dalman*) c

D4 Very finely crystalline limestone. Few fossils and these mostly specimens of Gypidula galeata. Coeymans . . 2½-3 feet

D5 Limestone, very coarsely crystalline from the abundance of crinoid joints and broken shells present. The lower portion is specially full of individuals of Gypidula galeata. Coeymans . . . . 4¼ feet

7 Favosites sphaericus *Hall* c
12 Lichenalia torta *Hall* r
23 Atrypa reticularis (*Linnaeus*) r
45 Gypidula galeata (*Dalman*) C
88 Stropheodonta becki *Hall* c
98 Uncinulus mutabilis *Hall* r
102 U. *sp.*
123 Platyceras *sp.* R

D6 Bed D5 changes suddenly to a friable, finely grained rock. Coeymans . . . . 9 feet

23 Atrypa reticularis (*Linnaeus*) r
45 Gypidula galeata (*Dalman*) c

D7 A rather coarsely crystalline limestone very similar to D5 Coeymans . . . . 11½ feet

D8 A rather finely crystalline gray limestone containing numerous chert bands. The chert appears here for the first time since leaving locality D1. Lower New Scotland.................... 30½ feet

5 Enterolasma strictum *Hall* c
33 Coelospira concava (*Hall*) r
40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa *Hall* c
42 Eatonia medialis (*Vanuxem*) R
47 Leptaena rhomboidalis (*Wilckens*)
52 Meristella laevis (*Vanuxem*) c
54 M. princeps *Hall* R
74 Rhynchonella bialveata? *Hall*
76 Rhynchospira formosa *Hall* R
121 Platyceras tenuiliratum *Hall* R

D9 Strata covered with talus. Lower New Scotland to Upper New Scotland .... 132 feet

D10 Gray shale. Upper New Scotland .... 10 feet

5 Enterolasma strictum *Hall* r
12 Lichenalia torta *Hall* R
33 Coelospira concava (*Hall*) c
40 Dalmanella subcarinata *Hall* r
42 Eatonia medialis (*Vanuxem*) r
72 Rhipidomella tubulistriata *Hall* R
82 Spirifer cyclopterus *Hall* c
123 Platyceras *sp.*
138 Dalmanites *sp.* R

D11 Concealed strata. Upper New Scotland, Becraft and Port Ewen .... 95 feet

D12 Blue limestone containing some chert. Port Ewen.. 5 feet

5 Enterolasma strictum *Hall*
12 Lichenalia torta *Hall*
53 Meristella lata *Hall*
94 Strophonella punctulifera (*Conrad*)

D13 Strata covered with soil take us to the top of a hogback which is formed of a finely grained, dark blue, very hard limestone which weathers first into a brown sandstone and then into a coarse yellow clay. Port Ewen .... 75 feet

D14 Strata covered take to the Trilobite bed. Port Ewen and Lower Oriskany .... 100 feet

D15 Concealed strata take to the swamp. Upper Oriskany .... 90 feet

Section E

Section E begins about 20 rods northeast of section D in a small, abandoned quarry in the Upper Manlius.

E1 Manlius .... 31 feet

This is subdivided as follows:

E1a A coarsely grained blue limestone. Lower Manlius.. 1 foot

E1b A quite finely grained blue limestone, with narrow calcite veins, capped by a 2 inch band very full of specimens of Stropheodonta varistriata (Conrad). Lower Manlius 3½ feet

E1c Limestone similar to the last. Few fossils. Lower Manlius .... 11 inches

E1d Tentaculite band. Specimens of Tentaculites gyracanthus (Eaton) are very abundant here. This band varies greatly in thickness, being at times represented by merely a superficial layer of the shells. Here were also found Megambonia aviculoidea Hall R and Beyrichia manliusensis Weller r. Lower Manlius.......................... ½ inch

E1e Finely grained, dark blue limestone, usually in 1 inch beds separated by black shale seams. Lower Manlius......... 6 inches

E1f A blue limestone of medium grain from which the following fossils were identified. Lower Manlius................. 1 foot

89 Stropheodonta varistriata (*Conrad*) c
128 Tentaculites gyracanthus (*Eaton*) R
146 Leperditia alta *Conrad* R

E1g Finely grained limestone with thin and very irregular shale seams. The upper foot is quite fossiliferous. Upper Manlius .... 3 feet

From it were identified:

86 Spirifer vanuxemi *Hall* R
89 Stropheodonta varistriata (*Conrad*) R
103 Whitfieldella? nucleolata (*Hall*) c

E1h Limestone similar to the preceding. Upper Manlius .... 3¾ feet

86 Spirifer vanuxemi *Hall*
103 Whitfieldella? nucleolata (*Hall*)
116 Loxonema *sp.*
128 Tentaculites gyracanthus (*Eaton*)

E1k A rather finely grained limestone which is very fossiliferous. The rock is very full of gastropod shells which are closely similar to Loxonema or Holopea; but as they are very coarsely crystalline it is almost impossible to get them from the rock. Upper Manlius .... 3 inches

86 Spirifer vanuxemi *Hall* r
89 Stropheodonta varistriata (*Conrad*) c
103 Whitfieldella? nucleolata (*Hall*) c
Loxonema?
144 Beyrichia manliusensis *Weller* r
146 Leperditia alta *Conrad* r

E1l A rather finely grained limestone. Upper Manlius . . 2¼ feet

89 Stropheodonta varistriata (*Conrad*) c
103 Whitfieldella? nucleolata (*Hall*) r
114 Holopea antiqua? (*Vanuxem*) c

E1m A rather coarsely grained limestone which is quite fossiliferous. A little chert was noticed in the lower portion. Upper Manlius . . . . 15 inches

89 Stropheodonta varistriata (*Conrad*) C
103 Whitfieldella? nucleolata (*Hall*) r
114 Holopea antiqua? (*Vanuxem*) c
144 Beyrichia manliusensis *Weller* R

From E1m to the base of the Favosites bed no strata are exposed. Upper Manlius . . . . 13 feet

Section F

A few rods northeast of the last section is a large abandoned quarry in the center of which this section begins.

F1 The Manlius is here separated into an outer and an inner portion by an old quarry floor. It is possible that the outer portion represents a block of the same rock as the inner, that, undermined by the larger stream that formerly flowed through this valley, has fallen to its present position. Such fallen blocks occur ¼ of a mile farther to the northeast at what is locally known as the Ramapo Hole.

Though this explanation is possible it does not seem probable. The strike and dip are the same for both portions of this locality. The fossils also indicate that the rocks are from different horizons. The outer portion (F1) has a thickness of 13 feet and is much weathered. It has the same lithic character as E1. No chert band was noticed. The following is a detailed subdivision from the base upward. Lower Manlius.

F1a Dark blue limestone. Lower Manlius . . . . 1 foot

F1b Gnarled bed. A concretionary, dark blue limestone, composed almost wholly of nodules varying in diameter from ⅛ inch to 1 inch, which on weathered surfaces are shown to be Stromatoporoid masses. This appears to be structurally similar to Stromatopora bed 3 at Becraft mountain.[1] Weller also notes the occurrence of Stromatoporoid masses over 30 feet beneath the Favosites bed.[2] Lower Manlius.. 5 feet

F1c Finely grained limestone. Lower Manlius......... 1 foot

F1d Lower 2 inches are a finely grained limestone, the rest is coarse. Both portions contain Spirifer vanuxemi Hall and Beyrichia manliusensis Weller in abundance. Leperditia alta Conrad and Loxonema sp. were occasionally found. Lower Manlius........................ 1 foot

F1e Very finely grained blue limestone, in which Spirifer vanuxemi Hall is very abundant. A few specimens of Leperditia alta Conrad were also found. Lower Manlius.. 1 foot

F1f Alternately fine and coarse grained blue limestone inclosing some shale bands. The following species, but not in abundance, were found here. Lower Manlius.................... 32 inches

86 Spirifer vanuxemi *Hall*
89 Stropheodonta varistriata? (*Conrad*)
116 Loxonema *sp.*
144 Beyrichia manliusensis? *Weller*
146 Leperditia alta *Conrad*

F1g Dark blue limestone. Lower Manlius........... 4 inches

F1h Light gray limestone with many specimens of Spirifer vanuxemi Hall and Stropheodonta varistriata (Conrad). No other fossils were noticed. Lower Manlius.. 1 inch

F1k Dark gray limestone. No fossils found.......... 5 inches

F1l Dark blue limestone exceedingly full of specimens of Spirifer vanuxemi Hall and Stropheodonta varistriata (Conrad). Lower Manlius................. 2 inches

F1m Alternating finely and coarsely grained, dark blue limestone. It has many conspicuous shale seams. Lower Manlius.... 4½ feet

The following fossils were collected:

86 Spirifer vanuxemi *Hall* C
89 Stropheodonta varistriata (*Conrad*) r
128 Tentaculites gyracanthus (*Eaton*) c
144 Beyrichia manliusensis *Weller* r

F1n A finely crystalline, dark blue limestone with alternating shale seams. Five inches from the top is a 1 inch band of which

[1] Grabau, A. W. Stratigraphy of Becraft Mountain, Columbia County, N. Y., N. Y. State Paleontol. An. Rep't 1902, p.1052.

[2] Weller. Geol. Sur. N. J. 3:78.

the lower and upper quarter inches are usually in large measure composed of Tentaculites gyracanthus (Eaton). Lower Manlius .... 20 inches

The following is a list of the fossils noticed here:

86 Spirifer vanuxemi *Hall*	145 Beyrichia *sp.*
128 Tentaculites gyracanthus (*Eaton*)	146 Leperditia alta *Conrad*

F1p Between cliffs F1n and F1q there is no outcrop. Upper Manlius .... 21 feet

F1q A dark gray limestone weathering dark blue. Lithologically it is quite similar to F1a-n but it is much less weathered. No fossils were found in the lower portion but in the upper 1½ feet were found Whitfieldella? nucleolata (Hall) C and Spirifer vanuxemi *Hall* r. Upper Manlius.................. 7 feet

All of F1 is very coarsely grained and apparently much more fossiliferous but this may be largely due to greater weathering.

F2 The "Favosites Bed" as in section D begins suddenly after 2 or 3 inches of a finely grained limestone have been laid down on ½ inch shale band.................................. 3 feet

The following is the subdivision of F2. It is similar to that of section D.

F2a Many specimens of Stromatopora concentrica? Goldfuss and a few of Favosites helderbergiae Hall, separated by finely grained limestone, make up most of this layer. Whitfieldella? nucleolata (Hall) is represented by a few specimens from the basal 3 or 4 inches. Fragments of undetermined Ostracods, probably of Beyrichia, are scattered through the bed.................................... 9-10 inches

F2b First crinoidal bed. This is similar in lithic character to D2b. The rock weathers easily at the juncture of F2a and F2b. Favosites helderbergiae Hall is quite abundant. Stromatopora concentrica? Goldfuss is rather rare. Besides these fossils several specimens of Lichenalia torta Hall and a pygidium of Dalmanites pleuroptyx (Green) were found.................................. 14 inches

F2c This lettered layer of locality D is absent here but its place is indicated by a line of weathering.

F2d Second crinoidal bed. This is lithologically similar to D2d . . . . 1 foot

The following fossils were found:

2 Stromatopora concentrica? *Goldfuss* r
6 Favosites helderbergiae *Hall* C
7 F. sphaericus? *Hall*

F2e Iron stain. Though other iron stain lines are noticeable at intervals, one can not mistake this one as it is the most continuous and most pronounced.

With the exception of Whitfieldella? nucleolata, brachiopods seem to be entirely wanting in the Favosites bed, but immediately above they are very abundant. This is the more noticeable since the lower part of F3 and the upper part of F2d have the same lithic characters and often weather as a single bed.

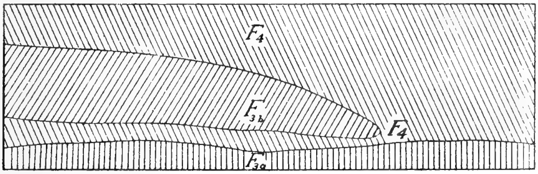

Fig. 6 Diagram of section F

F3 An alternation of coarsely and finely crystalline limestone. Coeymans . . . . 1-7 inches

The following is a list of the fossils found here:

6 Favosites helderbergiae *Hall* C
12 Lichenalia torta *Hall* c
23 Atrypa reticularis (*Linnaeus*) r
45 Gypidula galeata (*Dalman*) c
89 Stropheodonta varistriata (*Conrad*)
90 S. varistriata *var.* arata *Hall*
94 Strophonella punctulifera (*Conrad*)
102 Uncinulus *sp.*

This bed is subdivided as follows:

F3a A coarsely grained limestone mostly composed of crinoid joints, which seems to be a modified continuation of F2d. A few brachiopods were noticed . . . . 1-3 inches

F3b This is of the same lithic character as F4 and doubtless represents the beginning of the latter bed, but the conditions changing brought the typical F3 sediment in again, for at the northern end of the quarry, F4 rests on F3a but as we follow F4 southward, we find it penetrated by a more coarsely grained layer which at the southern end of the quarry attains a thickness of 3 inches. This is represented in the preceding figure [fig.6] . . . . 1-3 inches

F4 A finely grained gray limestone. The fossils are comparatively much less abundant than in either the preceding or succeeding bed. Coeymans .... 3 feet

The following is a list of the fossils:

7 Favosites sphaericus *Hall* r
12 Lichenalia torta *Hall* c
45 Gypidula galeata (*Dalman*) c
89 Stropheodonta varistriata? (*Conrad*) R
102 Uncinulus *sp.*
123 Platyceras *sp.* R

F5 A coarsely grained, dark gray limestone made up in great part of large crinoid joints. Most of the grains are surrounded by a coating of limonite. Coeymans........................ $4\frac{1}{2}$ feet

The following fossils were obtained here:

6 Favosites helderbergiae *Hall* C
7 F. sphaericus *Hall* c
12 Lichenalia torta *Hall* r
45 Gypidula galeata (*Dalman*) C
G. galeata *var.*
88 Stropheodonta becki *Hall*

F6 Alternately finely and coarsely grained limestone. Coeymans .... 20 feet

This is subdivided as follows:

F6a Finely grained similar to F4.................. 15 inches

F6b Coarsely grained similar to F5.................. 8 inches

F6c Finely grained, friable........................ 5 inches

F6d Very coarsely grained. Favosites helderbergiae Hall is common here...................... $4\frac{1}{2}$ feet

F6e Finely grained limestone, at times shaly.......... 10 inches

F6f Very coarsely grained........................ $3\frac{1}{2}$ feet

Here were found:

12 Lichenalia torta *Hall* r
40 Dalmanella subcarinata *Hall* r
45 Gypidula galeata (*Dalman*) c

F6g A rather coarsely grained limestone. The upper foot and a half is at times exceedingly coarse grained, with limonite surrounding each grain where weathered......................... 9 feet

The following fossils were found here:

5 Enterolasma strictum *Hall* c
8 Favosites *sp.*
23 Atrypa reticularis (*Linné*) r
44 Gypidula galeata (*Dalman*) C

58 Nucleospira ventricosa *Hall* r
75 Camarotoechia semiplicata (*Conrad*) r
89 Stropheodonta varistriata (*Conrad*) R

F7 This stratum is characterized by many chert bands which vary in width from a mere line to 2 inches................ 26 feet

This is subdivided as follows:

F7a A very dark blue limestone with a few bands of chert. Fossils were not abundant. The only species found were Enterolasma strictum Hall c and Gypidula galeata (Dalman) c. Coeymans............................ 5 feet 4 inches

F7b Blue shaly limestone weathering to a very light chocolate color. Coeymans .... 1 foot

5 Enterolasma strictum *Hall* c
45 Gypidula galeata (*Dalman*) c
47 Leptaena rhomboidalis (*Wilckens*) c

F7c Very dense, dark blue limestone with very many chert bands which, when weathered, furnish excellent bryozoa. The chert of the preceding beds even when weathered shows little else than crinoid joints and comparatively few of these. Coeymans.. 4 feet 4 inches

The following fossils were collected here, most of them from the weathered surfaces of the chert bands:

5 Enterolasma strictum *Hall* c
12 Lichenalia torta *Hall* r
13 Lioclema cellulosum (*Hall*) c
17 Orthopora regularis (*Hall*) c
18 O. rhombifera (*Hall*) C
19 Unitrypa nervia (*Hall*) r
20 U. praecursa (*Hall*) c
33 Coelospira concava *Hall* r
37 Cyrtina *sp.* R
39 Dalmanella perelegans *Hall* r
40 D. subcarinata *Hall* c
41 Delthyris perlamellosa *Hall* c
45 Gypidula galeata (*Dalman*) c
47 Leptaena rhomboidalis (*Wilckens*)
Orbiculoidea *sp.*
63 Pholidops ovata *Hall* c
68 Reticularia modesta (*Hall*) r
71 Rhipidomella oblata *Hall* R
73 Camarotoechia altiplicata? *Hall* R
77 Rhynchospira globosa? *Hall* r
88 Stropheodonta becki *Hall* r
136 Dalmanites nasutus? *Conrad* R

F7d Dense, dark blue limestone full of chert bands. Lower New Scotland .... 15½ feet

The following fossils were collected:

5 Enterolasma strictum *Hall* C
7 Favosites sphaericus *Hall* r
26 Bilobites varicus (*Conrad*) r
40 Dalmanella subcarinata *Hall* c

82 Spirifer cyclopterus *Hall* r
S. octocostatus? *Hall* R
88 Stropheodonta becki *Hall* r
140 Phacops logani *Hall* r

F8 Talus concealing strata. Lower to Upper New Scotland .... 72 feet

F9 An outcrop of slaty shale exposed in a dug road. Upper New Scotland .... 5 feet

Following is a list of fossils found here:

5 Enterolasma strictum *Hall* c
33 Coelospira concava (*Hall*) C
40 Dalmanella subcarinata *Hall* c
41 Delthyris perlamellosa *Hall* c
42 Eatonia medialis (*Vanuxem*) c
47 Leptaena rhomboidalis (*Wilckens*) c
52 Meristella laevis (*Vanuxem*) c
58 Nucleospira ventricosa? *Hall* R
62 Orthothetes woolworthanus *Hall* r
71 Rhipidomella oblata *Hall* r
73 Camaratoechia altiplicata? *Hall* R
82 Spirifer cyclopterus *Hall* C
83 S. macropleura (*Conrad*) C
94 Strophonella punctulifera (*Conrad*) r
95 Trematospira multistriata *Hall* c
102 Uncinulus *sp.*

F10 Unexposed strata. Upper New Scotland to Lower Oriskany .... 298 feet

F11 Trilobite bed. Lower Oriskany .... 6 inches

A low ledge which yielded the following fossils:

25 Beachia suessana *Hall* c
47 Leptaena rhomboidalis (*Wilckens*) c
115 Loxonema jerseyense *Weller* r
135 Dalmanites dentatus *Barrett* C

F12 Unexposed strata. Upper Oriskany .... 62 feet

This extends to the edge of the swamp.

Section G

Section G begins 15 rods northeast of section F.

G1 Upper Manlius .... 19 feet

Subdivided as follows:

G1a A finely grained, blue limestone. Few fossils ...... 4½ feet

G1b Tentaculite layer. Tentaculites gyracanthus (Eaton) is exceedingly abundant .... 1 inch

G1c Thin bands of a dark blue limestone, averaging one inch in thickness, alternating with thinner bands of shale. This begins with a half inch shale seam lying immediately on the Tentaculite band . . . . 10 inches

G1d The lowest portion is a 3 foot bed of solid limestone. This is succeeded by a rather shaly limestone, 2 to 4 inches thick, alternating with thin shaly seams, ¼ to ½ inch thick . . . . 11½ feet

The following fossils were gathered here:

86 Spirifer vanuxemi *Hall* C
89 Stropheodonta varistriata (*Conrad*)
103 Whitfieldella? nucleolata (*Hall*) C
116 Loxonema *sp.*
128 Tentaculites gyracanthus (*Eaton*)
144 Beyrichia manliusensis? *Weller* r

G1e Chert is sparingly scattered through the lowest layer of this . . . . 2 feet

Section H

Section H begins 5 rods northeast of section G.

H1 Upper Manlius . . . . 13 feet

H1a An exceedingly dense, finely grained, dark gray limestone with very few fossils. Even where weathered from preglacial times, there are very few fossil fragments shown . . . . 11 feet

H1b Alternately finely and rather coarsely grained, dark gray limestone . . . . 2 feet

Fossils are much more abundant than in the preceding bed. The following were identified:

Favosites?
86 Spirifer vanuxemi *Hall* r
103 Whitfieldella? nucleolata (*Hall*) C
116 Loxonema *sp.*
144 Beyrichia manliusensis? (*Weller*) r
146 Leperditia alta (*Conrad*) c

H2 Favosites bed. The lower 4 inches weather quite red. The whole bed is full of Stromatopora heads . . . . 1 foot

The following fossils were identified:

2 Stromatopora concentrica? *Goldfuss* C
6 Favosites helderbergiae *Hall* c
7 F. sphaericus *Hall* r
64 Rensselaeria *cf.* aequiradiata (*Conrad*) R
89 Stropheodonta varistriata (*Conrad*)
103 Whitfieldella? nucleolata (*Hall*) r

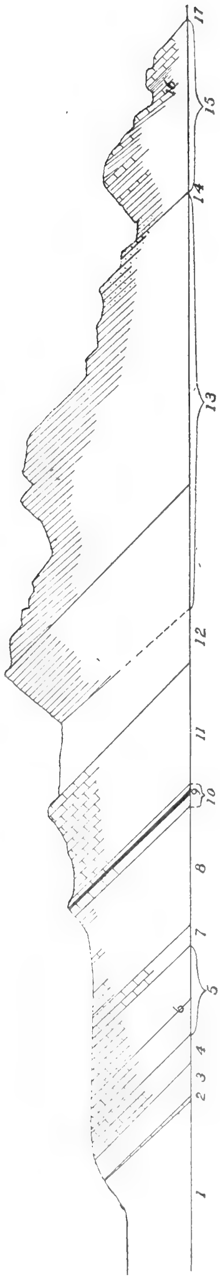

Fig. 7 Section K

Section K

This section begins 12 rods northeast of section H where a lane turns up the hill leading to the residence of Mr William Balmos.

K1 Uppermost Manlius immediately below the Favosites bed....................2 feet

K2 Unexposed strata. Favosites bed to Lower New Scotland................50 feet

K3 Very finely grained, cherty, blue limestone. Lower New Scotland..........6 feet

The following fossils were identified from this locality:

41 Delthyris perlamellosa *Hall* c
42 Eatonia medialis (*Vanuxem*)
47 Leptaena rhomboidalis (*Wilckens*)
50 Lingula *sp.*
52 Meristella laevis (*Vanuxem*)
113 Diaphorostoma ventricosum (*Conrad*) R
140 Phacops logani *Hall* r

K4 Thin bedded, dark gray shale. One foot from the base is a half inch band of light gray sandstone. Lower New Scotland.......
2 feet, 4 inches

42 Eatonia medialis (*Vanuxem*) C
43 E. singularis (*Vanuxem*) r
50 Lingula *sp.*
52 Meristella laevis (*Vanuxem*) r
Orbiculoidea *sp.*
88 Stropheodonta becki *Hall*
92 Strophonella headleyana *Hall*
132 Orthoceras *sp.*

K5 Dense, dark blue limestone. Lower New Scotland.....................15 inches

5 Enterolasma strictum *Hall* c
8 Favosites *sp.*
40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa *Hall* r

42 Eatonia medialis (*Vanuxem*) r
52 Meristella laevis (*Vanuxem*) c
71 Rhipidomella oblata *Hall*
92 Strophonella headleyana *Hall*

K6 An arenaceous limestone. Lower New Scotland... 5 inches

16 Monotrypella? abrupta (*Hall*) c
21 Vermipora serpuloides *Hall* c
24 Atrypina imbricata? *Hall*
33 Coelospira concava *Hall* c
40 Dalmanella subcarinata *Hall*
52 Meristella laevis (*Vanuxem*) R
60 Orbiculoidea discus? *Hall* R
68 Reticularia modesta (*Hall*)
71 Rhipidomella oblata *Hall*

K7 Following is given the detailed subdivision from the base upward. Lower New Scotland................ 2 feet, 8½ inches

K7a Dense, blue limestone in several thin beds...... 7½ inches

K7b Black shale.............................. ⅛ inch

K7c Light gray sandstone......................... ⅞ inch

K7d Dense, dark blue limestone in 4 to 6 inch beds, including in the middle a 1 inch shaly limestone....................... 2 feet

The following fossils were identified from K7:

1 Hindia fibrosa? (*Roemer*) R
28 Chonetes hudsonicus *Clarke*
40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa? *Hall* R
47 Leptaena rhomboidalis (*Wilckens*)
50 Lingula *sp.*
52 Meristella laevis (*Vanuxem*) C
56 Nucleospira concentrica *Hall*
71 Rhipidomella oblata *Hall*
83 Spirifer macropleura? (*Conrad*) R
104 Actinopteria communis (*Hall*) R

K8 A dark gray, very fossiliferous shale including microscopic films of a black shale. This latter at times constitutes the main rock mass. Three inches from the top is a 3 inch sandstone band. Lower New Scotland................................ 21 inches

40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa *Hall* c
43 Eatonia singularis (*Vanuxem*) c
47 Leptaena rhomboidalis (*Wilckens*)
52 Meristella laevis (*Vanuxem*) C
54 M. princeps *Hall* R
83 Spirifer macropleura (*Conrad*) C

K9 This is subdivided from base upward as follows. Lower New Scotland .... 6 feet, 7 inches

K9a Dark gray, sandy, calcareous shale in 2 inch beds.. 15 inches

K9b Chert band................................ 1 inch

K9c Dark gray, calcareous shale including a limestone of varying thickness .... 2 feet

K9d Shale including in the middle a 6 inch limestone stratum and at intervals a thin chert band.................... 3 feet, 3 inches

40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa *Hall* R
43 Eatonia singularis (*Vanuxem*)
47 Leptaena rhomboidalis (*Wilckens*)
50 Lingula *sp.*
52 Meristella laevis (*Vanuxem*) c
83 Spirifer macropleura (*Conrad*) c
95 Trematospira multistriata *Hall* r
117 Platyceras *cf.* gibbosum *Hall* R
123 P. *sp.* R

K10 A dark gray, calcareous shale. Lower New Scotland.................................. 2 feet, 8 inches

40 Dalmanella subcarinata *Hall*
47 Leptaena rhomboidalis (*Wilckens*)
83 Spirifer macropleura *Conrad* R
113 Diaphorostoma ventricosum (*Conrad*) R
140 Phacops logani *Hall* R

K11 Strata concealed. Lower New Scotland........ 12½ feet

K12 A dark blue, much cleaved shale, which weathers to a brownish yellow clay. Upper New Scotland.................... 42 feet

K12a Comprises the lower.......................... 28 feet

The following fossils were found here:

24 Atrypina imbricata *Hall* c
33 Coelospira concava *Hall* r
40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa *Hall* R
42 Eatonia medialis (*Vanuxem*) r
43 E. singularis (*Vanuxem*) R
47 Leptaena rhomboidalis (*Wilckens*)
50 Lingula *sp.* c
52 Meristella laevis (*Vanuxem*) c
63 Pholidops ovata *Hall* r
64 Rensselaeria *cf.* aequiradiata (*Conrad*)
82 Spirifer cyclopterus *Hall* r
83 S. macropleura (*Conrad*) R
88 Stropheodonta becki *Hall*
92 Strophonella headleyana *Hall*

The Lingulas occur in calcareous, phosphatic, clay nodules. No manganese was detected in the nodules. Hall[1] notes the occurrence of the nodules and their "uniformly elongated oval or ovoid form" in the New Scotland in Albany county, N. Y.

K12b Comprises the upper.......................... 14 feet

33 Coelospira concava *Hall* c
40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa? *Hall* R
47 Leptaena rhomboidalis (*Wilckens*)
52 Meristella laevis (*Vanuxem*) r
83 Spirifer macropleura (*Conrad*)
127 Tentaculites elongatus *Hall* R

[1] Pal. N. Y. 3:158.

K13 Concealed strata. Upper New Scotland.......... 17 feet

K14 A dense, blue, more or less shaly limestone, subdivided as follows. Upper New Scotland......................... 35 feet

K14a Rather coarsely shaly......................... 18 feet

33 Coelospira concava *Hall*
40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa *Hall* r
47 Leptaena rhomboidalis (*Wilckens*)
79 Schizophoria multistriata *Hall* R
82 Spirifer cyclopterus *Hall* c
88 Stropheodonta becki *Hall*

K14b The limestone becomes quite heavy bedded........ 6 feet

33 Coelospira concava *Hall* c
41 Delthyris perlamellosa? *Hall* c
47 Leptaena rhomboidalis (*Wilckens*)
52 Meristella laevis (*Vanuxem*) c
82 Spirifer cyclopterus *Hall* c
83 S. macropleura (*Conrad*) r
88 Stropheodonta becki *Hall* r
96 Trematospira perforata? *Hall*
100 Uncinulus pyramidatus *Hall* R

K14c Shaly limestone similar to K14a................. 8 feet

40 Dalmanella subcarinata *Hall*
41 Delthyris perlamellosa *Hall* c
47 Leptaena rhomboidalis (*Wilckens*)
52 Meristella laevis (*Vanuxem*) r
71 Rhipidomella oblata? *Hall*
82 Spirifer cyclopterus *Hall* c
83 S. macropleura (*Conrad*) c
94 Strophonella punctulifera? (*Conrad*)
130 Cyrtolites? expansus *Hall* c

K14d Limestone similar to K14b....................... 3 feet

Delthyris perlamellosa Hall is the only fossil collected here.

K15 Concealed strata. Upper New Scotland.......... 4½ feet

K16 Blue, shaly limestone, very fossiliferous. Upper New Scotland .... 2½ feet

40 Dalmanella subcarinata *Hall* c
47 Leptaena rhomboidalis (*Wilckens*)
52 Meristella laevis (*Vanuxem*) c
82 Spirifer cyclopterus *Hall* c
83 S. macropleura (*Conrad*) c
88 Stropheodonta becki *Hall*
92 Strophonella headleyana *Hall*

K17 Concealed strata which weather as though they were softer than the preceding. Upper New Scotland............... 12 feet

K18 Dense, blue, calcareous shale alternating with more arenaceous beds, the latter specially showing sub-bedding very conspicuously in gray and black laminae. No fossils were found in the beds conspicuous for their sub-bedding. Upper New Scotland.. 15½ feet

33 Coelospira concava *Hall*
39 Dalmanella perelegans *Hall*
40 D. subcarinata *Hall*
47 Leptaena rhomboidalis (*Wilckens*)
71 Rhipidomella oblata *Hall*
76 Rhynchospira formosa (*Hall*) R
79 Schizophoria multistriata? *Hall*
82 Spirifer cyclopterus *Hall* C
88 Stropheodonta becki *Hall*
138 Dalmanites *sp.* r

K19 Strata concealed. Becraft to Port Ewen.......... 73 feet

K20 Dark blue, thinly cleaved, calcareous shale. The upper part is more arenaceous and weathers a dark brown. Fossils are very rare. Port Ewen.............................. 20 feet

33 Coelospira concava *Hall* r
38 Dalmanella concinna *Hall*
88 Stropheodonta becki *Hall*
138 Dalmanites *sp.*
Fish scale?

K21 Concealed strata. Port Ewen.................. 103 feet

K22 Dense, dark blue limestone in beds from 3 to 6 inches thick. Lower Oriskany................................... 12½ feet

25 Beachia suessana? *Hall* R
31 Chonostrophia jervisensis *Schuchert*
40 Dalmanella subcarinata *Hall*
91 Strophonella? conradi? *Hall* r
105 Actinopteria textilis (*Hall*) R
119 Platyceras platystoma *Hall* r

K23 Dark blue, shaly limestone. At the base is the first occurrence of Dalmanites dentatus Barrett. Lower Oriskany .... 3 feet

25 Beachia suessana *Hall* r
31 Chonostrophia jervisensis *Schuchert* C
64 Rensselaeria aequiradiata (*Conrad*) R
71 Rhipidomella oblata *Hall* r
134 Dalmanites dentatus *Barrett* r

K24 Dark blue, shaly limestone. Very few fossils. Lower Oriskany .... 3½ feet

31 Chonostrophia jervisensis *Schuchert*
40 Dalmanella subcarinata *Hall* c
65 Rensselaeria ovoides? (*Eaton*) R
126 Tentaculites acula *Hall* r

K25 Dense, blue, arenaceous limestone. Lower Oriskany .... 7 inches

31 Chonostrophia jervisensis *Schuchert* C
61 Orbiculoidea jervisensis (*Barrett*) c

K26 Dark blue, rather heavy bedded, calcareous shale. It is exceedingly fossiliferous where weathered. Lower Oriskany. 1½ feet

31 Chonostrophia jervisensis *Schuchert* C
36 Cyrtina rostrata *Hall* R
40 Dalmanella subcarinata *Hall* c
47 Leptaena rhomboidalis (*Wilckens*) r
66 Rensselaeria subglobosa *Weller* c
71 Rhipidomella oblata *Hall* r
85 Spirifer murchisoni *Castelnau* r
106 Actinopteria textilis arenaria (*Hall*) R
122 Platyceras ventricosum *Conrad* R
126 Tentaculites acula *Hall* c
134 Dalmanites dentatus *Barrett* R

K27 Trilobite bed. Dense blue limestone, containing many trilobite fragments and shells. Lower Oriskany............. 5 inches

31 Chonostrophia jervisensis *Schuchert* C
40 Dalmanella subcarinata *Hall* c
66 Rensselaeria subglobosa *Weller* c
115 Loxonema jerseyense? *Weller*
126 Tentaculites acula *Hall* c
134 Dalmanites dentatus *Barrett* c

This bed is specially noticeable in the hogback northeast of the barn of Mr William Balmos. This is doubtless the locality where Professor Mather and Dr Horton found trilobites so abundantly as to suggest to them the name Trilobite mountain.[1] It is also probably the place from which Dr S. T. Barrett described Dalmanites dentatus.[2] The bed maintains a uniform thickness of 4 to 6 inches wherever seen. It is always bounded above and below by an inch of very arenaceous limestone. The included limestone is almost entirely made up of fossil fragments, specially of Dalmanites dentatus Barrett, Rensselaeria subglobosa Weller and Chonostrophia jervisensis Schuchert. The following fossils were identified in the strata from K25 to K28 inclusive, along the hogback northeast of Mr William Balmos's barn.

21 Vermipora serpuloides *Hall* c
25 Beachia suessana *Hall* c
31 Chonostrophia jervisensis *Schuchert* C
36 Cyrtina rostrata *Hall* R
40 Dalmanella subcarinata *Hall* R
47 Leptaena rhomboidalis (*Wilckens*) R
49 Leptostrophia oriskania *Clarke* R
53 Meristella lata *Hall*
57 Nucleospira elegans *Hall* c
59 Orbiculoidea ampla *Hall* r
66 Rensselaeria subglobosa *Weller* C
71 Rhipidomella oblata *Hall* r
79 Schizophoria multistriata? *Hall* R
82 Spirifer cyclopterus? *Hall* R
85 S. murchisoni *Castelnau* c
Strophomena *sp.*
87 Stenochisma formosa (*Hall*) r
91 Strophonella? conradi? *Hall* r
101 Uncinulus vellicatus *Hall* R
105 Actinopteria textilis (*Hall*) C

[1] Geol. N. Y. 1st Dist. p.333.
[2] Am. Jour. Sci. 1876. 2:200.

112 Diaphorostoma nearpassi (*Weller*) R
113 D. ventricosum (*Conrad*) R
115 Loxonema jerseyense *Weller* c
123 Platyceras *sp.* R
126 Tentaculites acula *Hall* r
127 T. elongatus *Hall* r
134 Dalmanites dentatus *Barrett* C
139 Homolonotus vanuxemi *Hall* c

K28 Dark gray, calcareous sandstone containing very few fossils. Lower Oriskany . . . . 2 feet

K29 Concealed strata. Lower Oriskany to Upper Oriskany . . . . 66 feet

K30 Upper Oriskany . . . . $3\frac{1}{2}$ feet

K30a Dark blue, rather heavy bedded, silicious limestone . 6 inches

K30b Concealed strata . . . . $1\frac{1}{2}$ feet

K30c Dark blue, rather heavy bedded, silicious limestone, very full of specimens of Orbiculoidea jervisensis (Barrett) . . . . $1\frac{1}{2}$ feet

The following fossils were identified from this.

25 Beachia suessana *Hall* R
48 Leptocoelia flabellites (*Conrad*) r
61 Orbiculoidea jervisensis (*Barrett*) C
85 Spirifer murchisoni *Castelnau*
120 Platyceras reflexum? *Hall* R
125 Conularia pyramidalis jervisensis *Shimer* r

K31 Strata concealed. Upper Oriskany . . . . 50 feet

K32 Very dense, blue limestone from which were identified Megalanteris ovalis? Hall, Spirifer cyclopterus Hall and S. murchisoni Castelnau. Upper Oriskany . . . . 21 inches

K33 Same as preceding but more shaly in beds of from 1 to 4 inches in thickness. One foot from the top and scattered through a half foot bed is the lowest chert noticed in the Upper Oriskany. There are very few fossils here. Upper Oriskany . . . . 6 feet

K34 Dense blue limestone terminating in a 6 inch ledge which has finely disseminated chert in the middle and closes with an inch which is practically composed of fossils. Upper Oriskany . . . . 7 feet

31 Chonostrophia jervisensis *Schuchert*
34 Coelospira dichotoma *Hall*
40 Dalmanella subcarinata *Hall*
48 Leptocoelia flabellites (*Conrad*)
53 Meristella lata *Hall*
85 Spirifer murchisoni *Castelnau* C
113 Diaphorostoma ventricosum (*Conrad*)
127 Tentaculites elongatus *Hall*

K35 Dense blue limestone with two small chert bands, each in the lower portion of a very fossiliferous layer. The fossils are almost wholly specimens of Spirifer murchisoni Castelnau. Upper Oriskany.............................. 3½ feet

K36 Strata concealed. Upper Oriskany................ 8 feet

K37 Dense, blue limestone. Upper Oriskany.......... 2½ feet

K38 Dense blue limestone, exceedingly fossiliferous. Upper Oriskany .... 6 inches

53 Meristella lata *Hall* r
80 Spirifer arenosus? (*Conrad*) R
85 S. murchisoni *Castelnau* C
113 Diaphorostoma ventricosum (*Conrad*)

K39 Very fossiliferous, dense, blue limestone. Upper Oriskany .... 18 inches

48 Leptocoelia flabellites (*Conrad*) c
53 Meristella lata *Hall* C
68 Reticularia modesta (*Hall*) r
88 Stropheodonta becki *Hall* r
127 Tentaculites elongatus *Hall* r
Phacops *sp.* R

K40 Blue limestone. The middle and upper parts are specially fossiliferous. Tentaculites elongatus Hall is by far the most noticeable fossil here. Upper Oriskany.............. 2 feet

53 Meristella lata *Hall* C
85 Spirifer murchisoni *Castelnau* C
111 Diaphorostoma desmatum *Clarke* r
127 Tentaculites elongatus *Hall* C
Phacops *sp.* R

K41 Esopus strata including the portion covered by the swamp between the Oriskany and the Esopus.................. 550 feet

The gross structure of the Esopus is shown in figure 7.

K42 A dark arenaceous shale, cleaving into slate pencillike pieces. Fossils, owing to the great development of cleavage, are exceedingly rare. The only species identified was Coelospira acutiplicata (Conrad), several specimens of which were found. This fossil-bearing horizon represents merely an inch or two of rock on the uppermost surface of the Esopus; for when followed southeastward, not a single fossil could be found though prolonged search was made for that purpose. Onondaga......... 1-2 inches

K43 The 29 feet of strata which are concealed beneath the Erie Railroad here outcrop almost a quarter of a mile to the southwest along the eastern side of the railroad tracks. The only fossil identified was Coelospira acutiplicata (Conrad). It was found in very large numbers but all were more or less distorted from the very great development of cleavage. Onondaga...... 29 feet

K44 On the northwestern side of the Erie tracks at this section is an excellent exposure of very dark gray, calcareous shale, weathering light gray. It is very fossiliferous, many of the fossils being pyritized, specially the gastropods. This cleaves into much larger and broader pieces than in the two preceding localities. The cleavage here as in all the Esopus strata is so perfect and continuous that it closely resembles bedding. At this locality the bedding is seen in the dark colored ribbons about 6 inches in width passing across the cleavage surface. In this respect it closely resembles the Pennsylvania roofing slate except that the latter has, as a rule, narrower ribbons. Onondaga........................ 18 feet

The following fossils were identified:

Zaphrentis? r
27 Chonetes hemisphericus? *Hall* r
29 C. yandellanus *Hall* R
32 Coelospira acutiplicata (*Conrad*) C
35 C. grabaui *Shimer* C
40 Dalmanella subcarinata? *Hall* c
42 Eatonia medialis (*Vanuxem*) r
116 Loxonema *sp.* c

K45 These strata are very shaly, breaking into broad, thin plates. Slickensides were developed along the cleavage in places. At the top of the hill the strata become more calcareous; thin beds of impure limestone occur at intervals. Several specimens of Atrypa reticularis (Linn.) were found. Onondaga 100 feet

K46 Concealed strata. Onondaga.................... 12 feet

K47 The strata concealed by the old public road leading to the residence of Mr Henry Hoffman, are found further southward. The cleavage gradually becomes coarser, more platy and with the dark gray, shaly limestone occur intermittent beds of a dense, blue limestone which is at times quite fossiliferous but is usually apparently destitute of fossils. Onondaga................ 20 feet

23 Atrypa reticularis (*Linn.*) C
27 Chonetes hemisphericus *Hall* c
32 Coelospira acutiplicata (*Conrad*) R
47 Leptaena rhomboidalis (*Wilckens*) r
55 Meristella *sp.* R
67 Reticularia fimbriata (*Conrad*) r
84 Spirifer macrus *Hall* c
133 Dalmanites *cf.* anchiops (*Green*) R
Phacops rana (*Green*) r

K48 Mostly concealed strata but of lithic characters similar to the preceding. Onondaga.............................. 24 feet

K49 Strata rather shaly, mostly concealed. Onondaga... 15 feet

K50 A rather heavy bedded gray limestone. One layer near the middle is quite fossiliferous. This outcrops along the Newburg turnpike, opposite the barn of Mr Ludwig Laux; the outcrop is very noticeable from the great abundance of Atrypa reticularis (Linn.). Onondaga....................................... 10 feet

4 Ceratopora *sp.* R
8 Favosites *sp.* R
23 Atrypa reticularis (*Linn.*) C
33 Coelospira concava (*Hall*) R
Phacops rana (*Green*) r

K51 Cherty, exceedingly closely grained limestone, in beds 3 to 6 inches thick. The chert is most abundant in 2 to 6 inch bands parallel to the bedding but is found also scattered irregularly throughout all the beds. The chert does not occupy a bed to the exclusion of the limestone, as is usually the case in the New Scotland and Oriskany, but occurs in very irregular masses through it; this gives the rock when weathered an exceedingly rough appearance and at times it is pitted and amygdaloidal like. This rock is exposed for only about 600 feet along the Newburg turnpike, on the northeast side of the road, and rises in places almost on the dip to a hight of 30 to 50 feet. Onondaga...................... 7 feet

Section L

Section L begins at the foot of an old limestone quarry[1] about 150 rods northeast of section K.

L1 Strata covered from the marsh to the first rock outcrop at the base of an old quarry. Lower New Scotland and Upper New Scotland... 170 feet

L2 A dense, finely grained, bluish gray limestone. The lower and upper layers are quite shaly and show light and dark laminae. No chert was noticed. Fossils were abundant, in certain beds. As is usually the case, few or no fossils were found in the beds showing the light and dark laminae, except in the very lowest band. Upper New Scotland................................. 5 feet

[1]This is doubtless the Upper Quarry of Barrett from which he gave the name "Upper Quarry stone" to the Becraft. Am. Jour. Sci. 3, 13:386.

5 Enterolasma strictum *Hall* r
21 Vermipora serpuloides *Hall* r
33 Coelospira concava *Hall* c
40 Dalmanella subcarinata *Hall* C
47 Leptaena rhomboidalis (*Wilckens*) c
55 Meristella *sp.* r
71 Rhipidomella oblata *Hall* r
82 Spirifer cyclopterus *Hall* C
88 Stropheodonta becki *Hall* c
94 Strophonella punctulifera (*Conrad*) r
137 Dalmanites *sp.*
140 Phacops *cf.* logani *Hall* r

L3 Upper New Scotland.......................... 8⅔ feet

Subdivided as follows:

L3a Dark blue limestone in beds from 3 to 6 inches thick with considerable chert in the lower beds.................... 3½ feet

L3b Very cherty, bluish gray limestone.............. 1 foot

L3c Coarsely grained to very finely grained limestone usually in a single bed. Chert is developed in its lower portion. At times there are mere pockets of the coarsely grained scattered at intervals through the finely grained. This is very fossiliferous..... 2½ feet

L3d A dark bluish gray limestone alternating with half inch bands of an arenaceous limestone, the latter showing light and dark laminae and few or no fossils.......................... 20 inches

The following is a list of fossils identified from L3. The fossils from the different beds were not kept separate.

5 Enterolasma strictum *Hall* r
12 Lichenalia torta *Hall* c
31 Chonostrophia jervisensis *Schuchert* R
40 Dalmanella subcarinata *Hall* r
41 Delthyris perlamellosa *Hall* c
47 Leptaena rhomboidalis (*Wilckens*) c
52 Meristella laevis (*Vanuxem*) r
55 M. *sp.* c
82 Spirifer cyclopterus *Hall* c
88 Stropheodonta becki *Hall* c
95 Trematospira multistriata *Hall* R
97 Uncinulus campbellanus (*Hall*) R
101 U. vellicatus *Hall* R
127 Tentaculites elongatus? *Hall* R

L4 Coarsely grained, gray limestone, usually in one bed. Very fossiliferous. Becraft.............................. 2½ feet

5 Enterolasma strictum *Hall* r
11 Edriocrinus pocilliformis *Hall* c
12 Lichenalia torta *Hall* r
23 Atrypa reticularis (*Linn.*) r
46 Gypidula pseudogaleata (*Hall*) C
47 Leptaena rhomboidalis (*Wilckens*) C
52 Meristella laevis (*Vanuxem*) C
54 M. princeps *Hall* r
81 Spirifer concinnus *Hall* c
82 S. cyclopterus *Hall* r
92 Strophonella headleyana? *Hall* R

L5 Becraft.............................. 5 feet, 9 inches

L5a Rather finely grained, dark gray limestone. The basal foot in places is coarse and resembles the preceding. It is very hard and contains few fossils. Edriocrinus pocilliformis Hall r and Leptaena rhomboidalis (Wilckens) were the only species identified.. 3 feet

L5b Shaly, rather friable, finely grained limestone. Exceedingly fossiliferous.. 9 inches

From here the following fossils were obtained:

5 Enterolasma strictum *Hall* r
11 Edriocrinus pocilliformis *Hall* C
Dalmanella *sp.*
41 Delthyris perlamellosa? *Hall* R
47 Leptaena rhomboidalis (*Wilckens*) r
57 Nucleospira elegans *Hall* c
62 Orthothetes woolworthanus *Hall* R
81 Spirifer concinnus *Hall* C
94 Strophonella punctulifera (*Conrad*) R

Spirifer concinnus is in places so abundant that it makes up almost the entire rock mass.

L5c Limestone similar to L5a, usually in one bed. It is very hard and contains few fossils. The only species identified were Edriocrinus sacculus Hall r and Leptaena rhomboidalis (Wilckens) c.. 2 feet

L6 Finely grained, bluish gray limestone. At the base and in the middle are 4 inch friable, shaly bands similar to L5b and as we would expect, since the fossils are fairly abundant throughout the entire bed, many forms are similar to those in L5b, yet there is a great decrease in the abundance of Spirifer concinnus and an entire absence of Nucleospira elegans and Edriocrinus pocilliformis which were abundant in the lower bed. This is placed in the Becraft on account of the abundance of Spirifer concinnus. The other abundant fossils also are those which were specially noticeable in the Gypidula pseudogaleata beds.. 8 feet

5 Enterolasma strictum *Hall* r
23 Atrypa reticularis (*Linn.*) c
40 Dalmanella subcarinata *Hall* r
41 Delthyris perlamellosa *Hall* R
47 Leptaena rhomboidalis (*Wilckens*) c
52 Meristella laevis (*Vanuxem*) R
79 Schizophoria multistriata *Hall* R
81 Spirifer concinnus *Hall* c
82 S. cyclopterus *Hall* R
88 Stropheodonta becki *Hall* r
94 Strophonella punctulifera (*Conrad*) R
97 Uncinulus campbellanus? (*Hall*) R

L7 A bluish gray, arenaceous limestone showing darker and lighter laminae very plainly, specially in the upper portion. The lower is exceedingly fossiliferous and there the following fossils were found. Port Ewen.............................. 1 foot

33 Coelospira concava *Hall* C
40 Dalmanella subcarinata *Hall* r
43 Eatonia singularis (*Vanuxem*) c
50 Lingula *sp.* R
85 Spirifer murchisoni *Castelnau* c[1]
88 Stropheodonta becki *Hall* r
109 Cypricardinia lamellosa *Hall* R

L8 Concealed strata. Port Ewen to Lower Oriskany... 178 feet

L9 Finely grained, gray, argillaceous limestone. There is an alternation of more calcareous with more arenaceous beds. As followed southwest on the strike, it led almost directly below the trilobite bed. Chonostrophia jervisensis Schuchert is the only fossil found here. Lower Oriskany................ 14 feet

L10 Concealed strata. Lower Oriskany and Upper Oriskany .... 120 feet

L11 Strata concealed except 3 feet from the top, a 1 foot outcrop containing a band of black unfossiliferous chert, very similar to K33. Upper Oriskany.............................. 10 feet

L12 Strata concealed with the exception of the uppermost bed which is exposed on the dip for 15 vertical feet. This contains many specimens of Spirifer murchisoni Castelnau, Diaphorostoma ventricosum (Conrad) and Tentaculites elongatus Hall. Upper Oriskany .... 14 feet

L13 Strata concealed except the uppermost which is exposed on the dip for about 40 vertical feet. Here were found one specimen of Lingula perlata? Hall and very many of Leptocoelia flabellites (Conrad) but no specimens of Tentaculites were found. Upper Oriskany..................... 17 feet

L14 Strata concealed by the marsh. Upper Oriskany to Esopus .... 70 feet

L15 Esopus strata between the marsh and the Newburg turnpike .... 540± feet

[1] *See* note 1, p.251.

Discussion of individual species

HYDROZOA

Stromatopora concentrica? Goldfuss

The organism referred to this species is very abundant in the Favosites bed.

ACTINOZOA

Blothrophyllum promissum? Hall

Several specimens of a coral very similar to this species were noticed in the Onondaga formation along the Newburg turnpike. It was impossible to get any free from the matrix, but the sections which could be observed had all the appearances of this species.

Enterolasma (Streptelasma) strictum (Hall)

This simple coral is very abundant and always well preserved, specially in the Coeymans and New Scotland. It is found less abundantly in the Becraft and Port Ewen. A specimen of average size measures about 15mm in length by 6mm in width at the large end.

Zaphrentis roemeri Edwards & Haime

A specimen from the Favosites bed has a greatest diameter of 38mm. It has about 80 septa, most of those in the section reaching over half way to the center. There are a few shorter ones but no regular alternation of longer and shorter ones was observable. No entire specimens were procured so that the length is not known. This was observed only in the Favosites bed where it was quite abundant.

Favosites helderbergiae Hall

The very common coral of the lowest Coeymans, where it occurs in great abundance. It is found rarely in the upper Manlius. The fact that it is present in the greatest abundance in the coarsely crystalline beds seems to indicate that it is a reef species. A specimen from the base of the Coeymans shows as greatest diameter of corallites 1.5mm, the average width being 1.3mm. One section gave 10 tabulae in 7.5mm, another 12 in 9.5mm, averaging 1 tabula to 1mm. A specimen from the middle Coeymans gave as greatest diameter of the corallites 1.25mm, the average width was 1mm. It gave in one section 12 tabulae in 10mm; in another 18 in 15mm, averaging 1½ to 1mm. The wall in both specimens is always twice as thick as the tabulae. The majority of tabulae on the Coeymans specimen are very regularly concave with a concavity of from one third to one fifth the diameter of the corallite. The specimen from the Favosites bed shows most of the tabulae flat with only a few concave. A few tabulae on both specimens are placed obliquely to the walls. There were faint indications in both specimens when placed in weak acid for a short time of from one to two rows of pores on the sides of the cells, usually located about halfway between the tabulae.

Comparison of Favosites niagarensis and F. helderbergiae

	F. niagarensis	F. helderbergiae[1]
Average width of cells	1.3mm	1.5mm
Usual number of tabulae in 10mm...........	7–9	12
Extreme number of tabulae in 10mm.......	4, 10–12	10, 15
Corallum	Lenticular or hemispheric	Spheric

Professor Hall says[2] that "F. helderbergiae differs from F. niagarensis (which it resembles in the size of its cells) in having more numerous diaphragms and in the mural pores being on the lateral faces instead of at the angle of the cells." His figures of F. niagarensis, however,[3] show the pores on the lateral faces of the cells and not at the angles. This would leave no difference between the two species except the number of tabulae. The cells of a specimen in the Columbia University collection from the Niagara limestone, locality not given, average about 1.3mm in diameter; it has from 13 to 16 tabulae in 10mm, while the one to two rows of

[1]Measurement taken from Hall's figures, Pal. N. Y. 2:125, pl.34a (bis), fig.4a-i.

[2]Pal. N. Y. 6:8.

[3]Pal. N. Y. v.2, pl.34a.

mural pores are on the lateral faces of the cells and about midway between the tabulae. The tabulae are thus as numerous as in F. helderbergiae. The corallum is lenticular in shape, and accordingly the only difference between the two species is in the shape of the corallum.[1] It was only in the Favosites bed that the shape of the corallum was observable and this only in cross section. Here the corallum usually gives, at right angles to the bedding plane, a round or elongate cross section with the corallites growing in all directions from a central point. A few, however, were noticed which had a semicircular cross section with the flat portion lying on the bedding plane and the corallites growing from the center of the flat portion. It seems, then, that we have the lenticular, the hemispheric, as well as the spheric shaped corallums in this 3 foot Favosites bed.

It seems to be a question worth considering whether two distinct species should be based wholly on the form of the colonies of which the individuals are exactly alike. Might not the shape of the colonies be determined by the varying conditions of growth?[2, 3]

Favosites sphaericus Hall

Found from the Upper Manlius to the Lower New Scotland inclusive, being specially abundant in the Favosites bed. One specimen from the Coeymans measured 12mm in length by 10mm in width; the tubes averaged a diameter of .3mm with a few as wide as .5mm. The angles of the walls were quite nodose. On one specimen from the Upper Manlius the tubes averaged about .2mm in diameter, while the corallum was 5mm long by 3mm wide at the

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[1]After this determination was made, it was found that Lambe had reached a similar conclusion four years previously.

Contrib. Can. Pal. v.4, pt 1, 1899, p.7.

[2]F. niagarensis was established by Hall in 1852. Pal. N. Y. 2:125. F. helderbergiae was established by Hall in 1874. N. Y. State Mus. Nat. Hist. 26th Rep't. p.111.

[3]Girty concludes from a study of F. helderbergiae and F. conicus Hall from the Helderberg of Albany county, N. Y., that both may refer to the same organism at different stages of growth and preservation. Girty, G. H. A Revision of the Sponges and Coelenterates of the Lower Helderberg Group of New York. N. Y. State Mus. 48th An. Rep't. 1894. pt 2.

widest portion. One specimen from the Favosites bed was noticed incrusting a mass of Stromatopora and being in turn incrusted by it. Very small specimens of what appear to be this species are quite abundant in some of the Upper Manlius beds; but owing to the great density of the rock, only pieces too fragmentary to be identified were acquired.

PELMATOZOA

Edriocrinus pocilliformis Hall

Very abundant in the Becraft where alone it occurs. Only the bases of this crinoid have been found preserved and the radial plates could not be made out on them. Those from the shaly limestone are, as a rule, smaller than those from the heavier beds. The former average 6mm in the diameter of the summit of the base and 7mm in length; the latter average 8mm by 10mm. The larger species, E. sacculus Hall, was not noticed in the higher Oriskany beds.

BRYOZOA

Lichenalia torta Hall

Very abundant, but the celluliferous tissue has usually been removed, leaving only the surface of the epitheca. It was found quite abundantly in the whole of the Helderbergian with the possible exception of the New Scotland. It also occurs in the Favosites bed.

Lioclema cellulosum (Hall)

Very abundant in the Coeymans and quite well preserved on the weathered surfaces of the beds.

L. ponderosum (Hall)

This bryozoan was found only in the lower New Scotland and there not abundantly.

Monotrypa tabulata Hall

An elongated, spheroidal corallum of this species from the Lower New Scotland has an average of 20 corrugations on the outer surface of the cell tubes in 5mm, with a diameter for the cell tubes of about .4mm.

Monotrypella? abrupta (Hall)

One specimen from the Lower New Scotland averages about 10 septa in 1mm beyond the abrupt outward turning of the tubes.

Another specimen from the Lower Oriskany, identified provisionally with this species, appears to have as many septa before the abrupt outward bending of the tubes as after it. In this respect it differs from the type description.[1]

Orthopora regularis (Hall)

This small species does not appear to be quite so abundant as the following one and was found at the same horizon.

O. rhombifera (Hall)

Exceedingly abundant and well preserved in the Coeymans and Lower New Scotland.

Unitrypa nervia (Hall)

The most abundant fenestelloid bryozoan in the Coeymans; it does not differ from the type description.

U. praecursa (Hall)

Abundant in the Coeymans; it may be a distinct variety since the margins of the expanded summits of the carinae have simply a row of nodes; in no instance was there any lengthening of these nodes noticed so as to form slender bars connecting them with the contiguous carinae as noticed by Professor Hall.[2]

Vermipora serpuloides Hall

In one specimen from the Upper New Scotland the tubes have a diameter of from less than .5mm to .75mm, somewhat less than Professor Hall's description of the type specimen. The tubes are covered with close, prominent, concentric wrinkles. No longitudinal striae were noticed. It is quite abundant in the Lower New Scotland and much less abundant in the Upper New Scotland.

BRACHIOPODA

LINGULA

Many specimens of Lingula and Orbiculoidea occur in phosphatic nodules in the New Scotland beds. Usually the shell is too crushed

[1] Pal. N. Y. 6:13, pl.9.
[2] Pal. N. Y. 6:54, pl.21, fig.14-18.

for identification. Professor Hall[1] calls attention to these peculiar coproliticlike nodules in the rocks of this formation in Albany county, N. Y. Our specimens agree with his in that they are "uniformly elongate or oval in form."

Orbiculoidea ampla Hall

Rare in the lower Oriskany where alone it was found.

O. jervisensis (Barrett)

The most characteristic shell of the middle Oriskany. It occurs rather less abundantly in the Lower Oriskany. A noticeable feature of this species is that it frequently lies at right angles to the bedding plane.

Pholidops ovata Hall

This little shell is quite abundant on the weathered rock surfaces of the Upper Coeymans. It is also present in the Lower New Scotland. A specimen of average size measures 3.5mm by 3mm.

Leptostrophia oriskania Clarke

Only one specimen was found and that in the Lower Oriskany. It is smaller than the average given by Clarke[2] having a length of but 12mm and a width of 14mm. The irregular, concentric wrinkles can be plainly seen.

Leptaena rhomboidalis (Wilckens)

Abundant in the whole of the Helderbergian and Lower Oriskany. The characters of the shell are very constant and hold true to the type. It is specially abundant in the New Scotland and Becraft.

Stropheodonta becki Hall

Quite abundant in the whole of the Helderbergian, occurring also in the Upper Oriskanian. It holds quite true to the type description.

S. varistriata (Conrad)

Very abundant in the Lower and Upper Manlius, it is also present in the Favosites bed and Coeymans. The Coeymans species differs

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[1] Pal. N. Y. 1859. 3:158.

[2] N. Y. State Mus. Mem.3, p.53, pl.7, fig.29-35.

somewhat from that of the Manlius. In the Manlius the striae are strong and usually subequidistant, with from one to several finer striae between them. A pedicle valve measuring 19 by 27mm showed very little difference in the strength of the striae but a brachial valve of about the same size showed it very distinctly, but even here not so prominently as on the smaller shells. The Coeymans shells are a little more convex. The coarse striae are less pronounced, while the finer ones, which vary in number from four to a dozen or more, are filiform.

S. varistriata var. arata Hall

Shell very convex with its body covered with angular, coarse striae; the sides of these as well as the concave area between them are covered with about six filiform, rather undulate striations. The umbonal region and the somewhat flattened area at the cardinal angle show its derivation from the typical Manlius S. varistriata, for here the striae are less irregular and the intermediate area is flattened. It was found not very abundantly in the Coeymans and New Scotland.

Strophonella? conradi Hall

The specimens identified with this species are from the Lower Oriskany. The best preserved one measures 35mm by 40mm. The one figured by Hall[1] is somewhat smaller, about 29mm by 37mm. The shell is uniformly convex, the greatest convexity being at the middle. It is more coarsely striated than Orthothetes woolworthanus, the striae being fine and sharp. These striae on exfoliation become rounded while the depressions between them are pitted. On another specimen of the same dimensions and similar striae, the exfoliated striae themselves are very distinctly punctate. No denticulations were noticed on the cardinal area which is poorly preserved.

S. headleyana Hall

Only molds of this species were found and these were usually fragmentary. The pedicle valve is distinctly convex at the umbo, with a long, broad and rather shallow concavity toward the front.

[1]Pal. N. Y. v.3, pl.16, fig.13-15.

The external molds of the striae are crenulate. It was found in the Lower and Upper New Scotland and probably in the Becraft.

S. leavenworthana Hall

A single specimen was found and this in the lower part of the Port Ewen. This is strongly geniculate toward the front of the shell, while the posterior portion, after a slight depression at the geniculation rises but little over low concentric wrinkles to the umbo.

S. punctulifera (Conrad)

Usually occurs only as external and internal molds. The brachial valve of this species is deeply concave at the umbo but becomes strongly geniculate toward the front. The puncta are usually poorly preserved. It occurs, but in moderate abundance, in the Coeymans, Upper New Scotland and Port Ewen; one specimen represents it in the Becraft.

Orthothetes woolworthanus Hall

Hall describes the surface of this as being covered with fine, rounded striae.[1] It is a rare species and is represented in our collection by several specimens from the New Scotland and Becraft. One well preserved brachial valve, measuring 28mm by 34mm, is flattened in the region of the umbo but becomes quite convex toward the front. The surface is covered with numerous, very fine, rounded, radiating striae.

Orthis sp.

In the Lower Oriskany several specimens of a large Orthis were found but they were all too poorly preserved for identification; they much resembled Rhipidomella musculosa (Hall).

Chonetes hemisphericus Hall

Quite abundant in the Onondaga. The specimens agree very closely in average size, convexity and striae with those described by Hall.[2]

C. hudsonicus Clarke

Several specimens from the Lower New Scotland are referred to this species. One of medium size measures 9mm by 15mm by

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[1] Weller speaks of the striae in the New Jersey specimens as angular. Geol. Sur. N. J. Paleontology. 3:278.

[2] Pal. N. Y. 4:118, pl.20, fig.6a-d.

1.5mm in length, breadth and thickness. The largest measures 12mm by 23mm by 3mm. No spines are noted. The surface is very finely striated.

C. yandellanus Hall

A pedicle valve about 7mm by 12mm in length and breadth, from the lower Onondaga was identified with this species. The cardinal angles are very distinctly flattened. There are about 50 strong, rounded, radiating striae which are as strongly developed on the flattened area of the valve at the cardinal angle as on the rest of the shell.

Chonostrophia jervisensis Schuchert

The resupinate character is well preserved in all the specimens. The striae are narrow with broad, rather flat interspaces where specially the very numerous and fine concentric markings are noticeable under a glass. A pedicle and a brachial valve of average size each measured 7mm by 12mm in length and breadth. This is one of the most abundant brachiopods of the Lower Oriskany. It is found more rarely in the Upper Oriskany, while one specimen only represents it from the Upper New Scotland.

Dalmanella concinna Hall

Represented in the Port Ewen beds by rather small specimens; they average 7mm by 6mm. They are often found as internal molds and one valve is preserved as frequently as the other.

D. perelegans Hall

Quite abundant and well preserved in the Coeymans and Upper New Scotland.

D. subcarinata Hall

Abundant, specially in the Coeymans, New Scotland and Lower Oriskany, but is also well represented in the Becraft, Port Ewen, Upper Oriskany and possibly in the Lower Onondaga. It is thus seen that this very persistent species thrived equally well in clear and muddy waters. Specimens of a Dalmanella similar to this species except in size are quite abundant in the Lower Onondaga. The largest form observed measured 10.5mm by 13mm in length and breadth.

Rhipidomella assimilis Hall

The single specimen from the Lower New Scotland identified with this species is the internal mold of the brachial valve; the front of the mold is destroyed. The anterior part of the flabellate muscular scar is quite high.

R. eminens Hall

There are several specimens from the Upper New Scotland in the collection which agree very closely with this species. Two are young individuals and show very prominently the alternation of stronger and finer striae.

R. oblata Hall

Shell well preserved and holds quite true to the type. It averages in size 28mm by 34mm by 11mm in length, breadth and thickness. It is never an abundant species but is found in the Coeymans, New Scotland and Lower Oriskany.

R. tubulistriata Hall

A single valve from the Upper New Scotland. It shows the characteristic fasciculation of the striae with the porelike openings on them.

Gypidula angulata Weller

One partial pedicle valve from the Coeymans answers to the description of this species,[1] with the exception that it has three plications on the lateral slopes of the shell instead of but one; the one next the fold is subangular and the most prominent, the other two are faint and broadly rounded.

G. galeata (Dalman)

Exceedingly common and well preserved in the Coeymans where it occurs from the base to the summit. It appears suddenly and in great numbers directly on the Favosites bed. A few specimens have prominent and even plications and lack sinus and fold; in these respects they agree with the varietal differences pointed out by Weller.[2]

[1] Weller. Geol. Sur. N. J. 3:280, pl.28, fig.13–21.
[2] ——— Geol. Sur. N. J. 3:280.

G. pseudogaleata (Hall)

Very abundant in the 2½ feet of the lowest Becraft and is of the average size of those figured by Hall.[1]

Stenoschisma formosa Hall

A single specimen was found in the Upper New Scotland and several in the Lower Oriskany.

Uncinulus campbellanus (Hall)

Occurs very rarely both in the Upper New Scotland and Becraft. At Becraft mountain, N. Y., it is very abundant in the latter formation.

U. nucleolatus Hall

Very abundant in the Lower Coeymans. In size as well as in number and shape of plications it is normal.

U. pyramidatus Hall

Not found outside the Coeymans. This with the preceding species is specially characteristic of the lower portion of the Coeymans proper.

Eatonia medialis (Vanuxem)

An abundant species, found both as perfect shells and as internal molds of the pedicle valve. It is most abundant in the New Scotland but also occurs in the Coeymans and Lower Onondaga. In the Lower Onondaga were found two internal molds of the pedicle valve, 16mm wide, but they have the characteristic muscular impressions.

E. singularis (Vanuxem)

Not nearly so abundant as the preceding but is usually well preserved and occurs frequently in the Lower New Scotland and Port Ewen and very rarely in the Upper New Scotland.

Beachia suessana Hall

Usually well preserved and quite abundant in the Lower Oriskany. One specimen was also noticed in the Upper Oriskany.

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[1]Pal. N. Y. v.3, pl.48, fig.2a-h.

Rensselaeria aequiradiata (Conrad)

One specimen is 25mm long and 15mm wide at the widest place which is anterior to the middle of the shell. The greatest thickness, 11mm, is posterior to the middle. Another one from the Lower Oriskany measures 23+mm by 15mm, the complete length could not be determined owing to the broken condition of the front of the shell.

R. subglobosa Weller

This shell was called by Dr S. T. Barrett,[1] on the identification of Professor Hall, Rensselaeria mutabilis Hall. But Dr Barrett explains that it is much larger than any known before. It differs from this, however, also in its surface markings and was hence made into a new species by Dr Weller.[2] This is one of the most abundant shells of the Trilobite bed, and is nearly always well preserved.

Megalanteris ovalis? Hall

Two specimens were provisionally identified with this species; both are internal molds of the pedicle valve and agree very closely with the figures and description given by Hall.[3]

Atrypa reticularis (Linnaeus)

Found only in the Coeymans, Becraft and Onondaga, the purely calcareous formations; it is quite abundant in each of these.

Atrypina imbricata Hall

Quite abundant in the Upper New Scotland but no specimen was noticed in the Lower New Scotland. A large shell measured 9mm by 9.5mm by 4.5mm in length, breadth and thickness respectively.

Spirifer vanuxemi Hall

One of the most abundant and constant shells in the Manlius. The usual size of the brachial valve is 5mm by 8mm by 2mm in length,

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[1]Notes on the Lower Helderberg Rocks of Port Jervis, N. Y. Lyc. Nat. Hist. Ann. 1876. 11:290.

[2]Geol. Sur. N. J. 3:329, pl.42, fig.11-18.

[3]Rensselaeria ovalis Hall. Pal. N. Y. 1859. 3:458, pl.106, fig.2a-l.

width and concavity respectively; that of the pedicle valve is 7mm by 9mm by 3mm.

This species is very similar to S. crispus of the Niagara group as shown by a comparison of Hall's figures and the following measurements:

Length	Breadth	Proportion of length to breadth	Number of plications on each side of sinus		
S. vanuxemi from Trilobite mountain, N. Y.					
6	8	1.34	2	Brachial valve	Average size
7	10	1.43	3	Pedicle valve	Average size
10	12	1.2	5	Pedicle valve very convex	
S. crispus, Niagara shale, Waldron Ind.[1]					
12	15	1.21	4	Pedicle valve	
11	15	1.36	3	Brachial valve	
S. crispus from Rochester shale, Niagara gorge, N. Y.[1]					
5.5	9	1.64	3	Pedicle valve	Shells of this size are very abundant
4.5	9	2	2	Brachial valve	Shells of this size are very abundant

As seen from the above comparisons and figures,[2, 3] S. vanuxemi bears a closer resemblance to S. crispus of Waldron than it does to the Niagara gorge species. This similarity is specially noticed in the proportion of length to breadth and in the number of plications. The Waldron shells are also much more gibbous and thus approach S. vanuxemi more nearly than do the Niagara gorge specimens. But the cardinal area is much higher even in the young of all specimens of S. crispus examined than in any of S. vanuxemi. It is thus seen that while S. vanuxemi is apparently much more closely related to the western S. crispus than it is to the eastern, that its possible derivation from the western species could not have been a direct one.

[1]These measurements are from specimens in the paleontologic collections of Columbia University, New York.

[2]S. crispus. Pal. N. Y. 2:262, pl.54, fig.3a-k.

[3]S. vanuxemi. Pal. N. Y. 3:198, pl.8, fig.17-23.

But this close similarity may be due to a possible derivation of both from S. petilus of the Waldron area.[1, 2]

S. cyclopterus Hall

The young of this species is quite similar to S. vanuxemi in external form and markings. A young specimen of S. cyclopterus from the Coeymans gives the following measurements:

Length	Breadth	Proportion of length to breadth	Number of plications on each side of sinus	
2.5	4.5	1.8	3	Brachial valve
5	9	1.8	4	Pedicle valve

In the above brachial valve, the central plication or fold is very slightly larger than those on each side of it; and the plications are but slightly wider than the furrows between them. No flattening of the fold was noticeable. The sinus of the pedicle valve near the umbo is but slightly wider than the furrows on each side, while at the front of the shell it is about twice as wide. All this is also true of S. vanuxemi. This young specimen also agrees with S. vanuxemi in the number of plications but exceeds it in the proportion of length to breadth of the valves. With the exception of this last fact, the similarity between the two species is almost perfect and suggests a possible derivation.[3]

In many of the New Scotland beds occur frequently only the internal molds of S. cyclopterus. They bear a general resemblance to S. murchisoni but the cast of the musculature of the pedicle valve of the former is narrower and the sinus in it is not as wide as in the latter species. The internal mold of the plications is also usually less pronounced in the former. The surface of the mold on both sides of the muscular impression is papillose in both species, indicating a punctate surface on the corresponding parts of the shell.

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[1] Grabau. N. Y. State Pal. An. Rep't 1902, p.1046.

[2] Clarke & Beecher. N. Y. State Mus. Mem. 1. 1889. p.75.

[3] Stuart Weller [Geol. Sur. N. J. 3:287] calls attention to the likelihood of the derivation of S. cyclopterus from S. vanuxemi.

S. cyclopterus occurs very abundantly in the Coeymans and Upper New Scotland; it is found less frequently in the Lower New Scotland and Becraft. The Coeymans specimens are more compressed laterally than the majority of those from the New Scotland. The latter ones have the plications more angular also, thus partially approaching S. murchisoni.

S. concinnus Hall

Exceedingly abundant in the Becraft. It differs somewhat from the type description.[1] The number of plications on a shell of average size is less than that given by Hall. The following table will give an idea of the comparison in the pedicle valve between Hall's figures, specimens measured from Becraft mountain, New York, from Schoharie, New York and from Trilobite mountain.

Length	Width	Number of plications	
Hall's figures			
25	34	12	From the New Scotland, called by Hall a large shell.
21	22	14	From the Becraft. This Hall calls large.
12	13	8	From the Becraft.
10	13	6	From the Becraft.
Specimens from Becraft mountain			
21	24	9, 10	A large specimen.
13	18	8	
15	22	9	The average size
Specimens from Schoharie, New York			
27	31	13	Probably from the New Scotland.
28	29	11	Probably from the New Scotland.
Specimens from Trilobite mountain, New York			
25	30	12	Large specimens.
17	24	8–10	Average specimens.

[1] Pal. N. Y. 3:200, pl. 25, 28.

From the above we see that it is only the specimens called by Hall "large" that have a sufficient number of plications to strictly come under the species according to his description. Large specimens both from Becraft mountain and Trilobite mountain may be placed in it but the great majority are comparatively small shells with an average of nine plications on each side of the sinus. Taking the large shell as the normal, the majority, both at Becraft and Trilobite mountains, represent immature development, for the large shells have passed through this stage as seen by taking younger stages on them.

In other respects the shells are very similar, they are quite strongly incurved and gibbous at the umbo, the cardinal area is high, concave and usually equals the greatest width of the shell. The sinus of the smaller shells is not as angular as in the larger ones and in this respect approaches S. cyclopterus. The similarity to this latter species is more clearly shown in the young. The pedicle valve of S. concinnus, measuring 6mm by 8mm, has five plications and a S. cyclopterus, 5mm by 9mm has four, but in the latter species the plications are almost as pronounced as in the mature shell, while on the former they are exceedingly faint. The convexity of the two shells is very similar. Notwithstanding the close resemblance of these two species, they can hardly be very closely related since the characteristic plications of each persist from the youngest stages.

S. murchisoni Castelnau

Hall[1] speaks of the great similarity between S. murchisoni and S. cyclopterus and says that the former may be perhaps only a variety of the latter "which in the sandstone attains a larger size than in the shaly limestone below." The young of S. cyclopterus is very like that of S. murchisoni, many of the former having angular cardinal extremities similar to the latter. The hight and concavity of the cardinal area as well as the number of plications and the surface markings are also alike. But there seems to be a slight but constant, greater incurving of the pedicle valve in the former. Of course with the mature shell there

[1] Pal. N. Y. 3:430.

is no difficulty of determination. The larger size and angular cardinal extremities of S. murchisoni are readily distinguished from the smaller size and usually rounded cardinal extremities of S. cyclopterus.

S. murchisoni is abundantly represented in the Port Ewen,[1] Lower and Upper Oriskany.

Summary of the preceding discussion of the Spirifers

S. vanuxemi may possibly, as far as external characteristics are concerned, have been derived indirectly from the western species of S. crispus (or both from S. petilus) and has probably given rise to S. cyclopterus.

The young of S. cyclopterus could hardly have become modified into S. concinnus though they are exceedingly similar, for the finer plications of S. concinnus are present even on the youngest shell examined.

S. cyclopterus may probably have given rise to S. murchisoni for though the young of all the latter examined have a less incurving of the pedicle valve than the former, yet there is an indication of a slightly increased incurving in the younger shells over the older ones. In all other respects the young are apparently similar. Hall and Clarke indicate a close relationship between the above species.[2] They place them all under the S. crispus type.

S. arenosus (Conrad)

One specimen from the Upper Oriskany, a mere fragment of a pedicle valve, is doubtfully referred to this species.

S. macropleura (Conrad)

Exceedingly abundant in the Lower New Scotland and also in the lower part of the Upper New Scotland. It is found more usually

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[1]The Port Ewen specimens are more or less transitional. They are like S. **murchisoni** in having angular plications and a subangular sinus. They are similar to S. cyclopterus in being usually small and having rounded cardinal extremities. The convexity of the pedicle valve is intermediate between the two species.

[2]Pal. N. Y. v.8, pt2, p.19, 36.

in the shale than in the limestone, e. g. it is questionably present in the dense blue limestone of K7, while 21 inches higher in K8, a dark gray shale, it is exceedingly abundant.

S. macrus Hall

Quite abundant in the lower beds of the Onondaga. No perfect valves were found. One very small specimen with a length of about 7mm and a width of 20mm has a cardinal area 2mm high and moderately concave; it has apparently six plications on each side of the sinus. Another partial pedicle valve, 10mm by 24mm, has nine plications on each side of the sinus, crossed by many lamellose, concentric striae. It looks very much like S. mucronatus but has a very much higher cardinal area. The largest specimen observed has an apparent width of 40mm.

Delthyris perlamellosa (Hall)

Abundant in the Coeymans and the whole of the New Scotland. It is very rarely found in the Becraft. This usually occurs in the same lithologic beds in the New Scotland as S. macropleura but unlike it, an apparently greater vitality enabled it to thrive in pure waters also.

Reticularia fimbriata (Conrad)

One shell from the lower Onondaga measures 22mm by 35mm by 18mm. The sinus is broad and of medium depth (not quite 2mm). The fold is quite high toward the front (3.5mm), but fades out before reaching the umbo. There are five low, rounded plications on each side of the fold and six on each side of the sinus. The concentric lamellae are quite prominent and imbricating toward the front of the shell. The specimen is much exfoliated but there appears to be an average of two elongate nodes to 1mm of width. Several specimens of fragmentary Spirifers from the upper portion of the exposed Onondaga may also belong to this species.

R. modesta (Hall)

This little spirifer is present in our collection only from the Coeymans, Lower New Scotland and Upper Oriskany.

Cyrtina rostrata (Hall)

One entire specimen and two well preserved pedicle valves found in the Lower Oriskany.

Coelospira acutiplicata (Conrad)

Very abundant in the lowest Onondaga directly above the Esopus-Schoharie. An average shell measured 10mm by 12mm by 4mm in length, breadth and thickness. This frequently occurs in the condition of pyrite casts.

C. concava Hall

One of the most abundant shells in the whole New Scotland formation, making up in places the entire rock mass; it is also one of the most characteristic species of the Port Ewen and is likewise well represented in the Coeymans. One brachial valve, 6mm by 7mm in length and breadth, from the Onondaga, seems to be identical with this species.

C. dichotoma Hall

Almost as abundant in the Upper Oriskany as L. flabellites.

C. grabaui sp. n.

Shell subovate in outline; marked by 9 plications on each valve. These plications are moderately prominent, and broadly rounded

Fig. 8 Coelospira grabaui Shimer. x2

near the front of the shell, decreasing in strength toward the cardinal extremities. The median depression of the pedicle valve is very deep from the center of the valve to the front, and contains a single plication which fades away toward the front. This produces a correspondingly accentuated elevation on the anterior portion of the brachial valve which has a strong depression down the center, thus forming two median plications, which, however, become merged into one at the front of the shell. The fold disappears at the middle of the valve and from there to the hinge the valve is flat. In the oldest portion of the shell, i. e. from the beak to about one half the distance to the front, both valves present the appearance of a typical C. acutiplicata (Con.). But from this point to the front the valves grow rapidly toward each other, thus producing a very conspicuous thickening of the shell. With this thickening there is an increased prominence of the concentric lamellae. The dimensions of a large specimen are: length, 12mm; breadth, 16mm; thickness, 9mm.

This species which is from the very lowest Onondaga, immediately above the Esopus-Schoharie, evidently represents an offshoot of C. acutiplicata which, rapidly accentuating certain characters, soon became extinct, for it was not found in any higher beds. It must be regarded as a phylogerontic type, in which the characters normal in the adult of its ancestors are lost in its own ephebic stage.

Figured specimen, paleontologic collection, Columbia University, catalogue no. 19,326.

Leptocoelia flabellites (Conrad)

One of the most characteristic Upper Oriskany species, and occurs also less abundantly in the middle Oriskany.

Whitfieldella? nucleolata (Hall)

Very abundant in the Upper Manlius. The shell is small, an average one measuring 6mm by 5mm by 3mm in length, width and thickness respectively. It is not noticed in the Lower Manlius, while several specimens of the average size were found in the Favosites bed.

Trematospira multistriata Hall

Abundant in the Upper New Scotland; it does not vary from the description of the type.

T. perforata? Hall

Several external molds and an internal mold of the pedicle valve from the Upper New Scotland present the characters of this species.

Nucleospira concentrica? Hall

In the Lower New Scotland are many specimens of a shell which in external characters comes nearest this species but differs from it in the absence of a central, longitudinal, depressed line of the dorsal valve and in the fact that the dorsal valve is not depressed at the beak. The average shell measures 14mm by 14mm by 6mm. The pedicle valve is convex, specially in the middle toward the beak. The brachial valve is most convex at the beak. One or two strong, concentric growth lines are usually present on each valve.

N. elegans Hall

Quite abundant in the Becraft and Lower Oriskany. A shell slightly above the average in size measures 15mm by 17mm by 8mm in length, breadth and thickness respectively.

N. ventricosa Hall

Rather poorly preserved and not abundantly represented in the Coeymans.

Meristella laevis (Vanuxem)

One of the most abundant Helderbergian species, occurring usually as perfect shells but often as internal molds. It is very abundant from the Coeymans to the Becraft inclusive.

M. lata Hall

Very abundant, specially in the Upper Oriskany. It occurs as frequently in the form of internal molds as in that of perfect shells. In a large shell of this species, the length of the striated portion of the internal mold of the muscle impress was 27mm. This was the largest specimen found. This species is also present in the Port Ewen.

The Meristella sp. of the Upper New Scotland L2 and L3 is a shell almost as broad as M. lata.

M. princeps Hall

Few specimens found but usually well preserved. One specimen was noted in the Lower New Scotland and several in the Becraft.

PELECYPODA

Pterinea? gebhardi (Conrad) var.

One large specimen from the Upper Oriskany agrees with this species in size and in the broad and not prominent radiating ribs. The grooves between the ribs have comparatively faint and narrow rays. The ribs themselves are very broad and are longitudinally striated, while the whole shell has rather faint concentric ridges, placed about 1.5mm apart on the main part of the shell but crowded as they curve around the anterior ear. The posterior ear is not preserved but was apparently much larger than the anterior one. On the ventral part of the shell the primary ribs increase in width anteroposteriorly from $\frac{1}{16}$ to $\frac{5}{16}$ inch while the grooves increase but slightly in breadth.

P.? naviformis (Conrad)

One well preserved left valve from the Coeymans has all the characteristics of this species. Hall cites it from the Pentamerus limestone, whether lower or upper he does not say.[1]

Megambonia aviculoidea Hall

Owing to the coarsely crystalline character of these shells, they are seldom sufficiently well preserved to admit of identification for the rock on breaking fractures more easily through than around them. It is apparently quite abundant in the Upper Manlius.

Actinopteria communis (Hall)

The specimens identified with this species have rounded radiating ribs and are not nodose. One quite well preserved specimen was found in the Lower New Scotland.

A. textilis (Hall)

Very abundant in the Lower Oriskany. The surface has strong radiating ribs which at the base are distant from one another about three times their width. In the middle of each intermediate space is a finer radiating ray. Concentric ridges give a cancelated appearance to the entire surface. The large specimens from here are of a size similar to those termed small by Professor Hall.[2] A comparatively large specimen was 30mm long from tip to tip of ears and 32mm in greatest length from the hinge to the front of the shell.

A. textilis var. **arenaria** (Hall)

This differs from the above merely in having the concentric ridges accentuated, becoming imbricating lamellae and spinose where they

[1] *See* Conrad. Acad. Nat. Sci. Jour. 1842. 8:210, pl.1, for original description.

[2] Pal. N. Y. 3:288, pl.53, fig.2-10.

cross the radiating ribs. It is usually quite well preserved and was found rarely in the Lower and abundantly in the Upper Oriskany.

Cypricardinia lamellosa Hall

One rather small but quite well preserved specimen from the lower part of the Port Ewen.

GASTROPODA

Platyceras cf. **gibbosum** Hall

The specimen from the Lower New Scotland identified provisionally with this species agrees with it in shape and size of volutions. It is, however, much less strongly plicate.

P. lamellosum Hall

One specimen from the Upper Oriskany agrees exactly with Hall's figures and description[1] in size and shape. It preserves, however, no surface markings.

P. platystoma Hall

Two specimens from the Lower Oriskany answer to the description of this species.[2] They measure 35mm by 40mm and 30mm by 35mm respectively; the first measurement in each case is the diameter of the aperture at right angles to the breadth of the shell, the other is the distance in a straight line from the posterior end of the apex to the anterior side of the aperture. Each has three broad rounded plications on one side, the other being mutilated.

P. reflexum? Hall

Two rather poorly preserved specimens from the Middle and Upper Oriskany are questionably referred to this species.

P. tenuiliratum Hall

One well preserved specimen from the Lower New Scotland.

P. ventricosum Conrad

One small specimen, 9mm in greatest length, from the Upper New Scotland and one 30mm in greatest length from the Lower Oriskany.

Platyceras sp.

A poorly preserved internal mold from the Coeymans shows three or four prominent plications toward the aperture. There is also evi-

[1] Pal. N. Y. 3:330, pl.63.
[2] Pal. N. Y. 3:326, pl.60.

dence of several rather prominent transverse folds. The spiral portion of the shell is not preserved.

Diaphorostoma desmatum Clarke

One shell from the Upper Oriskany has three volutions; its diameter through the plane of coiling is 17mm, the greatest distance at right angles to this plane is 10mm. The concentric striae are pronounced and closely crowded. The revolving striae do not cross the concentric ones and hence only modify the interspaces. This is very similar to the *young stages of* D. lineatum of the Onondaga and Hamilton above. On the adult shell of this latter species, however, the revolving striae become more and more pronounced, producing a cancelation; in the older shells the difference in the development of the two sets of striae becomes still more marked, and the cancelation becoming scarcely noticeable, the shell appears at a glance to be only longitudinally striated, the very opposite of D. desmatum.

D. nearpassi (Weller)

One small specimen was found in the Lower Oriskany. It is 8mm in greatest diameter and 4mm high. The lines of growth are crowded and raised above the surface of the shell. No revolving striae are present.

D. ventricosum (Conrad)

Shell normal in size and form. It is very abundant in the upper beds of the Oriskany where it almost invariably occurs as internal molds. It also occurs rarely in the Lower Oriskany beds and in the Lower New Scotland.

PTEROPODA

Tentaculites acula Hall

The characteristic pteropod of the Lower Oriskany where it is quite abundant.

T. elongatus Hall

Exceedingly abundant in some bands of the Upper Oriskany. It occurs much more rarely in the Lower Oriskany while one specimen was noted in the Upper New Scotland.

T. gyracanthus (Eaton)

This very characteristic Manlius fossil is very abundant both in the lower and upper portions of this formation. In one or two narrow zones of the Upper Manlius it practically occupies the bed to the exclusion of all else. The shell is normal in its development.

Conularia pyramidalis var. **jervisensis** n. var.

The specimens identified with this species are from the Upper Oriskany. They agree fully with Hall's original description of those from the shaly Helderbergian beds below, with the exception that on our shells the transverse striae are twice as numerous as on the typical species. Near the apex there are 20 striae to three lines while on the rest of the shell there are 30. Hall[1] gives 15 or 16 in three lines but says that at intervals near the aperture they are sometimes more crowded. Here the crowding has become the normal condition. The dimensions of a specimen incomplete posteriorly are 22mm in length, 9 mm in width at aperture.

CEPHALOPODA

Cyrtolites? expansus Hall

Five or possibly six specimens from the Upper New Scotland are all smaller than those described by Professor Hall.[2] The largest measures 15mm by 11mm by 16mm in width and length at aperture and length from apex to anterior portion of aperture respectively. The carination is quite prominent and two of the specimens show concentric striae. Only one specimen gives indication of a broadly expanded aperture.

Orthoceras helderbergiae? Hall

The internal mold from the Coeymans identified provisionally with this species agrees closely with the short description given by Professor Hall.[3]

Orthoceras sp.

One internal mold, 1½ inches long by ⅞ inch wide at the larger end by ⅝ inch at the smaller end, found in the Lower New Scotland,

[1] Pal. N. Y. 3:347.
[2] Pal. N. Y. 3:479, pl. 114.
[3] Pal. N. Y. 3:345.

shows 12 annulations which are angular with sharp crests. The vertical distance from furrow to ridge is about .5mm; from crest to crest of the annulations is 3.2mm. The concavity of the septum is one third of its width. No finer surface characters are preserved if they ever existed.

TRILOBITA

Proetus protuberans Hall

One well preserved pygidium with the characteristic flattened marginal border was found in the Coeymans.

Phacops logani Hall

Several specimens found in the Coeymans and New Scotland.

P. pipa Hall and Clarke

Several specimens found in the Onondaga.

Dalmanites cf. **anchiops** (Green)

A portion of a cephalon of what appears to be this species was found in the lower Onondaga.

D. dentatus Barrett

Exceedingly abundant in the ½ foot Trilobite bed, also rarely found through the entire 30 feet of the Lower Oriskany. An individual of average size measured: pygidium, 30mm by 28mm; cephalon, 30mm by 35mm in length and breadth respectively. The pygidium arched 11mm and had a spine at its end 4mm long.

D. pleuroptyx (Green)

Represented by one pygidium from the Favosites bed and another from the Coeymans, proper.

Homalonotus vanuxemi Hall

Very abundant in the lower Oriskany, specially in the Trilobite bed. A pygidium of average size measured 35mm in length by 37mm in breadth at its widest portion and arched from 4mm to 5mm.

ADDENDUM

We are indebted to Dr S. T. Barrett of Port Jervis N. Y., an active local geologist, for the opportunity of noting the two succeeding species from the Oriskany of Trilobite mountain.

Grammysia sp. nov.

One imperfect specimen of a Grammysia from the Trilobite ledge (Lower Oriskany) indicates a close relationship to G. undata of the Chemung group. It agrees with it in size and surface markings as far as these are preserved but differs from that species in that the hinge line anterior to the umbone has a greater extension and that the convexity of the shell posterior to the cincture is decidedly greater.

Nuculites barretti sp. nov.

Shell outline characterized specially by an abrupt downward curving to the hinge line posterior to the beak and by an oblique

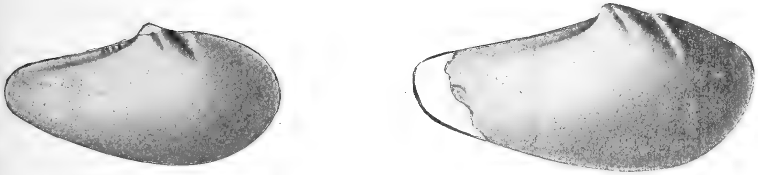

Fig. 9, 10. Nuculites barretti Shimer. x2

truncation anterior to the hinge line, as well as by the navicular curve of the base. Beaks separated by an area of medium width. Dentition taxodont, apparently multivincular. Anterior to the beak is a radial buttress[1] extending from the hinge line downward and slightly forward about one third of the distance to the base of the shell. The internal molds from which this description is made show on the umbone a slight depression running parallel to the radial buttress. An undefined sinus gradually broadening extends from the hinge line to the posterior basal extremity.

Three specimens measure in length and hight respectively, 19mm by 8mm, 20mm by 12mm (imperfect), 16mm by 10mm (imperfect).

This species, which is from the Upper Oriskany, more closely resembles in external characters Clidophorus cuneatus Hall of the Upper Ordovician[2] than any other species with whose description we are familiar. It differs specially, however, from C. cuneatus in being more elongate in proportion to its hight, in the more central location of the beaks and in the abrupt downward curving to the hinge line posterior to the beak.

[1]On comparing the radial buttress of this species with that of Machaera costata, a recent shell abundant along the whole New England coast, we note that in the latter species it is perpendicular to the shell and also is narrowest at the hinge line, increasing in breadth as it fades away, in this respect being just contrary to Nuculites barretti.

[2]Can. Nat. & Geol. 1860. 5:148.

Table showing faunal distribution according to horizons[1]

	Manlius Lower	Manlius Upper	Coeymans Favosites bed	Coeymans proper	New Scotland Lower	New Scotland Upper	Becraft	Port Ewen	Oriskany D. dentatus horizon	Oriskany S. murchisoni horizon	Onondaga
Spongia											
1 Hindia fibrosa *Roemer*	....	....	....	....	?	....	....	....	....	....	....
Hydrozoa											
2 Stromatopora concentrica ? *Goldfuss*	....	....	r-C	....	....	....	....	....	....	....	....
Actinozoa											
3 Blothrophyllum promissum *Hall*	....	....	....	....	....	....	....	....	....	....	?
4 Ceratopora *sp.*	....	....	....	....	....	....	....	....	....	....	?
5 Enterolasma strictum *Hall*	....	....	....	c	c-C	r-c	r	r	....	....	....
6 Favosites helderbergiae *Hall*	....	r	c-C	c-C	....	....	....	....	....	....	....
7 F. sphaericus *Hall*	....	r	?-C	r-c	r	....	....	....	....	....	....
8 Favosites *sp.*	....	....	....	r	r	....	....	....	....	....	R
9 Zaphrentis roemeri *E. & H.*	....	....	r	....	....	....	....	....	....	....	....
10 Zaphrentis *sp.*	....	....	....	....	....	....	....	....	....	....	?
Pelmatozoa											
11 Edriocrinus pociliformis *Hall*	....	....	....	....	....	....	c-C	....	....	....	....

[1] The classes are arranged in zoologic order; the species are in alphabetic order.
C indicates very common; c, common; r, rare and R, very rare.
The two letters in a square indicate the range in abundance of that species in the beds in which it occurred at all; for example, number 33 occurs rarely, commonly or very abundantly in the different beds of the Upper New Scotland, yet in some outcrops it was entirely wanting. Gypidula galeata of the Coeymans proper is practically the only species which is present in every outcrop; though several other species approach it in this respect, noticeably Spirifer murchisoni in the Upper Oriskany and Spirifer concinnus in the Becraft.

Bryozoa											
12 Lichenalia torta *Hall*			r	r-c		R-c	r	r			
13 Lioclema cellulosum *Hall*				c	?						
14 L. ponderosum (*Hall*)					r						
15 Monotrypa tabulata *Hall*					R						
16 Monotrypella ? abrupta (*Hall*)		?			c				?		
17 Orthopora regularis (*Hall*)				c	c						
18 O. rhombifera (*Hall*)				C	C						
19 Unitrypa nervia (*Hall*)				r							
20 U. praecursa (*Hall*)				c	?						
21 Vermipora serpuloides *Hall*					c	r			c		
Brachiopoda											
23 Atrypa reticularis *Linn.*				r-c			r-c				C
24 Atrypina imbricata *Hall*					R	c					
25 Beachia suessana *Hall*									R-c	R	
26 Bilobites varicus (*Con.*)					r						
27 Chonetes hemisphericus *Hall*											?-c
28 C. hudsonicus *Clarke*					r						
29 C. yandellanus *Hall*											R
30 Chonostrophia complanata *Hall*						R			r-C	r	
31 C. jervisensis *Schuch*										r	
32 Coelospira acutiplicata (*Con.*)											R-C
33 C. concava (*Hall*)				r	r-c	r-C		r-C			R
34 C. dichotoma (*Hall*)										r-c	
35 C. grabaui *Shimer*											C
36 Cyrtina rostrata *Hall*									r		
37 Cyrtina *sp.*				R							
38 Dalmanella concinna *Hall*								r			
39 D. perelegans *Hall*				r		r					
40 D. subcarinata *Hall*				r-c	r-c	r C	r	r	R-c	r	?

Table showing faunal distribution according to horizons (*continued*)

	MANLIUS		COEYMANS		NEW SCOTLAND		Becraft	Port Ewen	ORISKANY		Onondaga
	Lower	Upper	Favosites bed	Coeymans proper	Lower	Upper			D. dentatus horizon	S. murchisoni horizon	
Brachiopoda (continued)											
41 Delthyris perlamellosa *Hall*				c	R-c	R-c	?-R				
42 Eatonia medialis (*Van.*)				r	R C	r-c					r
43 E. singularis (*Van.*)					R-c	R		c			
44 Gypidula angulata *Weller*				R							
45 G. galeata (*Dal.*)				c-C							
46 G. pseudogaleata (*Hall*)							C				
47 Leptaena rhomboidalis (*Wilck.*)				c-r	c-r	c-r	r-C		R-c		r
48 Leptocoelia flabellites (*Con.*)										r-c	
49 Leptostrophia oriskania *Clarke*									R		
50 Lingula *sp.*					r	c		R			
51 Megalanteris ovalis *Hall*										?	
52 Meristella laevis (*Van.*)				c-C	R-C	r-c	R-C				
53 M. lata *Hall*								r	r	r-C	
54 M. princeps *Hall*					R		r				
55 Meristella *sp.*					R	r-c					R
56 Nucleospira concentrica *Hall*					r						
57 N. elegans *Hall*				?			c		c		
58 N. ventricosa *Hall*				r		?					
59 Orbiculoidea ampla *Hall*									r		

60 O. discus *Hall*					?	?					
61 O. jervisensis (*Barrett*)					?				c	C	
62 Orthothetes woolworthanus *Hall*						r	R				
63 Pholidops ovata *Hall*				c	r						
64 Rensselaeria aequiradiata (*Con.*)			c f			c f			R		
65 R. ovoides (*Eaton*)									?		
66 R. subglobosa *Weller*									c-C		
67 Reticularia fimbriata (*Con.*)											r
68 R. modesta (*Hall*)				r	r					r	
69 Rhipidomella assimilis *Hall*					R						
70 R. eminens *Hall*						r					
71 R. oblata *Hall*				R	r	r-R			r		
72 R. tubulistriata *Hall*						R					
73 Rhynchonella altiplicata *Hall*				?		?					
74 R. bialveata *Hall*					?						
75 R. semiplicata (*Con.*)				? r							
76 Rhynchospira formosa *Hall*				c	R						
77 R. globosa *Hall*				?							
78 Schizophoria bisinuata *Weller*				?							
79 S. multistriata *Hall*				?		R	R		?		
80 Spirifer arenosus (*Con.*)										?	
81 S. concinnus *Hall*							c-C				
82 S. cyclopterus *Hall*				C	r	r-C	R-r			R	
83 S. macropleura (*Con.*)					R-C	c-C					
84 S. macrus *Hall*											c
85 S. murchisoni *Castel*								c	r-c	r-C	
86 S. vanuxemi *Hall*	r-C	R-C									
87 Stenocisma formosa (*Hall*)						R			r		
88 Stropheodonta becki *Hall*				r-c	r	r-c	r	r		r	
89 S. varistriata (*Con.*)	r-C	R-C	r	? r							
90 S. varistriata arata *Hall*				r		r					

Table showing faunal distribution according to horizons (*continued*)

	MANLIUS		COEYMANS		NEW SCOTLAND				ORISKANY		
	Lower	Upper	Favosites bed	Coeymans proper	Lower	Upper	Becraft	Port Ewen	D. dentatus horizon	S. murchisoni horizon	Onondaga
Brachiopoda (continued)											
91 Strophonella ? conradi *Hall*									r		
92 S. headleyana *Hall*					r	r	?				
93 S. leavenworthana *Hall*								R			
94 S. punctulifera (*Con.*)				r		r-R	R	r			
95 Trematospira multistriata *Hall*						R-c					
96 T. perforata *Hall*						?					
97 Uncinulus campbellanus (*Hall*)						R	?				
98 U. mutabilis *Hall*				?-r							
99 U. nucleolatus *Hall*				c							
100 U. pyramidatus *Hall*				c		R					
101 U. vellicatus *Hall*						R			R		
102 Uncinulus *sp.*		r		r							
103 Whitfieldella ? nucleolata (*Hall*)		c-C	r								
Pelecypoda											
104 Actinopteria communis (*Hall*)					R						
105 A. textilis (*Hall*)									R-C		
106 A. textilis arenaria (*Hall*)									R	c	
107 Cypricardinia lamellosa *Hall*								R			
Grammysia *sp. nov.*											

108 Megambonia aviculoidea *Hall*		r									
Nuculites barretti *Shimer*											
109 Pterinea ? gebhardi (*Con.*) var.										r	
110 Pterinea ? naviformis (*Con.*)				R							
Gastropoda											
111 Diaphorostoma desmatum *Clarke*										r	
112 D. nearpassi (*Weller*)									R		
113 D. ventricosum (*Con.*)					R				R	r-C	
114 Holopea antiqua (*Van.*)		?									
115 Loxonema jerseyense *Weller*									?-c		
116 Loxonema *sp.*	R	r									c
117 Platyceras gibbosum *Hall*					cf						
118 P. lamellosum *Hall*										R	
119 P. platystoma *Hall*									r		
120 P. reflexum *Hall*										?	
121 P. tenuiliratum *Hall*					R						
122 P. ventricosum *Con.*						R			R		
123 Platyceras *sp*				R	R	R			R	R	
124 Pleurotomaria *sp.*		R									
Pteropoda											
125 Conularia pyramidalis jervisensis *Shimer*										r	
126 Tentaculites acula *Hall*									r-c		
127 T. elongatus *Hall*						R			r	r-C	
128 T. gyracanthus (*Eaton*)	c-C	R-C									
129 Tentaculites *sp*				r							
Cephalopoda											
130 Cyrtolites ? expansus *Hall*						c					
131 Orthoceras helderbergiae *Hall*				?							
132 Orthoceras *sp.*					r						

Table showing faunal distribution according to horizons (*concluded*)

	MANLIUS		COEYMANS		NEW SCOTLAND				ORISKANY		
	Lower	Upper	Favosites bed	Coeymans proper	Lower	Upper	Becraft	Port Ewen	D. dentatus horizon	S. murchisoni horizon	Onondaga
Trilobita											
133 Dalmanites anchiops (*Green*)											cf
134 D. dentatus *Barrett*									R C		
135 D. micrurus (*Green*)		R									
136 D. nasutus (*Con.*)				?							
137 D. pleuroptyx (*Green*)			R	?-R							
138 Dalmanites *sp.*						R-r		R			
139 Homalonotus vanuxemi *Hall*									c		
140 Phacops logani *Hall*				R	r	cf					
141 P. pipa *Hall & Clarke*											r
142 Phacops *sp.*										R	
143 Proetus protuberans *Hall*				R							
Ostracoda											
144 Beyrichia manliusensis *Weller*	?-c	?-r									
145 Beyrichia *sp.*	r	r-c	?								
146 Leperditia alta (*Con.*)	r	R-c									

I wish to express here my indebtedness to Prof. A. W. Grabau of Columbia University, under whose supervision this work was prosecuted and who has given me continuous encouragement in the work.

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CONTRIBUTIONS TO THE FAUNA OF THE CHAZY LIMESTONE ON VALCOUR ISLAND, LAKE CHAMPLAIN

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The following descriptions have been made in order to facilitate the study of a section in the Chazy rocks on Valcour island. All the species were obtained from the beds of this section.

CYSTOIDEA

Genus MALOCYSTITES Billings

Malocystites emmonsi sp. nov.

Plate 1, figures 3-7

Description. Viewed from above along an axis determined by the point of attachment to the stem and the center of the more globular portion of the theca, and with the food grooves or what I may call the sigma, turned away from the observer, the anus appears to be placed a little to the left and more or less in advance of the summit; this axis measures from 6 to 10 mm. Viewed from the right side, that portion of the theca bearing the rather prominent plates of the sigma is seen to be produced so as to form a distinct and somewhat contracted neck with the mouth from 40 to 80 degrees in advance of the distal end of the axis as defined above; the edge of the theca from base to anterior food groove is much flattened forming in most cases a rather straight line or chord of from 90 to 140 degrees; the posterior edge is also rather straight or but slightly convex, forming a chord of some 45 degrees from base; from here the outline is usually well rounded to neck under edge of posterior food groove, though some specimens are rather obliquely oval or subovate in outline; the longest diameter is from base to outer edge of posterior food groove and is from one fifth to one fourth longer than the measured vertical diameter. There are on an average some 43 plates in all, not counting the covering pieces, and their outlines usually vary from tetragonal to heptagonal. Some of the specimens are in part ornamented with fine regular, rounded, and not crowded granulations, while in others the raised granulations become quite irregular in outline and often confluent. The larger plates have each a more or less prominent umbo, which may be central or excéntric and which together give various angular outlines to different portions of the theca; there is usually a very large umbo between the anus and the base. More or less wide, raised ridges usually connect the umbones and many finer ridges run from them over the plate, branch, cross the sutures and form some very fine reticulations having rounded, depressed pits between them.

Observations. This species differs from M. barrandii in its much smaller size, the excentric position of the anus, the outgrowth of the theca to form a neck under the sigma, its conical base, its prominent umbones and varied angular outlines. Mr Percy E. Raymond writes me that the food grooves in the type specimens of M. barrandii are not so much elevated in proportion to the size of the theca as in this Valcour form.

These specimens are so well preserved that it seems proper to make their description still more complete. Specimen A, which has been chosen as the type, still bears two rings of the stem and shows it to have had a marked and permanent bend toward the posterior side. Another specimen has six rings of the stem still attached; these are circular, measure 1.2 mm across next to the theca and uniformly taper down to .9 mm without alternations in size. The outer surface of the joints is only gently convex and each joint is very faintly and closely ribbed across its edge; there are about six rings to the millimeter; here also a rather abrupt bend toward the posterior side occurs next the theca and it is rather difficult to distinguish the sutures between the first two or three rings; the lumen is round and about half the diameter of the ring. The stem appears to have been short and used perhaps as an anchor but not for complete support. The theca probably rested, in part at least, on the plates to the posterior of the proximal ring. This position would place the mouth at the summit of the theca and bring the arms into a horizontal plane and a similar external environment. Figures 4, 6 and 7, plate 1, show three specimens oriented as if supported by the stem alone, making the axis chosen for description the vertical axis on the plate. A glance at figure 7 will perhaps show the absurdity of considering this a normal position, particularly so if the sigma plates bore spreading brachioles, as their structure suggests. The posterior arm is usually the shorter and less developed, the difference in environment caused by the position of the anus being the probable cause.[1]

The plates of the type specimen, designated as A [pl. 1, fig. 3, 4] are arranged as follows. There are three basal plates, the anterior of which is about half the size of the others. This plate is in contact with but two plates lying above it, while each of the other two is in contact with four plates above. Numbering to the right from the posterior margin, plate 4 rests on the upper left side of plate 1, this plate and the next are tetragonal and small; no. 6 is heptagonal, large, and has a prominent and excentric umbo a little above and to the right of the center; plates 7 to 9 are nearly as large as 6, are

[1] I have for some years harbored a notion that one of the many laws underlying the production of variation and new species might be expressed by the term, "the survival of the unfit," perhaps better stated as "the survival of the weak," a law related to Cope's "law of the unspecialized." Failure to divide normally at the proper time gave cell aggregates and inaugurated a new wave in what Herbert Spencer points out as the law of rhythm in evolution. No new crest of strength springs from the crest of the last wave but each crest is preceded by a trough. The invagination of a weak hollow sphere of cells gave rise to the gastrula and forced a division of labor on the "unfortunate" aggregate; and this law, if I may so call it, offers suggestions as to the origin of many things from cell conjugation to the discovery of some weak mortal that he might make the pen mightier than the sword he was unable to use. The idea suggested a possible cause for the later change in shape of Eunema epitome. Lyriocrinus? beecheri, with its invaginated base produced at first by the yielding of weak basals to the persistent attack of gravity, is an illustration in point and an extreme is found in Blastoidocrinus carchariidens. The failure of plates to support increased weight has initiated variation along this line in many crinoids and natural selection has found certain mechanical advantages in the new forms; out of weakness has come strength. The law suggests that ancestors of Malocystites were once supported by the stem alone and had their arms in a normal position, but that descendants with weak stems often found themselves let down to the ocean floor and had to make shift to live under adverse conditions. Increased growth of the posterior plates or decreased growth of the anterior plates would have brought the arms again uppermost and given rise to a form like that here shown. A stem unused for support might become of advantage as an organ of locomotion and secure slow changes in position.

hexagonal, and have slightly raised centers; plate 10 is the last to have a side in contact with any of the basal plates, it is pentagonal and about the size of no. 7. Plate 11 is a large pentagonal plate and may be considered as the first in the third row, though it is so wedged

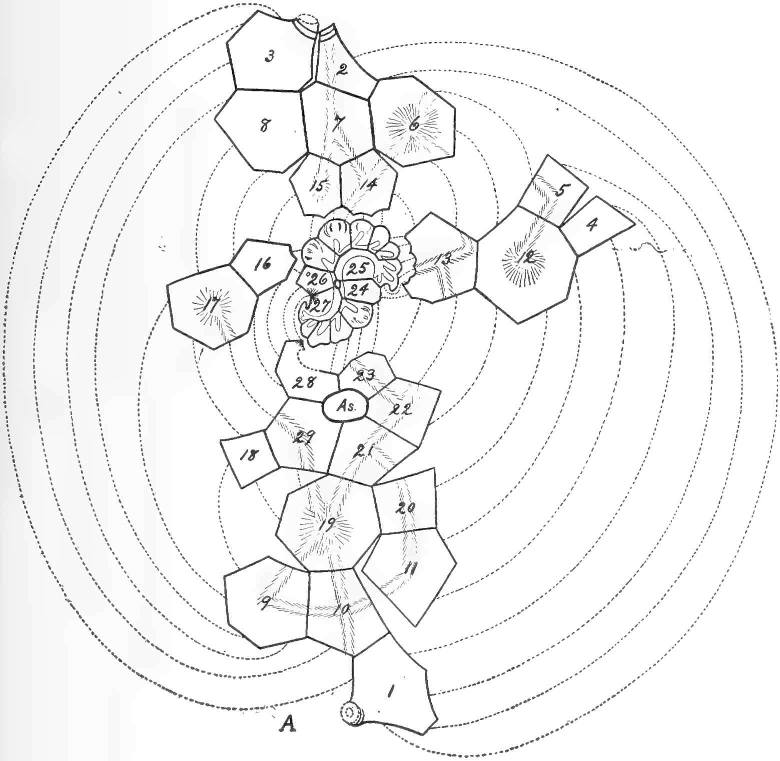

Fig. 21 Analysis of the type specimen, designated as specimen A, of Malocystites emmonsi. The mouth with its plates bearing the food grooves will be found just above the center of the diagram; the anus (As) not far below it; the basals are numbered 1, 2 and 3 and will be found at the extreme upper and lower portions of the figure. The more prominent mounds and ridges have been rather roughly indicated by hachures.

in between plates 10 and 4 as to have its lowest angle touch the highest angle of plate 1; the center of this plate lies a little to the right of a line drawn from anus to base and is the lowest of three that might be called the anal row. Passing still to the right, no. 12 is the largest of the remaining plates with one exception, is heptagonal, and bears a moderate umbo. Plate 13 supports the fifth and the following brachials (if I may so call these plates) of the anterior arm; plate 14 supports the third brachial of this arm and also half of the second and nearly all of the fourth brachial. The latter arm plate has a small shoulder against no. 13. Plate 14 is marked by a prominent ridge connecting with the umbo on plate 6 and the place of meeting of plates 13, 6 and 14 is depressed. Plate 15 supports

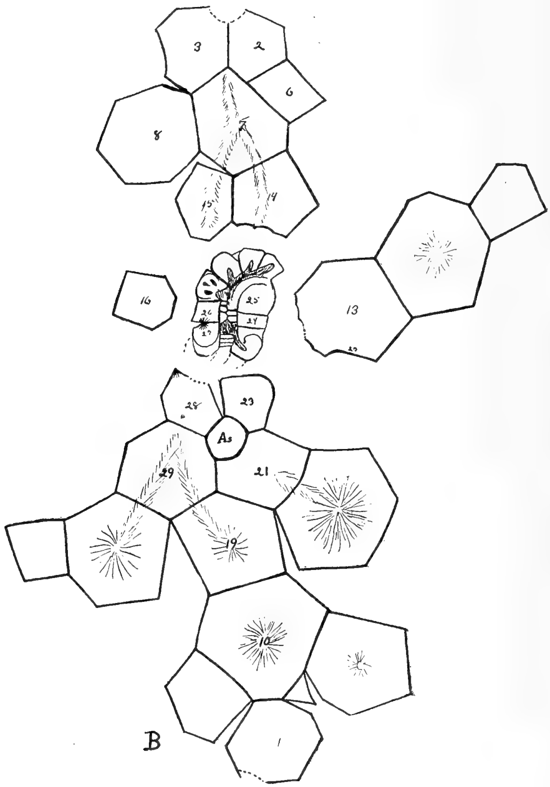

Fig. 2 Analysis of Malocystites emmonsi, specimen B [pl. 1, fig. 5, 6]

half of each of the first and second brachials, plate 16 has one shoulder against the first brachial and supports also the plate bearing the genital pore. The plates now leave the arm, 17 is moderately large, hexagonal and with a slight umbo just above its center; 18 is small and tetragonal; 19 is as large as any of the others, is hexagonal and has a very prominent and nearly central umbo; this completes the third row and is the last of the plates bearing umbones. Plate 20 comes directly over 11 and plate 21, above this, forms the lower border of the anus; plates 22 and 23 form the right and a portion of the upper border of the anus, and 23 also supports the first and half the second brachial of the posterior arm. Plate 24 is just anterior to and also supports the first brachial of this arm, it also reaches the mouth and forms part of its border; plate 25 is semicircular in outline, fills up the inner portion of the half sigma of the anterior arm and supports all of its brachials on this side; its inner border is raised to form the edge of a channel which receives the eight grooves of the anterior brachials. Plate 26 borders on the mouth, supports the posterior edge of the first anterior brachial, and bears the genital pore; 27 is formed like 25 and receives the six grooves of the posterior arm; 28 supports the last brachials of the posterior arm on the outer side of the curve and with 29 forms the left border of the anus. At the point where plates 26, 27 and 28 meet each other there is a peculiar, small, roughened mound which may represent the madreporite.

There is considerable variation in the plate arrangement in the three specimens figured. Specimen C was probably as aberrant a form as could have been found in the two hundred or more specimens collected. This specimen has 37 plates besides the brachials, A had 29, and B shows but 28.[1] The four plates bordering the mouth are constant and may be called the orals. They bear covering plates some of which may be seen in specimen B [pl. 1, fig. 5]. The plates I have called brachials are vertical plates with their lower edges resting on the neck plates of the theca and their middle portion against the opposite oral. These plates do not show covering pieces but the orals numbered 25 and 27 still continue their covering pieces which now reach completely across the food groove, forming a single series of rectangular plates. There were several of these in position on the anterior arm but they became lost through an accident and the only completely transverse plates now present are in the posterior arm. The first one or two brachials are the largest; the others then grow rapidly smaller as the half sigma recedes from the mouth. All bear truncate faces on their distal ends and the larger are marked as if they had borne extended and movable brachioles. The larger faces are directed more nearly upward and

[1]Compare figures 1, 2 and 3 of the text.

bear two crescentic depressions which face each other; their inner ends reach to the edge of the food groove; and partly inclosed between them is a third somewhat triangular depression pointing toward the food groove but situated nearer the outer edge of the

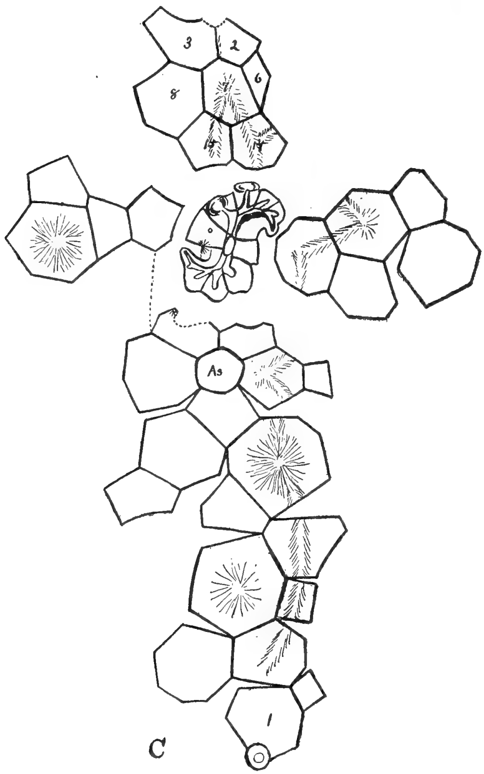

Fig. 3 Analysis of Malocystites emmonsi, specimen C [pl. 1, fig. 7]

plate. Surrounding all is a well rounded but not prominent ridge. The smallest plates seem to have had short extensions which were bent below the horizon of the sigma. Going toward the larger plates the angle of each truncate face gradually changes till we reach the larger and more vertical brachioles. The normal specimens have six grooves running into the posterior portion of the sigma and eight into the anterior portion, but it is difficult to determine whether these grooves represent so many separate plates. The last two are very small and I have as yet been unable to detect a suture between them.

Specimen C has but 10 radiating grooves in the complete sigma, five in each half. Specimen B seems to have no genital pore and the ornamentation of the plates varies considerably from that of A. The position of the madreporite is constant in all.

The anus is large, usually appearing as a rounded pentagon. The covering plates in some of the specimens seem to have been pressed into the anal opening; one specimen has the plates in position and they form a gently convex mound, the plates meeting so exactly that the determination of their number, whether five or six, is no easy matter. They are ornamented by radiating lines of exceedingly fine and close tubercles.

The specimens so far examined have each six neck plates, but there is much variation in their manner of supporting the plates of the sigma. The three basals seem to be constant with no. 2 always the smaller. The plate numbered 7 seems also constant in shape and position and the two plates directly above it always reach and support the sigma plates above them. In the figures illustrating the cup dissections I have crudely indicated the more marked umbones and the more prominent ridges connecting the same. Further study would no doubt enable one to designate many more of these plates as constants. The specific inheritance had not become as yet so fixed as to completely shut out some of the plates of an older inheritance. The anterior plates were evidently less disturbed in their early growth and so have more nearly a constant shape. Name given in honor of Dr Ebenezer Emmons, former state geologist of New York.

CRINOIDEA

Genus LYRIOCRINUS Hall

Lyriocrinus? beecheri sp. nov.

Plate 3, figures 1-4

Description. Cup small, but 6mm from base to upper angle of primaxil [1Ax], while the whole crown from base to top of incurved arms is 21mm; the cup has been crushed and thus slightly widened, but the greatest width still measures but little over 7mm. Proximal joint of column round and sunken in a hollow base formed by a strong infolding of the proximal portion of the basals; column next the cup formed of alternate narrow and wider rings. The basals appear to be hexagonal and each is marked by two very prominent keels running from the central portion of the plate toward the lower angles. Both are bent, with the convex side toward the ring; at their junction near the center of the plate they give rise to a short vertical fold which soon divides into two less prominent keels or

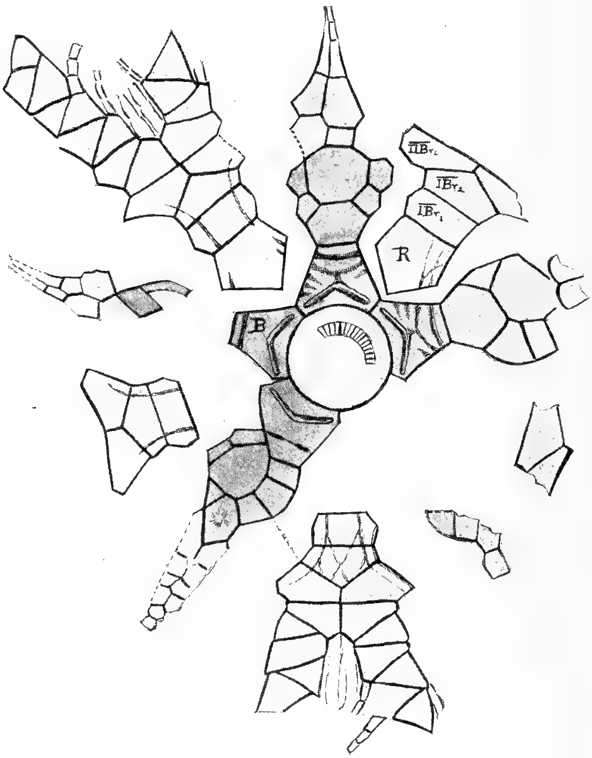

Fig. 4 Analysis of Lyriocrinus? beecheri. Interradial plates shaded and the position of the more prominent plate folds and ridges indicated.

ridges which pass outward to the radials; between the former and the latter are three faint folds, seen best next the edge of the plate and perpendicular to this edge; there is also a strong transverse ridge below and parallel with the truncate upper edge of the plate. The pentagonal, completely separated radials carry very slightly raised ridges continued from the basals; those near and parallel with the lateral margins are the more prominent and extend vertically over the brachials at about one fourth the width of the plates from their margins, as fine, raised ridges; these fork near the upper edge of IBr (first primibrach), and again just as they leave the IAx; the outer branch in each case remains the stronger but becomes very faint on $IIBr_1$. The first secundibrach ($IIBr_1$) is about twice as wide as high and the pentagonal IAx presents approximately the same area of surface. These plates seem to be ornamented only by what appear to be faint nerve ridges and their branches which present some very faint reticulations. No ray seems to have possessed a plate between IBr_1 and IAx. Each interradius has one large plate in contact with the basals, and six or seven plates in addition, one of which may be as large or slightly larger than the first; directly over these the pinnules from $IIBr_1$, with their plates somewhat enlarged, meet each other and are incorporated in the cup. The 10 arms, thus brought closely together, are comparatively large, biserial and, with their pinnules, obovate in outline; the IIBr counted on one side number 35 and over and are strong and rounded on the back; the pinnules are closely set and the longest measure about 5mm; the whole arm is very plumelike in appearance and the manner of folding over the cup extremely graceful. This folding is a mixture of the convolute and imbricate and is shown in figure 5.

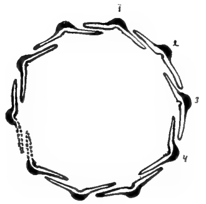

Fig. 5 Diagrammatic cross-section of Lyriocrinus? beecheri showing the manner in which the arms are folded over the tegmen.

Observations. The crushed condition of the cup has made the determination of the arrangement of the plates of the interradii a somewhat difficult matter. In my drawing of this plate arrangement (fig. 4), I have outlined only such plates as were present and in, or nearly in, their normal position. In one or two instances a fracture may have been taken for a suture. The complete interradius to the right in the cut was drawn from plates crushed in just below the first incorporated pinnules and perhaps should have one or two additional small plates near the latter. The completed interradius placed in the position of l. anterior IR apparently has had its basal, the top of which is broken across, forced to one side. This interradius seems to possess two or more very small tetragonal plates lying between but not belonging to the enlarged pinnules from $IIBr_1$; it should perhaps have been chosen to represent posterior IR. Owing to the condition of uncertainty I have refrained from completing the diagram and have made the left hand interradius of figure 1 [pl. 3] the vertical one in figure 4 of this text.

I am one of a host whom Prof. C. E. Beecher placed under lasting obligation through his kindly given and generous help. This specimen was found soon after his visit to my camp in the summer of 1903 and I name it after him, not alone in recognition of the eminent position he attained in the science to which he gave his life's labor, but also as a token of personal affection and in appreciation of many rare mental qualities which I came to see as one can best see such things through the freedom of field work by day and at the open camp fire by night.

Genus RHAPHANOCRINUS Wachsmuth and Springer

Rhaphanocrinus gemmeus sp. nov.

Plate 2, figures 1-5

Description. Cup small; its hight measured from proximal surface of basals to distal angle of first secundibrach 7.5mm; its diameter measured from upper edge of right posterior primaxil about 9.6mm; that of its base across lower shoulders of basals 4mm; that of proximal ring of stem 3.3mm; sides of cup from lower edge of basals to top of radials rather straight and from this point gradually curving to give a somewhat vertical edge to cup at IIB_1. The more or less narrow depressed margin of the plates is ornamented by numerous fine radiating lines which cross the sutures; a single large proximal interbrachial possesses more than 40 of these lines, and under a low power they are seen to be rows of fine tubercles; from the inner edge of this border the plates rise rather abruptly to the hight of about .5mm and become smooth or microscopically granular with a large flat or slightly concave area which shows, near its outline, a marked tendency toward suppression of the plate angles. The infrabasals are small and almost completely covered by the proximal ring of the stem. Near the cup the stem is made up of alternating light and heavy rings, slightly flattened on their radial edges and possessing radially disposed sutures. The basal plates are largest and are transversely depressed as if slightly bent outward at their bases or as if impressed with a quadrangular die that left four shallow pits at its four corners. The radials are next in size, their raised areas are nearly circular in outline and about 2mm in diameter; they also show slight traces of lateral impressions similar to those on the basals; the raised areas on these plates and on the basals are so large as to nearly or fully meet at the plate edges midway between the angles. The first brachials are smaller and their raised surface wider than high, this area showing a tendency to become diamond-shaped; the plates of the radii above these brachials are well rounded and smooth save for a single depression shown by the anterior and right anterolateral primaxils. The proximal interbrachials are but little smaller than the basals and their raised areas are more angular in outline and well separated from those of the adjoining plates; each supports two smaller plates and these in turn three others above them; a few smaller plates above the latter lose the smooth rounded subcentral elevations and present but a short, vertical, median ridge. In the posterior interradius there is an extra plate immediately above the anal which is followed by a vertical row of seven and perhaps more smaller regular hexagonal plates. The anal tube is about 2.3mm in diameter; rises with a slightly broader base, from a position but little posterior to the center of the oral surface; is bent down just above the ninth hexagonal plate of the anal row; curves slightly to the right and then back to the left and its tip nearly touches the $IIBr_4$ of the anterior R; the last part, 4mm in length, consists of about 10 rows of plates each .4mm long and the row so twisted as to bring a plate

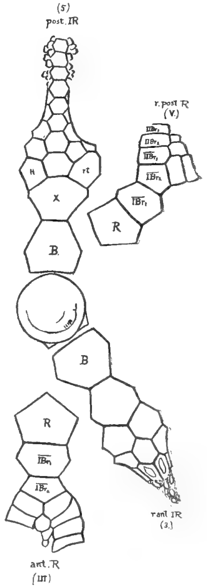

Fig. 6 Analysis of Rhaphanocrinus gemmeus. Three radii and three interradii not shown.

of one row directly under a plate of the next.[1] Some pinnules appear to have been incorporated in the lower portions of the tube. Arms above the $IIBr_4$ are wanting in the specimen. Intersecundibrachs present.

Genus CARABOCRINUS Billings

Carabocrinus geometricus sp. nov.

Plate 1, figures 1-2

Description. Cup small, its hight from base to level of upper edge of anal x, 6.5mm, its width measured across from base of left

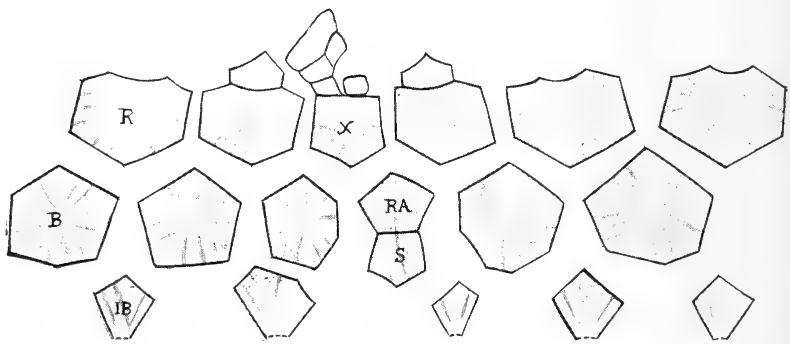

Fig. 7 Analysis of Carabocrinus geometricus. The outline of the radials is drawn as viewed from the side and the true outline of the oral edges is not seen. The more easily detected axial folds have been shown by shaded lines.

posterior IAX 7.5mm, its width half way between base and last measured diameter 6.5mm, subhemispheric with a slight vertical elongation and a tendency to show inversely conical outlines along the lines from base through the centers of the RR, particularly in the l. posterior R where the flattening of the side of the cup is well marked. Vertical diameter of the IBB a little less than that of the RR and their transverse diameters about one half of the latter; the IB of l. posterior R is a little larger than the others and pentagonal, one shoulder supporting the supplemental anal plate, the others are all tetragonal; the IB of r. posterior R is smaller than the others. The vertical and lateral diameters of the BB are about equal to the

[1] It will be seen that such a twist, if I may so call it, could be described as turning either to the right or to the left, or one might consider the tube to be formed of about 20 longitudinal rows of plates without "twist" but with the plates offset.

width of the RR; the B of R posterior IR is heptagonal, the other four are hexagonal. The plates of the anal row are pentagonal, the anal x is about two thirds of the width of the RR on either side of it, its vertical diameter is the same, one edge is uppermost and the two vertical edges are nearly parallel; the radianal is a little smaller with one angle uppermost and its sides of very nearly the same length; the supplemental plate is slightly smaller still, of nearly the shape of the anal x and with an angle down. The RR have raised centers and the axial folds of these plates pass across the sutures and over the neighboring plates after the manner of C. radiatus, but the folds are finer and less prominent. The plates are very faintly tuberculate, the tubercles showing rather more plainly along the upper edges of the axial folds. The first Br is also the IAX, it is pentagonal, stout, nearly or quite half the width of the R, and well rounded on the back; the hight of the outer edges is about one fourth of the width of the plate.

A very small portion of the tegmen is present in posterior IR; the relative size and position of the plates will be seen in plate 1, figure 2. At each of the other four junctions of the RR in the periphery of the tegmen there is a shallow excavation of the plate margins, forming a straight base and an acute angle at either end as if cut for a dovetail. This appearance suggests triangular deltoids with a bordering plate on either edge, but as I am not familiar with the tegmen of crinoids and do not have easy access to the literature of the subject I shall refrain from further suggestion.

Attached superficially to the left edge of l. posterior R there appears to be an anal pyramid of five plates which may belong to this species, and I have been careful to leave it on the specimen, though as the locality abounds in crinoid fragments its mere proximity should not be given undue weight. The apex of the pyramid shows a very small starlike opening, each plate having a more or less pointed tip and failing to meet its neighboring plates near the apex.

Three rings of the stem are still attached to the cup and seem to be rather uniform in size, about four to the millimeter and 1mm in diameter.

This species differs from C. radiatus in its less globular form, the stouter IAx, and the fact that its arms divide above the first free joint.

Collected by Mr Percy E. Raymond.

BRACHIOPODA

Genus SCHIZAMBON Walcott

Schizambon duplicimuratus sp. nov.

Plate 5, figures 6-7

Description. Pedicle valve subcircular, well rounded anteriorly, slightly straightened for about 70° on each side of the small and rather clean cut apex; length of shell 5mm, width 5.4mm; greatest convexity a little to each side of the pedicle opening and raising surface of shell about 1mm above the plane of the shell margin; apex about .5mm above the cardinal margin and slightly projecting over it. Foramen subovate, about .88mm wide, anterior edge 1.8mm from apex, earlier portions filled up leaving a narrow depression with smooth convex floor, narrowing posteriorly and reaching the extreme point of the apex. Surface ornamented with nearly concentric, raised striae which completely encircle the valve; they are single and rather crowded where they cross the cardinal area but are strongly raised and distinctly wider and double over the anterior and lateral regions of the valve. In front of the pedicle opening eight pairs of these striae can be counted in the length of 2.5mm on anterior portion of vertical axis. The spaces between one pair and the next are rather deep and .2mm wide, the distance across each pair is slightly less. The outermost rampart on the double portion bears a fringe of short spines set about .12mm apart.

Brachial valve similarly ornamented but less produced posteriorly along the cardinal margin.

Observations. This species seems to be a little larger than S. typicalis Walcott, and to differ from that species in its relatively larger pedicle opening, its more nearly spheric or transversely oval outline, and in the prominent and double, not lamellose, striae over the anterior and lateral slopes of the shell surface.

Described from three specimens, one of them collected by Mr Percy Raymond and kindly sent me for comparison.

Genus SYNTROPHIA Hall and Clarke

Syntrophia multicosta sp. nov.

Plate 5, figures 8-15

Description. Shell outline semioval, in some specimens inclining toward subquadrate; hinge line straight, usually equal to greatest transverse diameter and in a large specimen measuring 16mm. In such a specimen the length would measure 10.5mm and the distance from hinge line to apex of pedicle valve 8mm. Cardinal angles about 90°, not rounded, sides generally rather straight and parallel for a distance reaching nearly to the ends of the transverse axis; the anterior half of the shell uniformly rounded save for a distinct flattening of the anterior margin.

Pedicle valve with wide flat cardinal area the sides forming an angle of from 95° to 110° at the beak; beak slightly convex; the slope from beak to valve margin quite straight and nearly uniform in all directions. Delthyrium triangular, two thirds as wide at the hinge line as it is high, and reaching apex.

Brachial valve nearly flat with a very shallow sinus, not showing in all specimens.

Radiating costae are numerous and nearly uniform in size from near the point of their origin to their termination on the margin; as shell growth proceeds new costae are added by implantation. Shells about 2.5mm long have some 33 costae, shells of 5mm length have about 49, while adult shells have 81 and over. In figure 13, plate 5, if the two strong costae on either side of the midcosta are traced to their termination on the margin they will be found to have 11 costae between them instead of one. The new costae do not seem to have been added in regular order, for while the new group of five to the right have their middle one the longest, the middle one of the new five on the left is the shortest and youngest. The costae are crossed by fine raised striae, about .25mm apart. In the gerontic stage the additions to the shell margin of the brachial valve tend to add very markedly to its convexity.

The interior of the brachial valve shows a strong and prominent median ridge starting from the middle of the valve and widening backward till it meets the cruralium. This ridge gives off two lateral branches from its middle portion, equally raised but narrower and pointing toward the ends of the transverse axis. These ridges form the inner boundaries of four deep muscular pits of nearly equal size. The posterior pits with a very slight additional extension backward would leave the cruralium as a narrow platform supported by the wider portion of the median ridge. The two anterior pits are a little nearer together and each shows three distinct muscular impressions separated by two very narrow and slightly raised ridges. The middle scar of each three is the largest, is subtriangular, and has its apex pointing a little inside of the well marked dental sockets; the outer pair are a little smaller, of nearly the same shape and with apex pointing very nearly toward the small, narrow cardinal process; the outer impression of the three is a little smaller still and rather rounded in outline. The pedicle valve bears a wide spondylium well raised from the valve and supported by a fine and narrow median septum which is continued anteriorly to the middle of the valve. The arrangement of the genital and pallial sinuses is shown in plate 5, figures 10, 14. The muscular areas on the spondylium are not distinctly separated but one can distinguish three tracts, a central and two outer of nearly the same area, the boundaries of which are not sharply limited. The delthyrium is bordered by a narrow raised ridge which is continued around the cruralium of the brachial valve. At the apex this well rounded border meets a straight raised ridge tangent to the curve, and just anterior to the ends of this ridge, and outside of the curved border, are two short, narrow, depressed pits usually worn off in most of the valves found.

LAMELLIBRANCHIATA

Genus MODIOLOPSIS Hall

Modiolopsis subquadrilateralis sp. nov.

Plate 4, figures 8, 9

Description. Shell small, from anterior to posterior extremity nearly 9mm. Rather elongate ovate with anterior margin truncate, the straight portion of this margin making an angle of about 125° with the anterior third of the dorsal margin which is also straight;

the beaks are at the angle, and are therefore well forward; the hinge line carries the middle portion of the dorsal line above the flat plane of the umbones and gives the shell a very slightly alate appearance; posterior margin about twice the length of the anterior and quite regularly curved, the sharpest bend being found at the posteroventral margin; ventral margin very slightly convex, a little more straightened in middle portion and forming an angle of about 25° with the general dorsal area as viewed across the shell; the basal line forms an angle with the margin of the anterior truncate part of a little less than 90° and the curve of the basal margin gradually and regularly increases till it meets the margin of the anterior truncate portion in a well rounded angle. Extreme breadth of shell 3mm and at a point but little anterior to the middle and very closely halfway between dorsal and ventral margins. Beaks incurved and nearly touching, byssal pit just below them and the cause, in part, of the truncate appearance. Surface very regularly curved, the usual oblique ridge from beaks to posterior margin not prominently marked. Concentric growth lines very fine and numerous but not easily seen.

Genus CYRTODONTA Billings

Cyrtodonta? lamellosa sp. nov.

Plate 4, figures 10-13

Description. Shell of moderate size, its length being 20.7mm; length of hinge line 10mm; a perpendicular from posterior extremity of hinge line reaches posteroventral angle and measures 16mm. (posterior hight of shell); posterior margin convex and quite closely forming the arc of a circle of 10mm radius with center on axis of greatest length; the arc extended forward would follow the shell for about one fourth of dorsal margin and then enter the shell again at or very close to the beaks; ventral margin but little convex, nearly straight to point directly below beaks, anterior hight 7.7mm; anterior margin at first following the gentle curve of the ventral margin, but becoming markedly convex when it rounds back toward the beaks; the outline of the shell with the exception of the segment cut off by the straight hinge line and the projection of the anterior margin closely resembles the outline of the gibbous moon.

Crescence line diffuse, well curved, slope of surface of shell from this line to either margin gently convex; greatest breadth of shell on this line about one third way from beak to posterior angle and measures 7mm. The surface is lamellose and imbricated, lamellae widen as posterior angle is approached and are there placed with their edges something over 1mm apart; they project from the shell about 1mm or a little more and become crowded on the margin during the gerontic stage.

The valves seem to gape very slightly at the anterior extremity, perhaps indicating a byssal opening. Area crushed in, but posterior extremity of hinge line presents a well formed channel between the winglike posterodorsal extension of the valves, as in Unio alatus, as if to receive a parivincular, opisthodetic ligament. The shell substance is rather thin near the middle of the valve and becomes markedly thicker near the posterior margin.

A line connecting a series of points placed at the successive positions of posterior extremity of shell (measured from the probable position of the beaks) marks also the places of greatest breadth met in crossing the shell and lies over the path of the successive positions of the posterior adductor. A line from apex to posterior extremity of one of the earlier neanic stages, when the shell had attained about one third its length, makes an angle of 30° with the hinge line; during the growth of the remaining two thirds of the shell this line is gradually turned away from the hinge line through an angle of an additional 27°.

GASTROPODA

Genus EUNEMA Salter

Eunema historicum sp. nov.

Plate 4, figure 5

Description. Shell small,[1] turbinate, apical angle 80°, whorls about four. The body whorl shows five well marked minutely tuberculate spiral costae with trace of a faint sixth at the broken edge, well down on the base. The first costa (numbering down from

[1] The type specimen, being broken diagonally across the lower portion of the axis, has lost the aperture while the apex and most of the body whorl are preserved; it has a hight of 4.3mm.

suture) is sharp; the second and third are more raised, prominent, blunt, and each about one fourth as wide as the interspace; the fourth is a little nearer the third, less prominent and narrower; the fifth is nearer the fourth by about half the distance between fourth and third and is about half as wide as the fourth.

Following the outline of a vertical section through the body whorl, the shell is seen to be slightly angulated; from suture to outer edge of first costa the line is straight and at right angles to the axis; a straight line taken from first to third costa would make an angle of about 23° with the axis; the projection of the second costa beyond this line gives a slight convexity to this spiral belt of the whorl; the outer edges of the third, fourth and fifth costae are more nearly in line with each other and this line is nearly parallel with the axis of the shell, its inclination toward the base being but slight; from the fifth rib the surface approaches the axis by another flattened belt, at an angle of about 45°; the final approach to the axis is lost. The intercostal spaces are concave, the amount of concavity increasing markedly as the lower costa is approached, giving a rather horizontal surface to the upper portions of the stronger costae or in certain lights making this upper edge appear slightly reflexed. The suture lies at the base of the nearly vertical, spiral belt or just under the fourth costa and is thus situated at the apex of a clearly cut right angle, two sides of which are formed by the flattened belts already described. The shell is faintly marked with transverse striae the more prominent of which are about 2mm apart; between these a still fainter line can in many places be distinguished; their direction is at first very nearly perpendicular to the suture and on the body whorl they appear to run gently backward from the fourth costa; they are more easily seen above the suture and here seem to be nearly vertical across and beyond the fourth costa; finer growth lines may be detected.

A little more than the first whorl of this specimen is somewhat Natica-like, not angulated, destitute of costae, and the apical angle is more obtuse being about 90°. The transverse striae seem to appear first and are present on the second whorl. The vertical and horizontal flattened belts are present on the third whorl and the first, second, and third costae are clearly developed; the fourth costa seems to have had a later origin as it is not detected till we reach the later portions of this whorl. The intercostal spaces on the third whorl are more uniform and not so deeply concave; the gradual change to the greater concavity near the lower costa can be easily seen in different portions of the fourth or body whorl.

The name historicum was suggested by the well presented ontogenic series in shell growth.

Eunema epitome sp. nov.

Plate 4, figures 6, 7

Description. Shell small, turbinate, apical angle about 80°, length 10.3mm, whorls about four and one half, upper surfaces a little flattened giving a distinct conical aspect to the upper portion of shell. A well marked keel on periphery and three more of like character between this and the suture; these four keels nearly equidistant and clearly defining the broad, shallow, concave grooves which lie between them. Keel next the suture and distant from it about half the width of one of the grooves, finer and sharper than the others, the second keel from suture strong and rounded and touching the sides of the apical angle. The suture is formed on the peripheral or fourth keel, and the half groove of the body whorl is made to fit the base of the smaller groove of the whorl above in such a manner as to make the suture show as a simple line in the middle of a groove very similar to and but slightly deeper than the others. Base of shell near termination of penultimate whorl nearly flat making an angle of about 90° with upper surface; nearer the aperture the base becomes more convex and a tendency to lose gradually the angle of the penultimate whorl is well marked; the last third of the body whorl is lost but the changes introduced point to a well rounded aperture. There are five revolving keels on base, the three next the columella being the finer and closer together; two new ones with trace of a third are introduced soon after the commencement of the last whorl and are in position still below the three last mentioned. Very fine and obscure transverse striae, about seven to the millimeter, run backward from the suture and each keeps approximately in the plane of its origin till it terminates on the columella.

Observations. The apical angle of the shell in its two whorl stage is considerably over 100°, and becomes reduced to about 80° on the completion of the third whorl; on certain lines the fourth whorl rather increases this angle and so makes the outline across three whorls from shoulder to shoulder slightly concave. The revolving keels appear in the second whorl.

The earlier portions of the suture are a little more angulated, but acceleration seems to have carried back toward the apex the peculiar feature of making the suture appear as one of the grooves.

The slight flattening of the upper surfaces of the whorls and the very marked obliteration of the suture by turning it into a groove so very like the others may have served to make the shell less readily distinguishable, as such, to the primitive perceptive powers of some important enemies.

The introduction of the new keels and the widening to which they must have been subjected during the probable inflation of the base of the whorl and the rounding of the aperture suggests that the grooving of the upper portion of the whorl was later carried to the base of the last half of the body whorl. This change was probably induced by a changing in the position of the heavier shell during locomotion or rest, and enabled the possessor to still present the peculiar grooved aspect whatever may have been its purpose.

This shell also seems to recapitulate in its ontogeny some interesting features of its very remote history and at the same time, when compared with modern shells, to show quite as remarkable an acceleration as many of these; the name *epitome* therefore is suggested as an appropriate one.

Eunema altisulcatum sp. nov.

Plate 5, figure 3

Description. Shell small, turbinate, pyramidal, apical angle 52°, hight 6mm. Whorls four, uniformly increasing in size, hight and width of body whorl to total hight closely in ratio of 3:5; three prominent, projecting and clear-cut revolving keels on penultimate whorl, the uppermost of which is the weaker and forms the outer edge of a flat revolving shelf which is depressed at an angle of about 115° from the vertical axis. The edge of this keel is narrow and rather vertical. Just under it a second shelf commences, having about the same width and angle as the first; it is slightly concave and is limited by the second and stronger keel. Under this is a wider, more strongly concave space with its lower border sloping down at an angle of about 45° to the vertical; the limiting keel to this revolving groove is the strongest and most extended of all. The edge of the shell is now cut strongly back, beginning at an angle of about 90° with last surface and curving down to a very fine keel immediately above the suture or reaching the suture itself. The suture thus comes to lie in the widest and deepest revolving channel of the shell. There are five or six fainter revolving keels on the base but the shell is not depressed between them; the three next to the columella are the nearest together. The lip is broken but appears to have been well rounded and to have been slightly extended over the columella at the base of the outer lip so as to leave a very narrow and slitlike cavity appearing like a nearly covered umbilicus. The revolving keels do not begin to show till the latter part of the second whorl. Very fine and faint transverse striae, about 10 to the millimeter, cross the later whorls, and the edges of the keels are slightly roughened or finely nodular.

Collected by Mr Percy E. Raymond.

Genus STRAPAROLLINA Billings

Straparollina harpa sp. nov.

Plate 5, figures 4, 5

Shell very small, turbinate, spire low, hight 2.5mm, width about 4mm, apical angle about 125°. Whorls three, well rounded, rapidly enlarging, crossed by fine raised, laminate ridges, vertical to the surface and about .2mm apart. Umbilicus deep, about one ninth the width of the shell, the lip at the notch extended and partly reflected over it.

Differs from S. asperostriatus Billings in its smaller size, its more depressed spire, its relatively narrower umbilicus, the closeness of its raised striae, and the absence of any carina along the underside.

Described from three specimens collected by Mr Percy E. Raymond.

Genus SUBULITES Conrad

Subulites raymondi sp. nov.

Plate 4, figures 1, 2

Description. Shell small, fusiform; apical angle about 44°; length of specimen, with apical whorl, or a little more, lost, 9.5mm; greatest thickness across axis at middle of shell 3.4mm. Whorls five or six; penultimate whorl showing a rapid elongation, body whorl 6mm long or considerably longer than the spire.

Aperture elongate, oblique, narrow, with well formed anterior canal; inner wall of aperture nearly straight; outer lip convex, gradually increasing its distance from the axis for about one fourth its length, remaining very nearly parallel for another fourth and then slightly increasing its convexity to anterior extremity. With aperture toward the observer, the shell appears slightly angulated at a little above middle on the left, and a short distance below the middle on the right; turned toward the left through 90°, the right hand outline is more uniformly convex. Suture but slightly impressed; surface smooth.

Observations. The shell surface is well preserved and in some lights seems to show growth lines much like those of Terebellum subulatum Lam., to which this species shows a superficial resemblance in its spire, inner wall of aperture, and anterior canal. With other lighting however there seem to be growth lines running gently backward from the suture. These lines are not easily seen and some of them may be due to marks made in cleaning the specimen. Still very faint but more easily seen are some extremely narrow, fine, raised, transverse striae about 4mm apart.

This species has been named after Mr Percy E. Raymond, of the Carnegie Museum, Pittsburg Pa. who found the species in material from the section described.

Genus HOLOPEA Hall

Holopea microclathrata sp. nov.

Plate 4, figures 3, 4

Description. Shell small, turbinate, apical angle about 73°, length of type specimen in which apex and last fourth of body whorl are lost, measured from broken part of apex to most distant point on body whorl 8mm. Whorls about four, becoming gradually more oblique, longest diameter of body whorl near the aperture making an angle of about 50° with the vertical axis. Base of penultimate whorl slightly flattened and making an angle of about 90° with upper surface; angle well rounded and upper surface moderately convex; outline of whorl rapidly becoming more rounded as aperture is approached. Columella apparently strong and thickened and there seems to be a small umbilicus; no trace of lip across wall of aperture. Eight fine revolving, raised striae between suture and periphery; on the penultimate whorl the first, second, fourth, sixth and eighth are the more prominent of these. The spaces before the first and between this and the second are a little wider than the others and are gently concave; the third stria (the first of the fainter or secondary striae) lies at the center of a wider and shallow concave belt limited by the second and fourth striae; after the second the distance between striae is quite uniform and the secondary striae are nearly as prominent as the primary and are but slightly or not at all depressed below them. There is a peripheral stria and eight or more similar striae on base of penultimate and body whorls. The shallow spaces between the striae are crossed by very fine and sharp, raised, transverse striae, as close as 17 or more to the millimeter. These striae pass slightly backward from the suture, curve regularly and gently across the whorl and become directed forward on the base. Viewed from the middle of the whorl the lines appear to make no deviation whatever in any part of their course from the vertical plane of their origin. The suture forms a fine, rather impressed line just below the eighth stria, the whorls meeting at an angle of about 90°.

TRILOBITA

Genus CHEIRURUS Beyrich

Cheirurus mars sp. nov.

Plate 5, figures 1-2

Description. Glabella somewhat resembles a medieval, conical helmet, rising from the frontal rim with a curve of about 6mm radius for one third the distance to the apex of the cone. In the other two thirds the convexity becomes markedly less and the apex is approached with but very slightly convex outlines; from the apex to neck furrow the outline is at first concave and then straight. The cone or spur is thus rather high and produced backward over the neck ring. Length from frontal furrow to neck furrow 13mm, from frontal furrow to apex of cone 15mm, hight of apex of cone above neck furrow about 8mm, width of glabella just in front of the neck ring nearly 12mm. The glabellar furrows are convex toward the front throughout their length; the two anterior pairs reach to a little less than one fourth the distance across the glabella; the middle one is most convex toward the front; the posterior furrow is less bent at first, reaches about halfway to the apex of the cone and is bent so as to meet its axis at an angle of about 70°. Marginal furrow of glabella rounded in front, distinctly angled as it turns to pass along the sides, where it is concave toward the under surface with a radius of about 10mm.

Differs from C. vulcanus Billings, in the pronounced character of the conical spur, the absence of a sigmoid flexure in the posterior pair of glabellar furrows, the shortness of the two anterior pairs, and the front angles of the margin. Described from a cast the surface of which is smooth.

THE STRUCTURE OF SOME PRIMITIVE CEPHALOPODS

BY R. RUEDEMANN

Plates 6–13

Professor Whitfield has described [1886,[1] p. 319], as Orthoceras brainerdi, a cephalopod from the Fort Cassin (Upper Beekmantown) beds of Fort Cassin Vt., which is also very common in beds of like age outcropping along the shore of Lake Champlain at Valcour N. Y. While the originals of the species exhibit but fragments of the phragmocone and lack the living chamber and the apical parts of the conch, there are in the extensive museum collection of specimens secured at Valcour, not only conchs which supplement the original material but also a great number of siphuncles which exhibit interesting internal structures.[2] These and the peculiarities of the apical portion of the conch have led to the investigation, whose results are herewith presented. An extension of the research to the siphuncles of Piloceras explanator Whitfield, another form which is equally common in the Fort Cassin beds at the type locality and at Valcour, has brought to light homologous structures which are also described here.

1 Parts of siphuncle

In a siphuncle of the mature conch of Cameroceras[3] brainerdi four well defined parts, succeeding each other in apertural direction, can be differentiated. For reasons of plainer demonstration we will consider them here in the reversed order of origin or in apical direction. The first portion of the siphuncle of this species is entirely empty, as in Orthoceras [*see*

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1 See list of references.

2 Subsequently these structures were also found in specimens from Fort Cassin itself, which are a part of the State Museum collection.

3 We use here the older term Cameroceras not differentiating between Cameroceras and Endoceras, as Hyatt has done.

pl.6, fig.2]. The septal necks,[1] however, do not as in most orthoceratites extend only a short distance backward, but curve first gently inward, thus contracting the siphuncle slightly and just above the preceding septum bend again outward, growing thicker and standing on the latter septum. The cameras are thus completely shut off from the siphuncular space. There is, however, no separate siphuncular wall present in this part, the septal necks forming the only partitions. The proportional length of this part to the total length of the conch I have not ascertained; it is, however, certain that this open siphuncle extended for the distance of several inches apicad from the living chamber.

Under the second part of the siphuncle we comprise that portion in which the organic deposits characteristic of Cameroceras and consisting of endocones begin to form. The space included by the last formed endocone is a cone with elliptic or more frequently subtriangular section, the base lying parallel to the flat side of the siphuncle [*see* pl.8, fig.7]. The more convex side is provided with low annulations which are slightly convex forward. The cone is always filled with matrix, like the living chamber and open part of the siphuncle and is what Dewitz and other authors have termed the "Spiess" (or dart) of the endoceratites. The last endocone is in sections [*see* pl.9, fig.2] distinctly set off by its darker color from the coarsely crystalline white calcite infilling of the more apical portions of the siphuncle, which suggests that, when left behind by the advancing animal, it contained considerably more organic matter than is found in the solid part of the siphuncle where calcite infiltration has taken place. This endocone connects with a cylindric layer of equally carbonaceous lime carbonate, which being directly adjacent to the septal necks, lines the entire siphuncle and extends forward into the first part to an extent at present not known to me, but certainly not comprising the entire first part, for its absence in the siphuncle for several inches from the base of the living chamber could be ascertained in

[1] We prefer the older term "septal neck" to the later "funnel" proposed by Hyatt for the reason pointed out by Foord [1888, p. 130] that under funnel another organ of the recent Cephalopoda is understood.

several specimens. In the opposite or apical direction it extends close to the tip of the siphuncle. This internal lining layer of the siphuncle will be termed in this paper "endosipholining" [*see* p.303].

The third part of the siphuncle is that which has been filled by the endocones, but is still surrounded by the cameras of the phragmocone. The endocones have mostly become obliterated by the formation of coarse white calcite, but from the endosiphuncular canal there still proceed at intervals short lines which are parallel to the last endocone and represent the bases of former endocones [*see* pl.9, fig.2]. Occasionally also the entire walls appear still as gray lines in the calcite filling [*see* pl.6, fig.3]. The "dart" or "Spiess" extends at its apical end into a flat broad tube, which frequently passes through nearly the whole width of the siphuncle and which possesses strong, deep black walls of velvety appearance, suggesting their composition of conchiolin. This flat tube is the first part of the endosiphuncle.[1] The latter passes through the whole length of the siphuncle. Its characters are such as to invite detailed description, which will be given below.

The fourth part of the siphuncle of this species is that which projects apicad beyond the camerated portion of the shell (the phragmocone), and which, hence, was entirely free. This part is identical with the apical cone of N a n n o a u l e m a Clarke and V a g i n o c e r a s b e l e m n i t i f o r m e Holm. It is, however, not short and strongly inflated, but long and gradually widening at approximately the same rate as the anterior parts of the siphuncle. This free portion may have easily reached a length of 70 mm as the finely preserved specimen reproduced in plate 6, figure 3 indicates.

It might be presumed that in the specimens in hand the septa continued further apicad than their present preservation would indicate, and that the free apical cone is more due to incomplete

[1]We use here provisionally, till further definitions have been given, Hyatt's term "endosiphuncle" for the central tube of the siphuncle. Hyatt's definition is [1900, p.515]: "Organic deposits in the form of endocones, and taper off at the center into a spire that is sometimes tubular and hollow, or again flattened and elliptical. This is the endosiphuncle." Before this definition the term "endosiphon" had been in use for the same organ.

retention of the phragmocone than to its original absence in the apical portion of the shell. Since however in this species the septa by their septal necks or funnels form a continuous ectosiphuncular wall, which is thicker than the septal partitions and is readily distinguishable in one specimen [*see* pl.6, fig.3] by its light gray color contrasting with the black matrix, we have carefully searched for traces of this wall along the apical cone, without finding any beyond the contraction of the shell at the beginning of the visible chambering of the conch. A black conchiolinous deposit forms the undoubtedly outermost wall of this preseptal conch.

A little forward of the beginning of the cameras (about the fourth camera) there occurs a distinct contraction, as in the corresponding places in the species cited above. The apical portion of this free part is slightly curved. The endosipholining, which in the phragmocone is adjacent to the septal necks, extends through the full length of this apical free part of the siphuncle [*see* pl.3, fig.3]. It contrasts distinctly with the white coarse calcite filling of the siphuncle and retains its full width and sharp delimitation to within 30 mm of the apex, when it begins to thin out; and about 15 mm from the apex it has disappeared entirely, the siphuncle being there wholly filled by the white sugary calcite. The extension and composition of this layer of carbonaceous calcite leaves no doubt that it originally formed within a membrane and thus became charged with organic matter. This endosipholining is in section sharply outlined by a fine black line which represents an outer conchiolinous shell layer. This also extends into the chambered portion of the shell, at least into its earlier part. It is this layer which gives to the separate siphuncles of this species their black, shiny surface. There is no doubt that this is identical with the cuticle of horny matter which incases the whole mantle and also the siphuncle of Nautilus, and which also has occasionally been observed enveloping the siphuncle of fossil cephalopods.

The endosiphuncle passes unrestricted to the very apex of the siphuncle, where it distinctly empties to the exterior [*see* pl.6, fig.3]. Its last apical part (about 1 mm) is filled with black material which appears to be the same as the matrix. This suggests that in this form, as in Nanno aulema (according to Hyatt's observations) the endosiphuncle communicated for a time with the exterior, viz from the time of the destruction of the protoconch to that of the plugging of the canal between the first and second endocones. At the time of the burial of the shell in mud, this short end of the canal was still open and the surrounding mud could enter it. In the remaining portion of the endosiphuncle there has nowhere been found any matrix, in our material, not even directly behind the Spiess, which is always filled to near its tip with mud. Holm comments on this fact, but states that longitudinal sections through the endosiphuncle nowhere suggested the presence of any transverse partitions and assumes that soft parts of the decaying animal, remaining in the "Spiess" prevented the mud from entering the endosiphuncle, which apparently was through the lifetime of the animal in open connection with the latter.[1] In Nanno aulema however, as mentioned above, Hyatt observed a closing of the tube in front of the first endocone. Partition lines, forming acute angles with the endosiphon, leave no doubt that also the apical cone of Cameroceras brainerdi was provided with endocones though no traces of the same have been observed close to the apex.

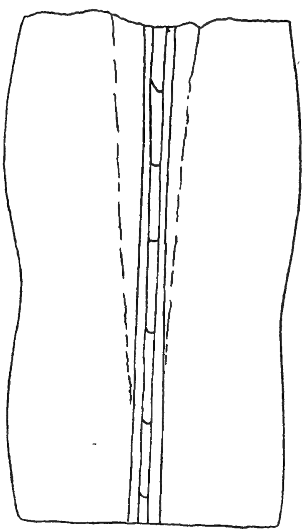

Fig. 1 Endoceras crassisiphonatum Whiteaves. Shows apparent dissepiments in endosiphuncle. (Copy from Whiteaves)

[1]Whiteaves [Roy. Soc. Can. Proc. & Trans. 1891, 9:79] has recorded that in one specimen of Endoceras (E. crassisiphonatum) from the Trenton limestone of Manitoba, "the interior of the narrow posterior end of the siphuncle (endosiphuncle) appears to be portioned off by a few transverse concave dissepiments" [*see* text fig. 1]. Since there exists an early genus (Diphragmoceras *Hyatt*) in which the siphuncle is divided by tabulae alternating with the septa of the camerated shell, it is quite as possible that the endosiphuncle also may have been tabulated in some forms, though Whiteaves's observation seems to stand quite alone at the present time. The observations of both Hyatt and Whiteaves would seem to support Zittel's view that the siphuncle has no particular function but is only a residual.

2 Former observations on endosiphonal structures and the terminology of the latter

The endosiphuncular structures of Cameroceras brainerdi which concern us most here are the flattened tube extending backward from the "Spiess," the fine, often capillary tube extending the greater length of the siphuncle and certain thin longitudinal layers of dark organic limestone radiating from these tubes to the walls of the siphuncle.

The attention of paleontologists was directed to similar structures only a comparatively short time ago, though the fine threadlike endosiphuncle had already been noticed by Barrande in a Newfoundland species (Orthoceras insulare) [*see* 1867, v.II, t.430, fig.5, 8-11; t.431, fig.8-10] and also been described by Dewitz [1879, p.172, 173, fide Holm] and Schröder [1881, p.76, t.2, fig.8d]. Dewitz also mentions [1880, p.377] that "in some species membranes seem to have proceeded from the posterior end of the fleshy siphuncle, which often, at least for some distance, extended to the internal wall of the siphuncular tube, and which also secreted covering sheaths, in which organic carbonate of lime was deposited," and adds, "These membranes probably served to attach the posterior end of the fleshy siphuncle to the interior wall of the siphuncular tube." He also figures a transverse section of Endoceras commune [pl.17, fig.7] which shows three longitudinal membranes radiating from the endosiphuncle, but which do not reach the siphuncular wall [*see* text fig.2].

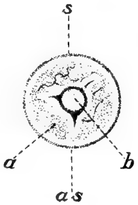

Fig. 2 "Endoceras commune." Section of siphuncle. s, siphuncular side; a s, antisiphuncular side. (Copy from Dewitz)

The flattened tube extending from the "Spiess" appears to have been first noticed by Dawson in a species of Piloceras [1883, p.4]. Sir William states [p.3] that "the lower part of the shell is divided by a vertical partition crossing its longer diameter," and again [p.4] that the internal cone "is flatter than the siphuncle, ending at the apex in an edge which is attached to a central shelly plate crossing the lower part of the siphuncle," and adds, "This plate shows at intervals slight projections giving rise to delicate cones apparently membranous." Hyatt [1884, p.266], though basing his definition of Piloceras on Dawson's description, did not recognize the presence of a partition, but believing in its tubular character, referred it to the endosiphuncle. Foord, however, observed again the same plate in a Piloceras from Durness and figured it [1888, p.159, fig.17, III, p.160], stating in regard to it in opposition to Hyatt's view: "Nevertheless there seems to have been an internal septum extending upwards, from the lower part of the siphuncle, between the wall of the latter and that of the sheath into which the endosiphon opens. This septum shows itself in some transverse sections of the siphuncle in the manner indicated at figure 17, II [copied here in text fig.3], and it can be traced for some distance upwards in the vertical section of this and of other specimens. The septum seems to have been penetrated by the endosiphon, as shown in the figure, but I am unable to give any satisfactory account of it, owing to its imperfect condition." Bather later [1894, p.433] copied Foord's figure, stating that the appearance of the partition is exaggerated and its significance unknown. Specimens of Piloceras explanator from the Fort Cassin bed, which are in the State Museum, show the same partition and we shall have occasion to recur to its structure [*see* p.329].

Fig. 3 Piloceras sp. Transverse section of siphuncle. e, endosiphuncle; p, partition. (Copy from Foord)

Meanwhile Holm had found a similar endosiphuncular blade strongly developed in a species from Esthonia, which he described in allusion to this feature as Endoceras gladius [1887, p.13]. In this important publication, to which we shall have frequent occasion to refer, Dewitz's observation of the winglike membranes of the endosiphuncle, is verified.

In a later publication [1895, p.605ff] the same author has introduced a number of terms for the parts of the siphuncle in view of the fact that Bather had criticized Hyatt's term "endosiphon" [*l. c.*, p.433] arguing that the "endosiphon" is in function the real siphuncle. As Foord [1888, p.132] has pointed out "exception might perhaps be taken to this term on the ground that it seems to imply the existence of two siphuncles, an inner and an outer one." Since, however, it will be found convenient to distinguish the fleshy siphuncle from the shelly wall that separates it from the septal chamber, and the term siphuncle has always been used in the latter sense in relation to fossils, he considers the employment of the additional term justifiable. To avoid its illogical and confusing use Holm has proposed a series of terms which it seems practicable to adopt here. These are "ectosipho" for the outer siphuncular tube—"sipho" being retained for the entire organ—"endosipho" for the contents of the ectosipho as a whole;[1] also for the parts of the endosipho are proposed new expressions. He terms "endosiphocylinder" the wider portion of the siphuncle, which is entirely occupied by the more cylindric anterior part of the fleshy siphuncle. This passes posteriorly into the "endosiphocone" (its walls are Hyatt's "endocones"); from this again proceeds the narrow canal which was termed first "endosiphon" and later "endosiphuncle" by Hyatt and for which is proposed the word "endosiphotube" by Holm [*see* text fig.18]. We have, in accordance with this terminology, proposed above the term "endosipholining" for the inner, thick, continuous layer of the siphuncular wall, which, according to Hyatt [1884, p.266], is characteristic of Cameroceras (Sannionites) in distinction from Vaginoceras and Endoceras. This layer is shown in plate 6, figure 3 and text figure 15 (*e s c*) and the sections on plate 7. To the endosiphuncular formation belong further thin, calcified membranes which connect the endosiphotubes and endosiphocones with the ectosiphuncle, and a broad conchiolinous double blade, extending backward from the endosiphocone.

The latter structure was originally termed by Holm, who was

[1] Following Hyatt in making a strict distinction between the fleshy "siphon" and its calcareous covers, the "siphuncle," we will employ here the terms "estosiphuncle" and "endosiphuncle." This usage will not vitiate the terms "endosiphocylinder" etc. in which only the radicle of the word siphon is incorporated; nor will it cause confusion since for the organ termed "endosiphuncle" by Hyatt, a new term is proposed.

the first to clearly recognize it, "schwertähnliches Blatt" [1887]. Later [1895] the same author introduced the term "endosiphoblade" ("endosiphobladet" in the Swedish original) and defined it as the thin calcified endosiphuncular membrane which extends longitudinally in several species of Endoceras and Piloceras and connects the endosiphotube and endosiphocone with the inside of the ectosiphuncle. It becomes evident from the discussion of this organ in the last cited publication that this term is meant to comprise both the hollow blade and the calcified suspensory membranes.

Since we shall show in this paper that the endosiphotube is a new formation, at least in our species, within the broad hollow endosiphuncular part, first called "schwertähnliches Blatt" by Holm, and also that the latter and the suspending membranes are of different origin in our form, it becomes desirable to distinguish between these two organs which are comprised in Holm's term "endosiphoblade." We will therefore, in view of Holm's definition, retain this latter term for the suspensory membranes and designate the broad and originally hollow endosiphuncular "Blatt" by a new term.

Holm named the species, in which he observed it, Endoceras gladius in allusion to this swordlike blade. "Gladius" would therefore be an appropriate term, were it not for the fact that this word is already used for the cuttlebone or pen of the cuttlefish. For this reason we shall use here instead the word "coleon," and to make it conform with the other terms, call this flattened tube the "endosiphocoleon." As "endosiphosheaths" we designate the walls of the funnel-shaped endosiphocones (Hyatt's "endocones"), which are left behind by the advancing animal.

3 Endosiphocoleon and endosiphotube

As we have noted above, Holm was the first to observe, in a species obtained in Esthonia from a transitional bed between the Vaginatenkalk and Echinosphaeritenkalk, the organ which we have found still more peculiarly developed in an American species and designated as endosiphocoleon. Holm termed the species at the time, Endoceras gladius, but he later [1896, p.400] reunited it with Endoceras (Nanno) belemnitiforme. This again has been referred to Vaginoceras by Hyatt [1895, p.9]. We will state on this occasion that while we had worked out the characters of the endosiphuncular organs before we were aware of Holm's prior elaborate description, we found by subsequent comparison that our material on the whole verifies Holm's observations for the species in hand, but that at the same time it indicates an origin of the endosiphotube and a relation between endosiphotube and endosiphocoleon which is different from those observed by Holm. These and such other differences as have become apparent between the endosiphuncular structures of Vaginoceras belemnitiforme and Cameroceras brainerdi will be noted at the end of the description of these structures in our species. We have copied here for comparison Holm's figure of the endosiphocoleon [text fig.4].

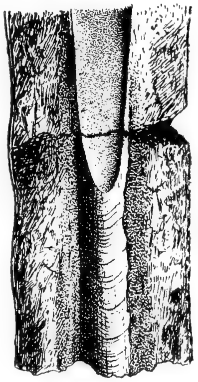

Fig. 4 Vaginoceras belemnitiforme Holm (sp.). Longitudinal section of siphuncle, showing endosiphocoleon. (Copy from Holm)

The endosiphocone which, at its forward end, is subcircular and only slightly flattened on the ventral (outer) side, becomes rapidly flattened toward its posterior end, the convex wall approaching the opposite flat one. It thus runs out into a double blade, which, lying approximately in the middle of the siphuncle and parallel to its flatter side, is at first almost as wide as the siphuncle and nearly touches its walls [*see* pl.7, fig.1]. This is at least the case in the large siphuncle of the later portions of the shell when the animal approaches maturity. This organ is the *endosiphocoleon*, which in our material consists just behind the endosiphocone of two thin, intensely black conchiolinous walls, forming a flattened broad tube. These walls are composed of extremely thin, concentric or rather long conical lamellae. They show a double sculpture, viz, low transverse ribs arching slightly forward and longitudinal lines which slightly disperse in a forward direction. The low ribs are evidently the remains of the ribs of the convex side of the endosiphocone, noted below.

Holm describes the middle portion of the endosiphocoleon which proceeds from the apex of the endosiphocone as possessing a very distinct and beautiful sculpture, consisting of growth lines. "These growth lines form an arch, which is strongly bent backward. Their form and curvature corresponds exactly with the outline of the apex of the 'Spiess' and thereby with the outline of the fleshy end of the siphon. On the anterior portion of the blade there also occur longitudinal lines which intersect the growth lines." Our material fails to show these growth lines so distinctly, but from the fracture lines of the oblique lamellae composing the wall of the endosiphocoleon we infer that they may be the intersections of these lamellae with its surface.

This middle part of the endosiphocoleon is on both narrow edges [*see* pl.7, fig.1; pl.9, fig.1; text fig.14] flanked by strong deep black conchiolinous semicylindric rods or wings, [w of figures] which, on the upper and lower side of the blade, quite abruptly change into a layer of dark gray limestone, such as composes the endosiphocone or last endocone. They correspond to the winglike lamellae, which according to Holm begin on the endosiphocone and continue along the endosiphocoleon and which we shall discuss later.

The further development of the endosiphocoleon can be best described by the use of a series of sections which were made apicad of the part of the endosiphocoleon reproduced on plate 7. These sections are figured on the same plate and diagrammatic sketches illustrating the further stages of development are inserted in the text [fig.5-12].

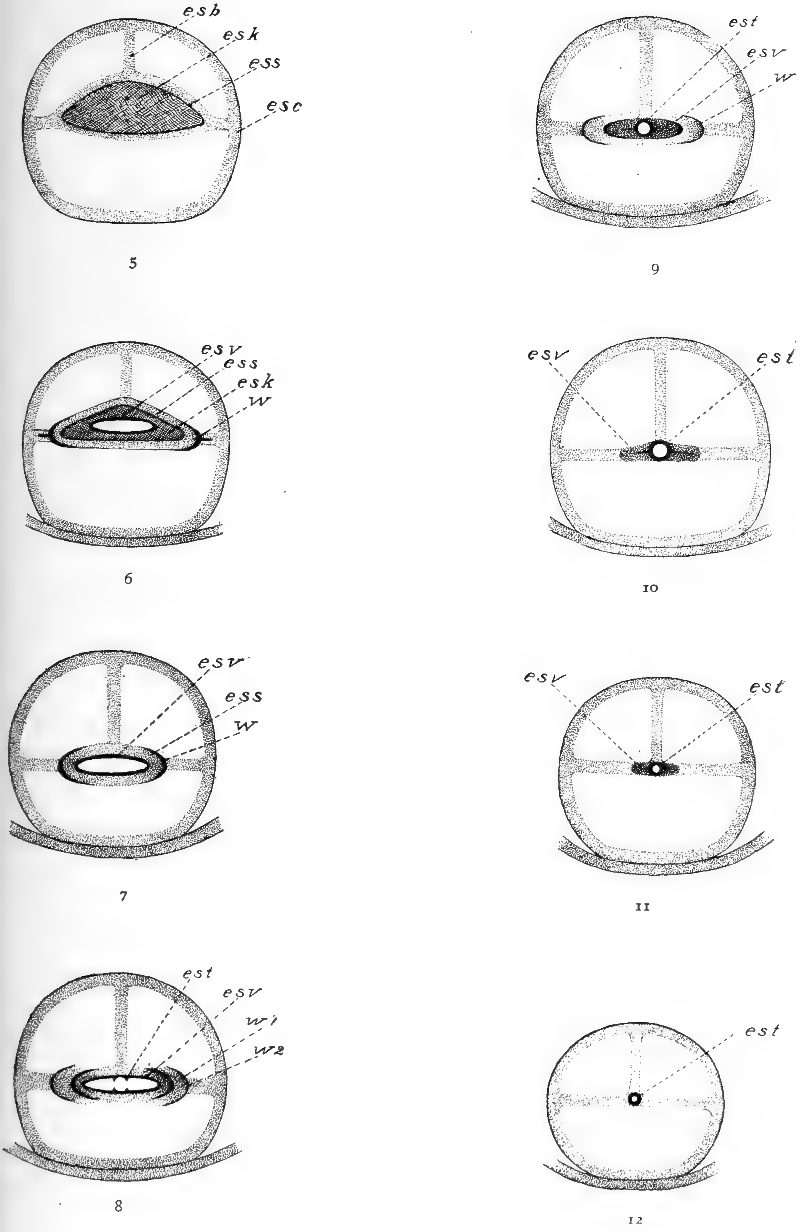

Fig. 5-12 Diagrammatic sections of siphuncle of Cameroceras brainerdi Whitfield (sp.); *esb*, endosiphoblade; *esc*, endosiphocylinder; *esk*, endosiphocone; *ess*, endosiphosheath; *est*, endosiphotube; *esv*, endosiphocoleon; *w*, wing; w_1, younger wing; w_2, older wing. In figure 11, the endosiphocoleon is shaded too dark.

Figure 5 of plate 7 [also text fig.10] shows the small, thick walled endosiphotube [*e s t*] contained within the endosiphocoleon [*e s v*], which is entirely filled with very dark organic carbonate of lime. This observation suggests that the endosiphotube is not a narrower apicad continuation of the endosiphocoleon, but a new formation within the same; an inference which is borne out by the observation of such sections as that reproduced in figure 2, in which a still incomplete tube is shown within the open lumen of the endosiphocoleon. This latter stage is also represented by the diagrammatic section text figure 8. Besides the inceptive endosiphotube [*e s t*] and the inclosing endosiphocoleon [*e s v*] we see the latter flanked on either side by a series of two wings [w_1 and w_2] which have formed on two successive endosiphosheaths. In text figure 9 only one of these wings, the outer and older is present. In order to make this peculiar relation of endosiphocoleon and endosiphotube still clearer we have added two longitudinal diagrammatic sections. Text figure 13 shows the outer, more anteriorly situated endosiphocoleon and the inner endosiphotube, and text figure 14 illustrates the position of the successive wings [*w*] on the endosiphoshaths [*e s s*]. A condition as that illustrated in text figure 8, when two wings embrace each other could be obtained by a transverse section in a plane, laid through the middle of the longitudinal section figure 14. We shall recur more fully to the relation of endosiphocoleon and endosiphotube.

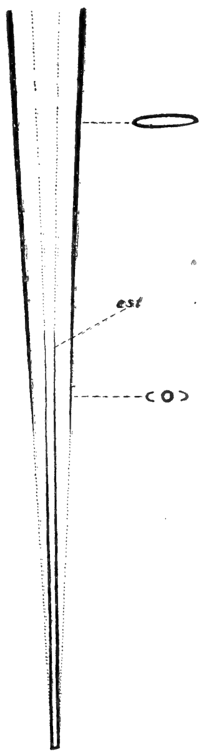

Fig. 13 Diagrammatic longitudinal section of endosiphocoleon, to show its relation to endosiphotube *est*, endosiphotube

Figure 3 of plate 7 is a section 5 mm distant from figure 1.

Between figure 3 and figure 5 (10 mm) a very abrupt quarter turn of the entire endosiphocoleon takes place, so that its horizontal position has changed to a vertical one. A horizontal section through the block containing this turn has been made and the rock polished down sufficiently to expose the turn [fig.4]. Figure 5 shows the front of the next block, which is identical with the posterior section of figure 4. Here the endosiphuncle has become a very narrow cylindric tube (endosiphotube) sharply limited by a black conchiolinous wall. It lies somewhat laterally to a broad, dark gray brown belt of organic lime carbonate, through which the walls of the large crystals of the siphuncle filling pass, though retaining the organic coloring matter in its original distribution. A split is noticeable in the upper part, as if the band here consisted of two lamellae. Text figure 10 represents this condition of the endosiphuncle. The endosiphotube is now the only remaining organ with distinct conchiolinous walls and the endosiphocoleon is reduced to a dark band of organic lime carbonate, a transverse median line of which indicates its former composition of two amellae.

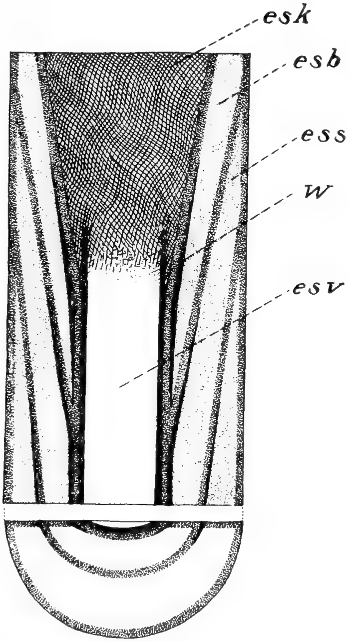

Fig. 14 Diagrammatic section of siphuncle to show the relation of the wings [*w*] to the endosiphosheaths [*ess*]. Endosiphocoleon cut through major axis

On the other side of the block [fig.6, 7.5 mm farther posteriorly] the endosiphotube has retained the same diameter as in the preceding section, though its shape has changed from circular to semicylindric; the endosiphocoleon has not diminished in size, but has become considerably lighter in color and more indistinct in outline, specially in the middle part, while the ends have remained colored slightly stronger and are wider so that the section assumes somewhat the shape of a dumb-bell. The median line, observed in the preceding section, has disappeared, but there remain two darker spots in the center of the end balls of the dumb-bell. This dumb-bell-like outline is again obliterated in the next section, figure 7 (7.5 mm distant from 6). In this the endosiphotube has again decreased since the last section to about one half of its former diameter, while the endosiphocoleon has retained its width. In the next it has even again become broader. Its ends are notably rounder and thicker than the middle of the plate and a fine central line can again be traced, indicating the composition of the blade of two conjoined lamellae. The entire endosiphocoleon, which before had swung to one side, has returned again to the median line of the siphuncle.

In this condition the endosiphocoleon remains to the apical end of this (not complete) siphuncle, i. e. it extends across the siphuncle as a dark gray brown band with indistinct outline which includes the fine endosiphotube; its swollen lateral extremities touching or coalescing with the gray wall of the siphuncle. Figure 10 is taken 15 mm from the preceding section and shows no material change from the latter. It shows white cross-lines which transect the brown band of the endosiphocoleon. These are due to secondary crystallization, the endosiphocoleon being—in contrast to the irregular crystallization of the remainder of the interior of the siphuncle—composed of two layers of parallel crystals which distinctly grew from the median line of the endosiphocoleon as a base.

Text figure 11 shows the position and extension of the endosiphocoleon in a very early portion of the siphuncle or near the apex [*see* fig. 7]. It is here a light brown transverse band with a central black conchiolinous endosiphotube. This condition is reached shortly behind the endosiphocone in the earlier portions of the siphuncle, when its diameter is still small as is exemplified by the section [pl.8, fig.1].

In order to obtain a complete portrayal of the endosiphocoleon and endosiphocone of Cameroceras brainerdi we will add the description of a few other sections which show features slightly different from or explanatory of those observed in the series of sections noted above. There is, first, the longitudinal section [pl.9, fig.2] in which a well preserved endosiphocone with sheath is exhibited which at its apex contains a newly formed portion of the endosiphocoleon as a free standing black and conchiolinous tube[1] [*see* text fig.15]. This shows that here the endosiphocoleon is not a mere continuation of the apex of the endosiphocone, as it was found in Vaginoceras belemnitiforme but a new formation, growing within the apical part of the visceral cone, presumably preparatory to a succeeding withdrawal of the animal from that part of the siphuncle and the formation of a new endosiphosheath.

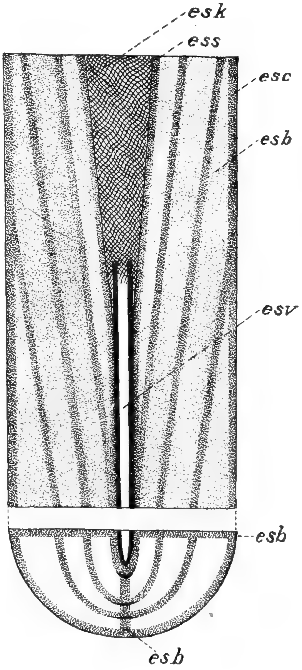

Fig. 15 Diagrammatic section of siphuncle to show relation of endosiphocoleon [*e s v*] to endosiphocone [*e s k*]. Endosiphocone cut through minor axis: *e s b*, endosiphoblade; *e s c*, endosipholining; *e s s*, endosiphosheath

Two sections which exhibit the same features are those reproduced in plate 7, figure 1 and plate 9, figure 1. These possess on both narrow sides of the endosiphocoleon a series of two black concentric crescents which are not in contact with it. In some of these specimens [pl.7, fig.1] the innermost of these crescents can be directly traced along the longitudinal sections to the strong conchiolinous wing or lateral staff of the endosiphosheath described above [*see* text fig.14].

Directly germane to the sections and diagrams given here and illustrative of the formation and characters of the wings of the endosiphocoleon is the section in plate 8, figure 7. In this the apical part of the endosiphocone is transected and its semicircular outline shown in the center of the figure and its base, which corresponds to the flat or outer (ventral?) side of the siphuncle, is drawn out into short, obliquely ascending horns. The wall of the cone is formed by the endosiphosheath which is continued in the direction of the horns to the wall of the siphuncle and

[1] It is twice as long as the lithographer's reproduction.

also connected at its convex side to the nearest wall by a band of crystals of organic carbonate of lime. The interspaces are not only arranged symmetrically, but also delimited so sharply by uninterrupted lines, that it is hardly to be doubted that the calcite bands connecting the endosiphocone and wall of siphuncle are the remains of the membranes which held the visceral cone in position within the siphuncle and probably became partially calcified during the lifetime of the animal. The interspaces remained cavities till they were filled by the large calcite crystals now occupying the siphuncle.[1]

The supposition of the fixation of the visceral cone and inclosing endosiphosheath to the ectosiphuncle, finds support in the occasional presence of bands of gray brown limestone, extending from the endosiphocoleon (virtually the continuation of the visceral cone) or more posteriorly from the endosiphotube, to the wall of the siphuncle. Such a section is reproduced in plate 8, figure 5. The horizontal transverse band with the inclosed endosiphotube is evidently the "endosiphoblade" of Holm. This is held in a manner corresponding to the fixation of the endosiphocone described above by a band that is placed perpendicular to the endosiphocoleon.[2] The extension of the internal space of the visceral sac (endosiphocone)

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[1]In this particular siphuncle the interior is 20 mm from the end of the endosiphocone already so calcified, apparently by secondary calcification, that hardly any trace of the endosiphocoleon is left [*see* pl.8, fig.8].

[2]These supporting membranes were, as we have mentioned above, recognized by Dewitz and more fully described by Holm. The latter author [*l. c.*, 1887, p.16] sums up his observations on these supporting membranes in Endoceras gladius in the following statement: "During the retrogression of the siphon in the siphuncular tube there were secreted by the siphon three longitudinal membranes which were probably soft, pliable and extended to the wall of the siphuncular tube, one from each of the angular marginal edges and one from the median line of the convex side. Their function was probably to fix the end of the siphon, which was suspended in the siphuncular tube in a position in the middle of the latter. A similar organ was, as we have seen above, observed by Dewitz in the siphuncular tube of a specimen of "Endoceras commune." In consequence of this structure the "Spiess" maintains in all specimens of the species in question, which have been investigated by me, the same position in the middle of the siphuncular tube and indicates an invariable position of the end of the siphon. The thin (cuticular) membranes were secreted along the whole length of the siphon."

into the angles [pl.8, fig.7] and the continuation of the angles into the supporting membranes indicate that the latter already supported the visceral cone before the formation of the last endosipho-sheath, determined the form of the latter and at the time of its formation probably became the situs of organic deposits of lime carbonate. This latter view is at least suggested by the presence of cavities between the well defined bands of lime in the section.

If these membranes served as suspensory organs of the visceral cone and its posterior extension, their arrangement will give us a hint as to which side of this Cameroceras conch was the ventral side or turned habitually downward in the moving animal, the position of the siphuncle on one side of the conch not being a reliable criterion on account of its shifting sometimes in the same individual. It will now be noticed that in the sections reproduced in plate 8, figures 5, 6, the tube is suspended by three membranes, two of which form a diameter of the siphuncle, parallel to its flat side, while the third holds a perpendicular position to this diameter and connects the tube with the side of the siphuncle diametrically opposite to its flat side. If now a tube is suspended by means of three membranes, forming an inverted T, it is evident that the middle was the upper one. The alternative possibility that the tube was held by props or propping blades instead of by membranes, in which case the relation of the three blades would be inverted, may be neglected on account of the evident thinness and frailty of the supporting organs. It then follows that the flat side of the siphuncle which is in contact with the conch was the lower or ventral side.

4 Comparison of endosiphuncular structures in Vaginoceras belemnitiforme and Cameroceras brainerdi

Holm's elaborate description of the endosiphocoleon of Vaginoceras (gladius) belemnitiforme permits a close comparison of the development of this organ in the Swedish type and in this American form.

In the description of the endosiphocoleon of V. belemnitiforme a distinction [*l. c.*, p.14] is made between the lateral and middle parts of the "Blatt." The former are described as being a continuation of the two winglike lamellae that flank the endosiphosheath and the latter, which is characterized by its sculpture, as a continuation of the middle part of this endosiphosheath. This difference is in our material, if anything, still more apparent, and the two parts are entirely separated owing to their different places of origin. The wings are formed on the outside of the endosiphocone, while the middle part, which is the real tube of the endosiphocoleon, is formed within the endosiphocone [*see* text fig.14]. The two conchiolinous bodies are hence in Cameroceras brainerdi separated by a layer of gray organic lime carbonate, the endosiphosheath [*see* pl.9, fig.1 and text fig.14]. It is, however, apparent that in V. belemnitiforme both parts are considered as having originated on the outside of the endosiphocone or to be the direct continuations of the endosiphosheath, and the figure [*see* text fig.4] would seem to bear out this conclusion.

Germane to this observation of Holm as to the origin of the middle part of the endosiphocoleon is the further observation and resultant conclusion which is cited here [*l. c.*, p.15, translation]: "With the exception of the conchiolinous calcareous sheath covering the endosiphocone itself, there occur no traces of such sheaths secreted by the siphon, within the siphuncular tube. Neither does the calcareous filling show any conical surfaces of separation. Since, moreover, the lamellae of the swordlike structure which proceeds from the endosiphocone form a direct, uninterrupted continuation of the sheath of the siphon it must be assumed that the siphon did not secrete the conchiolinous calcareous sheath until the animal was full grown and no longer enlarged its conch nor advanced in the siphuncular tube." This blade in V. belemnitiforme is supposed to have reached to the apical end of the siphuncle.

Our observations would indicate somewhat different relations in C. brainerdi. First the presence in transverse sections of a series of embracing crescentic conchiolinous sheaths [*see* pl.7, fig.1 and text fig.8], which are the remains of the winglike lamellae formed on the outside of the endosiphocones, demonstrates that the wings were formed *successively* on the acute edges of the flattened posterior part of each new endosiphocone [*see* text fig.14], thus leaving with advancing growth and the formation of new embracing endosiphosheaths this series of conchiolinous margins behind. As to the middle portion of the endosiphocoleon we have shown that in our species this is formed within the apical portion of the endosiphocone or visceral cone and is hence always surrounded by the endosiphosheath. The fact of the presence of the anterior portion of this endosiphocoleon within the endosiphocone indicates, in our opinion, that it kept growing continuously at its anterior end and during a greater part of the lifetime of the animal (probably from the beginning of the nepionic stage to that of the ephebic stage); this growth within the endosiphocone being preparative of an approaching withdrawal of the animal and the subsequent formation of a new endosiphosheath. The very gradual disappearance in our specimens of the endosiphocoleon posteriorly by a replacement of the conchiolinous material by organic lime carbonate, without a notable diminution in width, is taken by us as a further argument of the gradual formation at the anterior end of the organ and a corresponding gradual absorption posteriorly [*see* text fig.13]. With this gradual absorption of the posterior endosiphocoleon went hand in hand the new formation of the almost capillary but strong walled endosiphotube.

While we thus hold that in the species in question the formation of the endosiphocoleon was not delayed till maturity, but took place during the entire ephebic stage, we are quite convinced that maturity with its cessation of siphuncular growth and advance of the animal led to a longer continued secretion of conchiolinous matter at the posterior parts of the visceral cone and in the anterior part of the endosiphocoleon, thus producing the thick conchiolinous deposit observed in such specimens where the siphuncle has attained approximately its maximal width, while in siphuncles of still small diameter these same parts, even close to the endosiphocone, are provided with much thinner walls.

Holm subsequently [1895, 17:616; 1896, 18:406] added observations on V. belemnitiforme without, however, recurring to his description of the endosiphuncular structure of the Esthonian material of Endoceras gladius. He states, however, that the latter showed that structure "remarkably well developed and preserved" [*l. c.*, p.617] and that also in Swedish specimens of V. belemnitiforme (=gladius) the endosiphoblade could be observed.

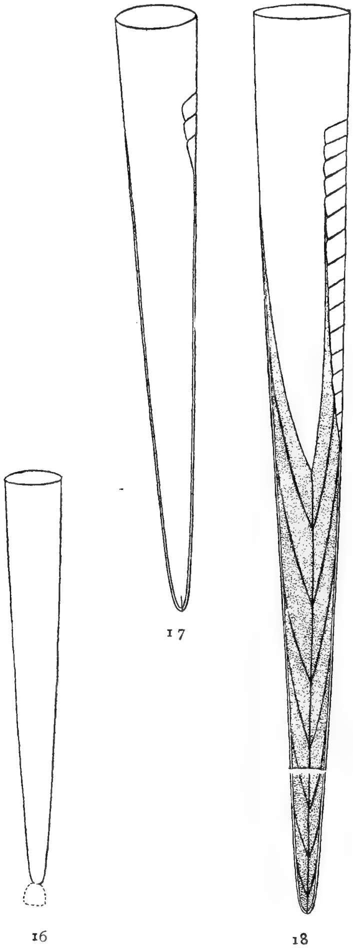

Fig. 16–18 Diagrammatic sections of early growth stages of shell of Cameroceras brainerdi

The distinction apparent in our material between the narrow endosiphotube and the wider endosiphocoleon, which in apicad direction becomes a compressed blade, has not been noticed in the European material and consequently Holm's term "endosiphoblade" comprised both the apical blade-like continuation of the endosiphocoleon and the thinner membranes which connect this and the ectosiphuncle.

5 Growth stages of shell

The description of the transverse and longitudinal sections through the endosiphuncular structures in their various stages of development enables us now to portray the processes which took place within the siphuncle of Cameroceras brainerdi during the animal's advance from the apical cone to the living chamber at maturity.

The *protoconch* or earliest embryonic stage is not preserved.[1] Its former presence outside of the initial apical cone of the shell is clearly indicated by the perforation of the apical end and the opening of the endosiphotube.

The growth stages of the animal of C. brainerdi, as recognized in the shells, are characterized by the successive forming of the apical cone, of the chambered portion, the filling of the siphuncle and the formation of the final endosiphosheath [*see* text fig.16-18]. The shell (protoconch) in which the embryonic stage was passed has not been preserved. The first shell which could be preserved was an open small cup which grew out into a long cigar-shaped open conch, the preseptal or apical cone, or *nepionic bulb* of Hyatt [*see* text fig.16, 19]. It was originally entirely filled by the animal and its wall consisted only of the present outer conchiolinous periderm. The aseptate stage is in Nanno termed the *ananepionic* stage by Hyatt. In C. brainerdi it must have extended through a considerable period of the life of the animal if we can use the length of the preseptal cone as an indicator of the lapse of time.

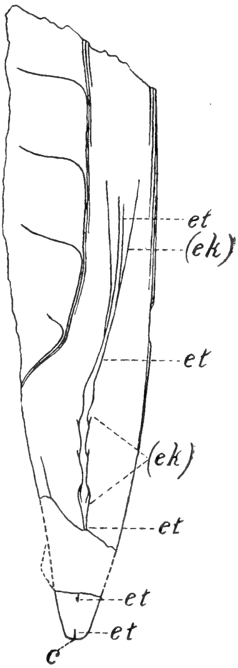

Fig. 19 Vaginoceras belemnitiforme Holm (sp.) Section of apical part showing the nepionic bulb, first cameras, cicatrix [*c*], endosiphotube [*et*] remains of endosiphosheaths [*ek*] and long septal necks, characteristic of Vaginoceras

The *metanepionic* substage in Nanno is characterized by Hyatt as that with septa and a huge empty siphuncle, while the *paranepionic* stage is that with the first endocone and an endosiphuncle formed at the apex. The formation of the first cameras in Vaginoceras belem-

[1]Several authors have at first considered the large apical cone of Nanno aulema and of Vaginoceras belemnitiforme as a protoconch. But the finding of the opening of the endosiphotube at the apical end in both species and of a cicatrix at this opening in the closely related Piloceras (by Foord) leave no doubt that the protoconch in these forms has not been capable of preservation.

n i t i f o r m e has been well depicted by Holm [*l. c.,* p.6, 7] and that of the endosiphosheaths by Bather. We therefore take the liberty of quoting from both of these authors.

The first of these (cameras) originated in this way: On one side of the upper portion of the visceral sac a circular and almost inclosed constriction was produced. The fold of the mantle thus formed deposited shell matter making an inclined wall and a division of a part of the originally open initial chamber. The resulting chamber was empty and formed the first air chamber. The chamber is, thus, bounded by only one septum and in this case lies behind the wall corresponding to the first septum in Nautilus. It therefore corresponds to the initial chamber in that genus. As it here has the same function as the other air chambers, I have termed it the first air chamber, although in fact it is a remnant of the open initial chamber. Moreover, the second air chamber is probably formed in part from the anterior portion of the initial chamber. The visceral sac of the animal was now divided by a constriction into an anterior and posterior portion. . . The anterior portion now forms the actual habitation chamber, but the great visceral sac also fills the posterior portion. *Holm*

This writer describes further how, by the formation of more cameras, the siphonal cord of the animal originates, and concludes: "Hence the siphon of E n d o c e r a s b e l e m n i t i f o r m e must have had its origin in a differentiation of the visceral sac." This differentiation of the visceral sac by the formation of several cameras also took place in C. b r a i n e r d i [*see* pl.6, fig.3 and text fig.17] and may be taken as denoting the metanepionic stage. Whether the cameras were formed for the purpose of supplying a hydrostatic apparatus to the ever heavier growing animal, as Holm assumes, or whether they served simply the purpose of shutting off space no longer used within the conch by the animal which now grew rapidly forward and expanded laterally, is here immaterial.[1]

[1]The possibility of a different function of the cameras from that of having been air chambers has been asserted by Jaekel [*see* Zeitschr. d. deutsch. geol. Gesellsch. 1902. p.67] and discussed by the writer in a review of Jaekel's paper [Am. Geol. 1903. 31:199].

After the formation of several cameras the animal began to withdraw also from the apical conch and then the formation of the endosiphosheaths set in, which continued throughout the neanic or adolescent age. Bather has described this process so graphically [1894, p.433] that we can do no better than quote here from him.

We know that in Nautilus and Spirula after the secretion of the septal necks, the outer coat of the siphuncle, both inside and outside the region of the septal neck, becomes hardened by calcium carbonate; this gives it a certain rigidity and assists its retention in the fossil state. The same thing must have occurred in the coat of the visceral cone. Now in Piloceras, when the animal advanced in the shell its viscera naturally followed it, and by suction the walls of the visceral cone were drawn in so as to form the narrow and empty siphuncle. At least such would have been the case had not the stiffness of the outer coat prevented complete yielding of the skin, especially at the posterior part where the siphuncle tended to begin, but where the coat was most calcified. It must therefore have happened that the inner layers of the skin were gradually torn away from the outer layers. Another stiffening of the skin would take place higher up and the process would be repeated.

As an explanation of this periodical sloughing it is suggested that the actual moment of the casting "was after the emission of the generative products, when the visceral cone was flaccid; this explanation coincides with Seeley's explanation of the origin of septation itself, but it is not exposed to the objections brought against the latter."

Perhaps the fact that the cast of the visceral cone preserved by the mud filling of the "Spiess" within the last endosiphosheath is sometimes of an undulating character, as in the specimen reproduced in plate 8, figure 3, and at other times well expanded and smooth, thus indicating considerable difference in the relative tension of the wall of the visceral cone, can also be taken to point to the conclusion that the visceral cone, which in our form undoubtedly expanded far back into the siphuncular tube, served principally as the receptacle for the generative organs, which in Nautilus are situated in the posterior part of the visceral sac.

Hyatt determines the close of the nepionic age in Nannoaulema with the formation of the first endosiphosheath, after which in that form the endosiphotube becomes plugged and thus the open connection closed with the embryo bag or if the latter had been already destroyed, that with the outside. We have no evidence that such a process took place in C. brainerdi after the formation of the first endosiphosheath though here also the matrix did not enter deeper from the outside into the endosiphotube than the thickness of one or a few endosiphosheaths, but it seems to us that the nepionic stage could not be well considered as ended till the nepionic bulb or preseptal cone had been entirely left by the visceral sac of the animal or, in other words, had become filled with endosiphosheaths.

The tube passing through this first endosiphosheath is still both endosiphotube and endosiphocoleon, the differentiation between these two not yet having taken place. Where and when they become differentiated I am not prepared to say. But this differentiation is clearly consequent on the widening of the siphuncle. The latter, as nepionic bulb has only a diameter of 2 mm at the perforation of the first endosiphosheath; it increases to about 10 mm where the formation of the septa begins, measures 15 mm where the endosiphocoleon is fully developed [pl.7, fig.10] and 20 to 25 mm at its passage into the living chamber of a mature individual. With the increase of the diameter of the siphuncle that of the major diameter of the endosiphocoleon apparently keeps pace. Since, however, as the animal removes itself more and more from the nepionic conch, only a narrow fleshy band is left behind, a new narrow tube is secreted by the latter within this older endosiphocoleon, as we have shown above [*see* pl.7, fig.2 and text fig.8]. This is the *endosiphotube.* As we have indicated in text figure 13, no differentiation between these tubes has yet taken place near the apex. If we take the long slender nature of the apical conch in account, it appears quite probable that the two tubes do not separate for some time and perhaps not till the neanic stage is reached.

The *neanic* stage is one of continuous growth. It begins with the filling of the nepionic bulb and the accomplishment of the withdrawal therefrom, and ends with the cessation of the formation of cameras and the secretion of the last and terminal endosiphosheath. Its substages are not clearly defined but since the differentiation of the endosiphocoleon and endosiphotube takes place in this stage, it is possible that one substage, perhaps the metaneanic, will be found to be marked by this differentiation. The advance of the endosiphocone with the attendant secretion of endosiphosheaths, forward growth of the endosiphocoleon and, lagging behind, of the inclosed endosiphotube, persisted during a great part of the individual lives of the species here under discussion, as is demonstrated by the considerable length of the conch through which these structures pass with but slight change. The adolescent stage and notably its last or its last two substages were hence remarkably long. The endosiphocoleon is decidedly the most striking endosiphonal structure of this stage.

When finally *maturity* was reached there were still available to the animal the living chamber, a very long portion of the wide and open siphuncle and the endosiphocone, which was closed by the last and final endosiphosheath. The latter and the last formed portion of the endosiphocoleon are characterized by specially thick walls, formed during ephebic age. Further growth took place only by a lengthening of the living chamber at its anterior margin.

Gerontic characters have not been observed.

The following tabulation may serve to bring out the differences of the three principal growth stages of this species in more concise form:

Growth stages of Cameroceras brainerdi Whitfield

STAGE	SUBSTAGES	CONDITION OF CONCH
Embryonic stage		Protoconch not retained
Nepionic or larval stage	Ananepionic Metanepionic Paranepionic	The conch is at first but an open unchambered, conchiolinous shell (ananepionic substage). With further growth a part of the space inclosed within the conch is set apart by septa as cameras, and thus the phragmocone or chambered portion of the conch becomes separated from the open cone (metanepionic substage). Then the nepionic bulb becomes filled by endosiphosheaths and intercalated organic carbonate of lime (paranepionic substage).
Neanic or adolescent stage	Ananeanic Metaneanic Paraneanic	Continued growth of the animal necessitates continuous formation of cameras and of endosiphosheaths and leads to a widening of the siphuncle and the separation of an endosiphotube and endosiphocoleon.
Ephebic or mature stage	Anephebic Metephebic Parephebic	The siphuncle is open, separated from the phragmocone by the ectosiphuncle (contiguous septal necks) in the anterior portion; by the ectosiphuncle and endosipholining in the posterior portion. The endosiphocone is bounded hy the final endosiphosheath. Further growth of the conch is only apparent along the apertural margin of the living chamber.

6 Relations of Proterocameroceras to Cameroceras, Vaginoceras and Nanno

A reference of our species to any of the genera of the Endoceratidae is beset with considerable difficulty. A short historic review of the varying generic references of the two most nearly related forms, Vaginoceras belemnitiforme and Nanno aulema, will demonstrate this. The first form with a free apical cone or nepionic bulb was described by Holm as Endoceras belemnitiforme [1887, p.5]. The author of the species named stated that it is unknown whether the apical conch in the genus Endoceras agrees with the form described, but added that he was able to trace in several species of Endoceras the apical portion to a diameter of a few millimeters, and that in all of them it was simple and conical, and possessed septa and siphuncle like the remainder of the phragmocone.

In 1894 Clarke described a species with similar apical cone from the Trenton beds in Minnesota, making it the type of a new genus, N a n n o a u l e m a [1894, p.205]. In the Minnesota report [1897, p.770] this interesting form has been described very elaborately and it has been pointed out there that "the continuance of an aseptate condition for a considerable period in the early history of Nanno is itself indicative of an important difference from Endoceras (Cameroceras) and Piloceras, inasmuch as this determines it to have been a more elementary organism than either." Holm's species is here also referred to Nanno. It is evident that both observers saw in the free apical cone a differential feature of considerable importance.

On account of Holm's conservative reference of his species to Endoceras, the validity of the genus Nanno was questioned by several authors (Sardeson, Bather). Holm himself discussed the relations of the endosiphonal structures soon after [1895, p.616] and came to the conclusion that inasmuch as it is not yet established that the apexes of all species of Endoceras have not the same structure as that of E. b e l e m n i t i f o r m e, the only difference between Endoceras and Nanno consists in the unequal longitudinal and transverse dimensions of the siphonal apical cone: the siphuncle of Nanno attaining its greatest width within the apical cone, whence it decreases to the beginning of the cameration, while in the other Endoceratidae the siphonal apical cone began undoubtedly very small, and the siphuncle increased gradually within the chambered conch. For this reason he adopted the term Nanno for a subgeneric group of Endoceras and in the following year (1896) described two additional types of this subgenus, adding also another subgenus Suecoceras. He redefined the subgenus Nanno, seeing its principal diagnostic character in the inflated apical cone which corresponds in length to the combined length of at least three of the oldest cameras, and which thereafter contracts so rapidly that already within the third camera the siphuncle attains its normal dimensions. This subgenus is made to include Nanno aulema, Nanno belemnitiforme and two new smaller forms. It is apparent that we would have to enlarge greatly the definition of this subgenus if we wished to commit our form, with its very long but slightly inflated apical cone, to it.

The question is, however, quite differently viewed by Hyatt. This foremost of the later authors on fossil cephalopods subjected the remarkable type from the Minnesota Trenton to an independent investigation and came to a different conception of the genus Nanno [1895, p.1]. It is evident from his discussion of the relations of Nanno to other genera, as also from his reference of Holm's species Endoceras (Nanno) belemnitiforme to Vaginoceras and his later definition of the genus in Zittel-Eastman's handbook [p.515], that he did not see in the large inflated apical cone more than a primitive character of the nepionic stage, which may be retained in various genera, but considered the restriction of the "endosiphuncle" (endosiphotube) to the apical end as well as the absolute contact of the shell and siphuncular wall on the ventral side, which leads to a bending of the sutures apically into a lobe passing around the siphuncle, as those characters of Nanno which are of generic importance and differential from the similar genus Narthecoceras. Thus defined, the genus Nanno becomes restricted to the single species Nanno aulema and this is to be regarded as a modified descendant of a genus which retains the endosiphotube throughout life. In regard to Cameroceras brainerdi we have shown that the endosiphotube passes not only through the apical cone but also through a large portion of the siphuncle of the shell to a point near the endosiphocone where it enters the endosiphocoleon. For this reason a reference to the restricted genus Nanno is impossible even if the siphuncle were in as close contact with the conch in our species as in Nanno aulema.

The septal necks or funnels of the Valcour form reach only from the septum of origination to the next apicad of this [*see* pl.1, fig.2], and the siphuncle is lined by an inner, thick, continuous layer (endosipholining). If we, hence, accept Hyatt's division of the forms originally comprised under Endoceras into the genera Vaginoceras, Cameroceras and Endoceras by the criterion of the relative length of the funnels, and the presence or absence of the inner siphuncular lining, our form would have to be brought under Cameroceras. We would then be in the peculiar situation of having three groups of species belonging to three different genera which have in common large preseptal apical cones or nepionic bulbs, indicating long continuation of a very primitive condition in early youth of the forms. In at least two of these genera these primitive groups contrast with the larger number of the younger congeners, in which the siphuncle has been entirely inclosed into the phragmocone and the preseptal cone superseded.

While we do not intend to question Hyatt's view which clearly considers the genus Nanno with the scope and definition given to it by Clarke and Holm, as of polyphyletic origin, and therefore restricts it to Nanno aulema, we are also convinced that it would not serve the ends of a proper delimitation of closely related and equally advanced forms, if one would include in these three genera the forms which clearly represent an older phylogenetic stage than the genotypes. For this reason we propose to separate these phylonepionic forms characterized by preseptal cones from the later and typical phylephebic congeners and designate them as subgenera by the prefix "protero." We thus have a "Proterocameroceras" represented by Proterocameroceras brainerdi, which is a Cameroceras with a large preseptal cone or nepionic bulb; and a "Proterovaginoceras," which is a Vaginoceras with a like cone. To the latter would have to be referred Endoceras (Nanno) belemnitiforme Holm, while the position of E. (Nanno) fistula Holm and E. (Nanno) pygmaeus Holm is uncertain till their siphuncular structures have been studied. As the long, stafflike, cylindric conchs would indicate, they may belong to neither of the two genera mentioned and be rather genuine Nannos or come under Hyatt's genus Narthecoceras. In the latter case we might have a third genus with "protero" forms and later forms.

It is in line with the more primitive character of Proterocameroceras brainerdi that it occurs in the Beekmantown formation; while Cameroceras does not find its principal development till the Black river and Trenton stages.

The close similarity in the structure of the apical portion of the conchs of Proterovaginoceras belemnitiforme and Nanno aulema has been recognized by Clarke, Holm and Hyatt. We have found a like nepionic siphuncle in Proterocameroceras brainerdi. Proterovaginoceras belemnitiforme and Proterocameroceras brainerdi have further in common the strong development of the peculiar organ which we have termed the endosiphocoleon, leaving as structural differences only the different length of the septal necks or funnels and the presence of the endosipholining in the latter. The phylogenetic relationship or common origin of the Proterovaginoceras-Vaginoceras series, the Proterocameroceras-Cameroceras and the Nanno series is therefore not to be doubted. Of these again the Vaginoceras series has retained the most primitive characters, as is apparent by the longer septal necks. A Vaginoceras-like form is therefore with great probability to be considered as the common radicle of the entire group. This form, which in the appended diagram we have designated as "Protovaginoceras," would have to be looked for in stages still preceding the late Beekmantown.

Our view of the relation of the species of Vaginoceras, Cameroceras, Nanno and Piloceras[1] attained here is expressed in briefer form in the following table.

	VAGINOCERAS SERIES	CAMEROCERAS-ENDOCERAS SERIES	NANNO SERIES	PILOCERAS SERIES
Typical or mature development	Vaginoceras multitubulatum (Vaginoceras wahlenbergi) (Vaginoceras vaginatum) etc.	Cameroceras trentonense, Cameroceras proteiforme	? (Nanno) fistula ? (Nanno) pygmaea	Piloceras
Proteroforms	Proterovaginoceras belemnitiforme	Proterocameroceras brainerdi	Nanno aulema	(Proteropiloceras)
Protoform	Protovaginoceras			

[1]*See* chapter 8, p.329.

7 Similarity between the endosiphocoleon and the proostracum of belemnites

An inspection of the system of surface lines of the endosiphocoleon consisting of forward arching transverse ridges and longitudinal lines can not fail to suggest the proostracum of the belemnites; and a study of the relative position of the two organs and of the probable phylogenetic relations of the Belemnitidae with the Endoceratidae makes this comparison seem less farfetched or strained than would appear at first glance.

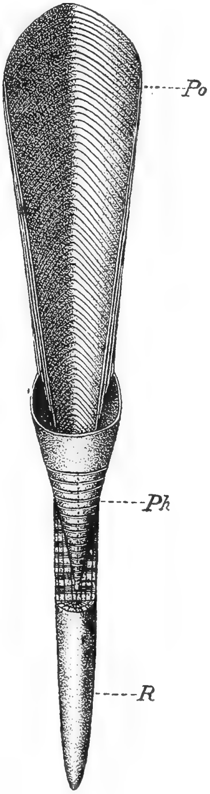

Fig. 20 Restoration of a Belemnite shell: *R*, rostrum; *Ph*, Phragmocone; *Po*, Proostracum. (Copy from Zittel)

The belemnite shell, when complete, consists, as is well known, of three parts [*see* text fig.20]. These are the rostrum, the phragmocone and the proostracum. Of these the rostrum or guard is a later acquisition which does not concern us here. The phragmocone is identical with the phragmocone of the early cephalopods which here however has become entirely inclosed within the mantle. From the dorsal side of the last large chamber of the phragmocone (the former living chamber of the conch) proceeds a broad, thin, somewhat arched blade, the proostracum, which consists of two stronger longitudinally striated lateral regions and a very thin intercalated dorsal blade. In the typical belemnites this organ has a size much surpassing that of the rostrum and phragmocone as in the restoration here copied; and in later forms both the latter organs become reduced,[1] while, on the other hand, if the Belemnitidae are traced backward in geologic history, the proostracum becomes smaller and more insignificant and the Triassic forms do not seem

[1]The homologies of the different parts of the cuttlebone or sepion of the Sepia with those of the belemnite shell are not yet clearly established as the differing views of Bather [1888, p.298] and Blake [1888, p.376] evince.

to have yet acquired it, while inversely the phragmocone, as in Atractites, was still so well developed that this genus was at first unhesitatingly referred to Orthoceras. Where the proostracum is fully developed the animal has discarded the phragmocone entirely as living chamber, and inclosed this former exterior conch within the mantle whereby the rostrum and phragmocone find their position in the posterior end of the animal.

The endosiphocoleon, which externally resembles the proostracum, lies within the anterior part of the siphuncle. It is, as we have demonstrated, formed within the endosiphocone. As now the endosiphocone contained the posterior portion of the animal ("visceral cone" of Bather), and this was inclosed by the mantle, the endosiphocoleon forming at the posterior end of the visceral cone was undoubtedly produced by the mantle and since the surrounding endosiphosheath was left behind by the outer mantle, this more anterior endosiphocoleon is to be considered as secreted within a mantle flap or fold situated at the posterior end of the animal. Both the endosiphocoleon and proostracum are hence formed in identical places.

If we further take into account that while in our Proterocameroceras a large portion of the siphuncle served as chamber of habitation to the animal, and that in the Belemnitidae the animal had entirely withdrawn from the conch, the different position of the endosiphocoleon and of the proostracum relative to the phragmocone will be seen not to constitute a fundamental distinction. One might say that the animal in withdrawing first from the siphuncle and finally also from the living chamber pulled the endosiphocoleon after it till the latter came to lie in front of the old living chamber of the phragmocone.

It can not be held that the proostracum is a direct further development of the endosiphocoleon in view of the fact that the latter is only found in the early Endoceratidae and could have no place in the later orthoceracones with their shrunken siphuncles, while, on the other hand the proostracum does not appear till the phragmocone has been reduced to a rudiment in the Belemnitidae. But since the Belemnitidae, as Hyatt has claimed, can be linked to paleozoic orthoceraconic cephalopods and the latter again quite probably took their origin from endoceratitic forms—by way of Baltoceras—and since therefore there is good reason to consider the Belemnitidae as descendants of the Endoceratidae, the similarity of the proostracum and endosiphocoleon is probably more than a mere analogy between unrelated forms due to formation by a like organ (mantle) in the like posterior position, but it partakes more of the nature of the recrudescence of an organ discarded before, when a new use had been found for it within the same race.

It does not matter that the endosiphocoleon is a flattened tube and the proostracum only a blade, as a flattened tube would be readily changed into a blade under the stress of a new adaptation.

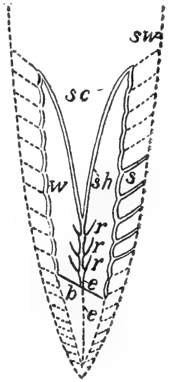

Fig. 21 Piloceras amplum Dawson. Longitudinal section; showing endosiphocone [*s c*], last endosiphosheath [*s h*]; endosiphotube [*e*] and remains of endosiphosheaths [*r*]. Dawson's original drawing. (Copy from Foord)

8 Endosiphuncular structure of Piloceras

We have already anticipated the results of our investigation of Piloceras in the synoptic table on page 326, in deriving Piloceras from a more primitive genus Proteropiloceras, that stands on the same plane of phylogenetic development as Proterocameroceras and Nanno. We have also recorded [p.301] that in Piloceras an endosiphoblade has been observed by Dawson, which indicates that the endosiphuncular structure may not only be homologous to that of Cameroceras by the possession and strong development of the endosiphosheaths, but also by the character of the endosiphuncular tubes.

While, however, in the few specimens of Piloceras in which the apical end has been actually observed, no nepionic bulb has been found, and the siphuncle has been seen to expand gradually and to be inclosed entirely within the phragmocone [*see* Foord], we have found that P. explanator Whitfield at least retains very distinct traces of the nepionic bulb or apical inflation [*see* pl. 13, fig.3]. This species points hence clearly to the existence of types which held the same relation to the phylephebic species of Piloceras as does Proterocameroceras to Cameroceras; and which would be properly called "Proteropiloceras." If in P. explanator the cameras did not extend on one side to near or quite to the apex of this nepionic bulb, we would not hesitate to make this form the type of the proposed subgenus. It is evident that a process of acceleration in the phylogeny of this genus has led to a crowding back of the formation of septa, which originally was the cause of the contraction of the siphuncle, to the very apex of the nepionic bulb without, however, having yet been able to efface all vestiges of this former inflation of the conch. This also points clearly to the process by which the nepionic bulbs of Proterocameroceras and Proterovaginoceras have become reduced in Cameroceras and Vaginoceras, i. e. by a tachygenetic encroachment of the metanepionic growth stage on the aseptate ananepionic stage.

Besides the presence of the nepionic bulb, Piloceras exhibits also in its endosiphuncular structure characters which link it closer to the Protero-forms of the other associated series, than to Cameroceras.

The siphuncle is, like the conch, short, conical, with elliptic to oval section [*see* pl.10]; the endosiphocone is short and broad with elliptic upper section, rapidly shrinking to a flat blade at its narrower end [*see* pl.13, fig.1, 2]. Its cast shows peculiar flutings arranged in bundles and which, in one specimen, appear to consist of longitudinally arranged pits and strongly remind one of the similar depressed lines found on the outer conch. Since the latter are produced by muscular attachment of the animal within the living chamber, the presence of these scars on the wall of the endosiphocone seems to me a strong argument for the view that in this primitive form the visceral cone shared still to a great measure the functions of the living chamber. We have already seen that in Proterocameroceras brainerdi a large anterior portion of the siphuncle remained unobstructed by deposits and was evidently occupied by the animal during its lifetime. In Piloceras explanator this portion of the siphuncle was considerably wider though not longer, for this reason probably amounting to as large a proportion of the animal as in Proterocameroceras.

Endosiphosheaths and endosiphofunicles. The endosiphosheaths were, corresponding to the heavy weight they had to support, rather stout membranes, reaching in some instances a thickness of 1mm. They are mostly well preserved, sometimes closely crowded and separated by intervals not wider than .5mm [*see* pl.12, fig.5]; but in at least one instance they were also separated by an open space of 5mm into which calcite crystals freely project. Their sections are not evenly curved ellipses, but partake more of the nature of polygonal surfaces or are even bounded by undulating lines. This is due to their being held in position by guy ropes or funicles, which we will designate here as "endosiphofunicles." These are of the same nature as the endosiphosheaths and appear in sections as dark gray to black pillars of organic carbonate of lime, often bounded by black lines. They originated from membranous funicles, in which organic carbonate of lime was deposited in similar manner as in the endosiphosheaths. The sections [pl.11, pl.13, fig.3] show them well developed. Several have been further enlarged to show their relation to the endosiphosheaths [*see* pl.12].

If it were not for the outward curvature or angulation of the endosiphosheaths [*see* pl.12, fig.1, 2] at the points of connection with the endosiphofunicles, and for the fact that the outer wall of the siphuncles passes over these funicles [*see* pl.12, fig.2; pl.13, fig.5], one might be inclined to consider them as worm tubes; specially where they appear in such great numbers as in plate 11, figure 2. But in this latter section it will be noticed that the greater number pass only from the outer wall of the siphuncle to the first endosiphosheath; while but a smaller number—among these the remarkable one in the upper right corner which bifurcates three times [*see* pl.12, fig.1]—reach the inner endosiphosheath or the endosiphocoleon.

In looking over the series of sections, beginning with figure 1 [pl.11] we will readily notice that the number of endosiphofunicles diminishes very rapidly with the shrinking of the endosiphosheaths toward the apical end. This can be easily explained by the fact that the endosiphocone in its anterior part needed the most guy ropes on account of the greater weight of the visceral cone there. Therefore also the number of endosiphofunicles diminishes so greatly from the outer zone to the next, because the outer endosiphosheath inclosed a much larger section of the visceral cone at the plane of the section than the later inner endosiphosheath did at the same point.

In section I the endosiphofunicles of the outer whorl appear distinctly as fine tubes with thin conchiolinous walls, their lumen being filled by a milk-white calcite which strongly contrasts with the more limpid calcite crystals surrounding the tubes. Many of these tubes bifurcate near the ectosiphuncular wall, one several times. There is secured by this mechanical contrivance a larger base of fixation, which insures steadiness and freedom from vibrations for the visceral cone during the movements of the animal.

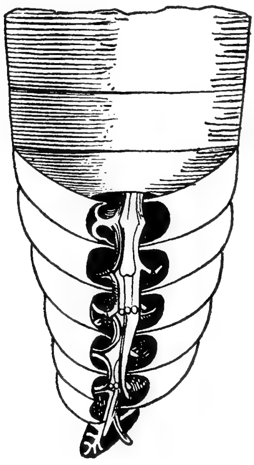

Fig. 22 Actinoceras abnorme Hall (sp.). Section showing the endosiphuncle and tubuli. (Copy from Zittel)

Whether the numerous endosiphofunicles were but a modification of the endosiphoblades which, as we have seen, hold the endosiphocoleon and endosiphosheaths in position in Proterocameroceras brainerdi and originated by a dissolution of these suspensory membranes in numerous strands, or are a new formation induced by the necessity of supporting the heavy visceral cone hanging free within the broad siphuncle, is a question which we can not con-

NOTE. We can not yet determine whether these endosiphofunicles are homologous to the remarkable verticils of sometimes branching tubuli which in some species of Actinoceras connect the endosiphuncle with the ectosiphuncle. Both undoubtedly are quite similar in appearance. The tubuli of Actinoceras [*see* e. g. Actinoceras abnorme Hall, N. Y. State Mus. 20th An. Rep't, pl. 18, fig. 10 (copied here after Zittel)] are by Foord described in Actinoceras bigsbyi [*see* 1888, p. 166] as penetrating the siphuncular wall, and it has been suggested by Owen [Pal. 1860, p. 85] that they served for the passage of blood vessels to the living clusively answer. But the fact that the endosiphocoleon is also here in the earliest successive sections of the siphuncle [*see* pl.11, fig.5, 6] supported either by continuous membranes proceeding from its corners or by longitudinal series of closely arranged endosiphofunicles would argue for a derivation of the endosiphofunicles from the endosiphoblades. That indeed in the apical portion of the siphuncle one of the two mentioned modes of suspension prevailed is to be inferred from the fact that in the above cited succeeding sections—and as well in the sections found on the other side of the cutting planes and separated from them by about 1mm—the dark lines which are the sections of the suspensories, retain the same position throughout.

The arrangement of the endosiphofunicles and endosiphoblades in the sections [pl.11] shows quite conclusively that the side of the siphuncle which is the upper in the drawings was also the upper side during the life of the animal. In the longitudinal section [pl.13, fig.3], which exhibits a series of endosiphofunicles the direction of the latter is of still further interest as giving a hint as to the direction in which the animal carried its conch. We notice that if we give the endosiphofunicles a perpendicular position, such as they should have according to their function as suspensories the conch assumes a direction which is obliquely ascending under a small angle. This stands in full accord with what we know thus far as to the dorsal and ventral sides of the animal; the siphuncle being in contact with the ventral wall of the conch, while the chambers form on the upper (dorsal) and lateral sides.[1] The fact brought out by the outline of a large specimen given by Whitfield that the ventral side is nearly straight,

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membrane of the septal chambers; while Hyatt [1883, p.272] believes with Barrande that they did not penetrate the true external wall of the siphuncle. If Barrande and Hyatt are right in this contention and Hyatt also in his view that the "rosettes" or endosiphuncular deposits of Actinoceras are strictly homologous to the endosiphosheaths of Endoceras and Piloceras [1883, p.27] the endosiphofunicles of Piloceras explanator may indeed be homologous to the "tubuli," and their function identical, viz, that of suspensories for the siphon, whose outer membranes have become calcified.

[1]In the section the chambers of course appear only on the upper (dorsal) side.

while the dorsal one is very convex, or in other words, that the ventral side appears as a base, all growth taking place in dorsal direction, tends also to support the view that the conch was carried slightly oblique and at rest placed in a horizontal position.

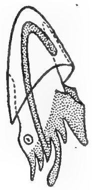

Fig. 23 Diagram of original cephalopod. (Copy from Lancaster)

It is interesting to note in this connection the views held by prominent zoologists as to the polarity of the Cephalopoda. Huxley, Lancaster and Lang give the original cephalopod the position shown in the diagrammatic figure reproduced here from Lancaster, while Verrill holds that the antero-posterior axis of the cephalopod is shown by forms as Loligo at rest [*see* fig.24]. It seems that the structure of Piloceras explanator, which both in organization and the time of its appearance is to be considered as a primitive form, could be easily reconciled with this latter view, if we assume that it was a sluggish creeping form which would rest its shell on the flat ventral side, but lift it up slightly while moving.

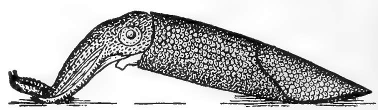

Fig. 24 Loligo at rest. (Copy from Verrill)

Endosiphocoleon. It remains to us to trace the development of the endosiphocoleon of the siphuncle of Piloceras explanator, which can be best done by reference to the series of sections 1–7 on plate 11.

We have already stated that the endosiphocone becomes flatter as it approaches its posterior end till at its termination it is five or more times as broad as high [*see* pl.13, fig.2]. From this end proceeds the endosiphocoleon, a flat sheathlike canal, which is nearly as wide as the innermost endosiphosheath; in section 1 by a secondary fracture apparently still wider. The longitudinal section [pl.13, fig.3] shows this endosiphocoleon in a young specimen, cut through its shorter axis. It demonstrates that the endosiphocoleon possesses a thin conchiolinous wall which extends through the last endosiphosheath into the cavity of the endosiphocone; and hence was here not formed as a continuation of the external conchiolinous layer of the endosiphosheath, but within the apical end of the endosiphocone. It is hence identical in origin with the endosiphocoleon of Proterocameroceras brainerdi.

From its lateral ends proceed the endosiphofunicles described above, apparently mostly in longitudinal series. Corresponding to the vertical contraction of the siphuncle the section of the endosiphuncular canal is broader than high and its lateral ends coalesce into a conchiolinous blade. As the central portion retains its full lumen, the section becomes in this specimen at first very broadly triangular [fig.4] and finally (through fig.5, 6) a low triangle. The apical termination of this endosiphuncular canal is not shown in the specimen here sectioned because the ventral portion of the siphuncle has been worn away. There is, however, not more than 11mm wanting of the total length of the siphuncle, and it is therefore evident that no endosiphotube with distinctly circular conchiolinous wall passes, as in Proterocameroceras brainerdi, through a large apical portion of the siphuncle. The coloring of the calcite within section 4 suggests perhaps [*see* enl. pl.12, fig.3] that also here only a lumen with circular section may have remained open within the endosiphocoleon, but the next section (5) fails entirely to show any inclosed tube.

We have hence no evidence of the formation of an endosiphotube in Piloceras explanator, but do not doubt that where the siphuncle becomes longer and more tubular instead of remaining short and broad as in this species, an endosiphotube may be formed, as indeed it has been found in other species of Piloceras.

The wings of the endosiphocoleon in Proterocameroceras brainerdi, which originate from a deposit of conchiolinous matter on the outside of the endosiphosheath and which there form such a striking feature, have been observed in but one instance, where the apical portion of the siphuncle is extremely broad and flat and the lateral margins of the endosiphosheath form hence acute angles. They seem for this reason to have been strengthened by conchiolinous deposits.

Among the eight species of Piloceras which have thus far been described, one, P. newton-winchelli Clarke [1897, p.767], from the Shakopee formation in Minnesota is of special interest in relation to the genetic history of this genus and in our opinion stands at the opposite end of the series from P. explanator. While in the latter the ectosiphonal wall distinctly consists of the coalesced reflexed margins of the septa (septal necks), Clarke's careful description and figures [*see* fig.25] demonstrate that in P. newton-winchelli the funnels or septal necks are only very short and the siphuncular wall is distinctly formed by a secondary formation, "the annuli".[1] If we adopt Hyatt's fundamental division of the Nautiloidea, we find the genus Piloceras brought under the Holochoanites which are characterized by the extension of the funnels from one septum to the next preceding or beyond. Piloceras newton-winchelli is hence not a member of the genus Piloceras as defined by Hyatt, indeed it has the ectosiphuncular structure of another suborder, the Orthochoanites; or has advanced in the character of its ectosiphuncle from the Cameroceras stage found in the other Piloceras forms, to the later Orthoceras stage. The relation of this form to the typical Piloceras appears to us identical with that of Endoceras burchardii Dewitz to the true Endoceras, the latter being a species which, while retaining the habit of an Endoceras has, as Holm has shown [1897, p.171] the ectosiphuncular structure of an Orthoceras. Holm proposed the genus Baltoceras for this form, a genus which is considered by Hyatt as the first and most primitive of the genera of Orthoceratidae.

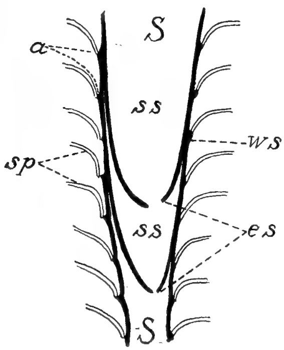

Fig. 25 Clarkoceras newton-winchelli Clarke (sp.). Enlargement of portion of section to show the siphuncle [*S*]; endosiphosheaths [*ss*]; ectosiphuncle [*ws*]; endosiphotube [*es*]; septa [*sp*] and annuli [*a*]. (Copy from Clarke)

[1]It is doubtful whether these annuli or siphuncular segments of the Orthochoanites form a homologue to the continuous "endosipholining" of Cameroceras, as it would appear at first glance. The endosipholining is considered by Hyatt as composed of the upper unresorbed ends of the endosiphosheaths, while the siphuncular segments find their fullest development where, on account of the reduction of the siphuncle, no more endosiphosheaths are formed. Nor is any genetic connection between the segments and the endosiphosheaths apparent in text figure 25.

On the same principle P. newton-winchelli should be removed from the holochoanitic Piloceratidae and brought under the Orthochoanites, where, as far as I am aware, it constitutes a new genus (Clarkoceras).

A further character quite significant of the advance of Clarkoceras newton-winchelli beyond the typical Piloceras stage is to be seen in the reduction of the endosiphosheaths of which only two were observed in a specimen of which only a small apical portion is missing [*see* fig.26]. These leave large endosiphuncular chambers between them which are not filled by depositions of lime carbonate, as the much smaller chambers in the species of Piloceras are. The endosiphotube is only indicated by the perforation of these endosiphosheaths and has lost its own wall. The entire endosiphuncular structure is distinctly in a process of dissolution, resulting from the reduction of the size of the siphuncle in consequence of the more complete withdrawal of the visceral cone. In Baltoceras the process of dissolution has gone already a step farther and all traces of endosiphosheaths have been lost notwithstanding the still considerable width of the siphuncle.

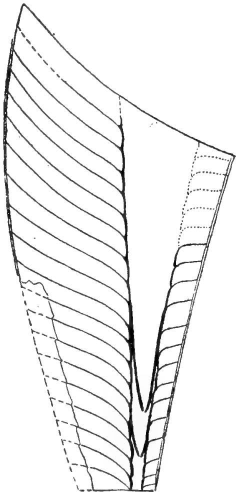

Fig. 26 Clarkoceras newton-winchelli Clarke (sp.). Median vertical section of a specimen. x1.5. (Copy from Clarke)

Summary

1 The conch of Cameroceras brainerdi from the Upper Beekmantown formation begins with a long slender preseptal cone or nepionic bulb, which terminates anteriorly with a slight constriction where septation sets in.

2 The nepionic bulb and the middle (neanic) portion of the siphuncle are filled by endosiphosheaths, while the anterior (ephebic) portion is empty.

3 The empty anterior portion is closed in apical direction by the final endosiphosheath, which incloses the endosiphocone

(visceral cone). From this last formed endosiphocone a broad, flattened tube with conchiolinous walls extends backward, for which the term "endosiphocoleon" is here proposed. This forms within the endosiphocone preparatory to a further withdrawal of the animal and the formation of a new endosiphosheath. In apicad direction it changes into a blade, consisting of two lamellae, disappearing gradually by being altered into organic calcium carbonate and becoming confluent with the calcium carbonate filling of the siphuncle. The endosiphocoleon grew hence at its anterior end and was absorbed at its posterior end or vanished there by secondary alteration into lime carbonate.

4 In the same measure as the endosiphocoleon disappears, a capillary conchiolinous tube, the endosiphotube, becomes prominent. This forms within the endosiphocoleon by the posterior contraction of the siphon. It extends to the apical end of the nepionic bulb, where it empties (into the protoconch which is not preserved):

5 The endosiphocoleon is flanked on both sides by conchiolinous wings, having a crescentic section. These form on the outside of the angles of the flattening endosiphosheaths and are hence separated from the endosiphocoleon by the organic lime carbonate composing the endosiphosheaths.

6 The posterior portion of the empty, ephebic siphuncle is lined by the endosipholining, the anterior portion only by the septal necks or funnels.

7 The endosiphocone, endosiphocoleon and endosiphotube are held in position by (mostly three) radiating suspensory membranes (endosiphoblades), which affix the endosiphosheath etc. to the preceding endosiphosheath and the ectosiphuncle.

8 The presence of a preseptal cone or nepionic bulb in an early, otherwise typical, Cameroceras (C. brainerdi),—while in the later species of Cameroceras the nepionic bulb has disappeared—, as well as in a typical Vaginoceras (V. belemnitiforme), in Nanno aulema and in a Piloceras (P. explanator), demonstrates that these genera have passed through the same early

stage of development with a prominent nepionic bulb, which fact is of sufficient phylogenetic importance to require recognition by assigning these forms to subgenera (Proterocameroceras, Proterovaginoceras and possibly Proteropiloceras) of their respective genera.

9 The endosiphocoleon is revived in the proostracum of the belemnites, the probable Mesozoic descendants of the Paleozoic holochoanitic and orthochoanitic orthoceraconic cephalopods.

10 In Piloceras explanator Whitfield the nepionic bulb is still recognizable by an inflation of the apical portion of the siphuncle, which by tachygenesis has become inclosed in the phragmocone.

11 The endosiphocoleon extends without becoming absorbed to or nearly to the apical end. This results from the wide short form of the siphuncle.

12 The endosiphosheaths and endosiphocoleon are held in position by numerous suspensory funicles (endosiphofunicles). These proceed from angulations of the endosiphosheaths and frequently divide in outward direction.

13 The arrangement of the endosiphofunicles on the side opposite the flat side of the conch, where siphuncle and conch are in contact, indicates that this latter side may have been the ventral one and that the conch was carried in a subhorizontal, slightly ascending direction.

14 Piloceras newton-winchelli Clarke is by the structure of its ectosiphuncle not a holochoanitic form as the other congeners, but an orthochoanitic form and represents a genus (Clarkoceras) which holds the same relation to Piloceras as Baltoceras to Endoceras.

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NOTES ON THE SILURIC OR ONTARIC SECTION OF EASTERN NEW YORK

BY C. A. HARTNAGEL

The Ontaric section of central and western New York, as developed west of the Helderberg is subdivided into 10 divisions,[1] and it is from this section of the State that all but one of the locality names applied to these divisions are derived. Each of these divisions is more or less distinctly characterized by differential lithologic features and all are fossiliferous.[2]

On the east side of the Helderberg and including the section extending from Ulster county southwest to New Jersey, the Ontaric lacks several members of the group, while the fossils found are of an age not earlier than late Salina, the lower members of the Ontaric where present being entirely without fossils. The fact that the Manlius and Rondout formations alone of the entire Siluric series have stratigraphic continuity across the Helderberg, has left the outcrops of the Siluric rocks in New York divided into two nearly distinct geographic areas.[3]

While the main purpose of this paper is to bring out the relations of the Cobleskill formation as developed in eastern and southern New York, it will also attempt to show certain relations of the lower members of the Ontaric formation in so far as they have come under the observation of the writer. The lower members of the Ontaric section in this portion of the State are entirely unfossiliferous and confusing in their lithologic features, and it will still require considerable study to accurately locate their correct position in the geologic series. This condition is brought about by the discovery that the Cobleskill horizon is above the Salina deposits, a fact which suggests that the Shawangunk grit and red shales above it may possibly represent a later age than that to which they have been usually referred.

[1] Clarke. N. Y. S. Mus. Handbook 19, July 1903. Table 1, p. 9.

[2] While the Salina beds are sometimes regarded as being nonfossiliferous, it will be observed that the Salina as now defined includes at its base the Pittsford shale and at its top the Bertie waterlime. Both of these formations are characterized by an Eurypterus fauna.

[3] A third area is developed in Rensselaer county. The Ontaric is here represented by a single member known as the Rensselaer grit. This is generally considered the equivalent of the Oneida or of the Shawangunk grit.

Shawangunk grit and conglomerate

The lowest member of the Ontaric section in eastern New York is the Shawangunk grit. This designation was first applied to the formation by Mather,[1] the term being derived from the mountain area of that name, which extends from near High Falls in Ulster county southwest through Orange county and beyond the limits of the State. The Shawangunk grit, wherever the contact has been observed, is seen to rest unconformably on the Lower Siluric shales. The Shawangunk grit is generally correlated with the Oneida conglomerate, the latter term often being applied to it. Of these two formations the Shawangunk grit has the greater development, the thickness varying from less than 50 feet in parts of Ulster county and gradually increasing in thickness to more than 200 feet within a few miles. The Oneida conglomerate in its type section has a thickness of from 15 to 20 feet and in its western extension it gradually grades into a sandstone known as the Oswego sandstone, which in Oswego county has a thickness of more than 100 feet. Both the Oneida conglomerate and the Oswego sandstone are transitional into the Medina sandstone above.

It will thus appear that while we may consider the Medina as directly following and transitional from the Oneida in central New York, the sequence of events following the deposition of the Shawangunk grit in eastern New York has never been satisfactorily established. While for many years the red shales lying above the Shawangunk grit in Ulster county and further south have been generally correlated with the Medina of central New York, no proof has ever been set forth to establish their identity with any degree of certainty. Mather[2] in the final report of the first district, the western limit of which was as far west as Herkimer county, did not definitely correlate these red shales, though he was inclined to refer them to the Medina. He says, " The observations made do not render it certain whether these red rocks are equivalent to the Onondaga salt group or the Medina

[1] Geol. N. Y. 1st Dist. 1843. p. 355.
[2] Geol. N. Y. 1st Dist. 1843. p. 355, 363.

sandstone; but it is thought probable, from some of the mineral characters, no fossils having been seen, that they belonged to the epoch of the Medina sandstone, and that the subjacent Shawangunk grit is equivalent to the gray sandstone (=Oswego) instead of the Oneida conglomerate."

While it is known that Mather[1] recognized and designated a formation in eastern New York as "coralline limestone" which recently has been shown to be identical with the Cobleskill limestone, it is evident from the above citations that Mather could not have regarded it as of Niagaran age, or he would not even have suggested the possibility of the underlying red shales being of Salina age. For many years following the publication of Mather's report the section under consideration was not much studied. The discovery, however, by Dr Barrett, of Cobleskill fossils near Port Jervis in strata which lie above the red shales, and the studies of Lindslay of the same formation at Rondout, left little doubt as to the continuity of these rock masses in the intervening section, and since the Cobleskill at that time was correlated with and generally accepted as the equivalent of the Niagaran formation as developed in western New York, it served for the time being as apparently conclusive evidence that the underlying shales could scarcely be correlated other than with the Clinton and the Medina, or at least it was not thought they could possibly represent the Salina. As we now know that the Cobleskill limestone is of an age later than the Salina, the age of the red shales together with the so called Clinton quartzite lying above the Shawangunk grit again comes into question, since both the Salina and the Medina are below the Cobleskill. As no fossils have been found in the red shales, a feature which contrasts them with the Medina of central New York, it is evident that in any attempt to correlate these red shales, evidence must be had from other sources.

It was early shown by Vanuxem[2] and Hall[3] that in central New York the passage from the Oneida to the Medina was a

[1] Geol. N. Y. 1st Dist. 1843. p. 331.
[2] Geol. N. Y. 3d Dist. 1842. p. 71.
[3] Pal. N. Y. 1852. 2:15, 16.

gradual one, the conglomerate or the sandstone (Oswego) being transitional into the Medina. The lower portion of the Medina throughout the central portion of the State contains pebbles abundantly and is also characterized by an oblique laminated structure which is well shown in the exposures of the Medina in Herkimer county. On the other hand the base of the red shales (=High Falls shales) above the Shawangunk grit in Ulster county and farther southwestward do not possess the transitional features ascribed to the Medina of central New York. In the eastern section these shales are entirely devoid of pebbles, generally of a bright red color and uniform in character, specially near their base. On exposure to the atmosphere they break into small angular fragments which are easily washed away leaving the sloping surface of the conglomerate beneath clean and white. In small protected areas on the western face of Shawangunk mountain, where the agencies of weathering and erosion have been less severe and the shale, perhaps, of a firmer texture, a number of isolated patches of these red shales occur. They are, however, easily removed and the underlying conglomerate brought to view. On the farm of Patrick Winn at High Falls the contact of these red shales with the conglomerate is favorably shown. At this place the shales formerly were quarried and used for making paint. They here retain their characteristic features down to the conglomerate. It is evident then that there is a very marked change in the character of the sedimentation following the conglomerate, suggestive of a hiatus at this point. Nowhere in central New York has the base of the Medina the features presented by the red shales of this section. In lithologic features they are more like the Vernon red shales of the Salina than any bed of the Medina, though in the upper portion of the Medina there are beds of red shales of a somewhat similar character but more arenaceous. Such beds can be favorably examined at Lewiston on the Niagara river.

A study of the overlaps on the west side of the Helderberg shows that the Salina shales extend farther east than does the Medina, and since the period was one of increasing submergence, it is but natural that we should expect to find in eastern New York manifestations of Salina time rather than the Medina and the Clinton. The so called Clinton quartzites (=Binnewater quartzites) lying above the red shales were so designated because they are in some respects similar to the Clinton formation of western New York, and probably also because of their similarity to the green shales with iron pyrites lying beneath the Cobleskill in Schoharie county which were formerly also correlated with the Clinton. In this connection it is interesting to note that the view as given above was held by Mather.[1]

With this correlation in view, it follows that, if the quartzite with the iron pyrites in eastern New York is the equivalent of the green shales of the Schoharie section then the quartzite of eastern New York is Salina and not Clinton, since it is known that the green shales of Schoharie county are of an age not earlier than late Salina. South from High Falls the quartzite below the Wilbur limestone becomes more calcareous and of a shaly nature. At Accord, a few miles south from High Falls, the shales are seen in the cut on the Ontario & Western Railroad. At this place the beds are light colored, soft, argillaceous shales with considerable mineral matter. They are exposed for a thickness of 18 feet. Southwest from this point there are no favorable exposures for the examination of these shales in New York.

If we regard the red shales above the Shawangunk grit and conglomerate as Salina in age, it is quite probable that the Shawangunk in this portion of the State is much later than has been generally supposed. Recent studies indicate that the Shawangunk represents the invading basal member of the Salina series.

Poxino Island shale

This is the term applied to irregular bedded, buff colored, calcareous beds which are exposed just across the New York State line in the Nearpass section in New Jersey and farther south. At the Nearpass section they are but obscurely shown for a thickness of 1 foot, and they here form the lowest member

[1] Geol. N. Y. 1st Dist. 1843. p. 353, 354.

that can be observed in the Nearpass section. These shales have not been identified with certainty in New York State. Near Cuddebackville a few miles north from Port Jervis, somewhat similar shales, but containing iron pyrites, have been observed. They hold a position below the Decker Ferry formation, but the contact with the Decker Ferry could not be observed. The shales below the Decker Ferry as recognized at Accord have a somewhat similar appearance to the Poxino Island shale. In this section the Bossardville limestone which lies between the Poxino Island shale and the Decker Ferry formation could not be observed. It is probable, however, that the Bossardville limestone has failed by thinning out before this section is reached. The age of the Poxino Island shales has as yet not been definitely established, but they probably belong to the Salina.

Bossardville limestone

No outcrop of this formation has been recognized in New York State, though it probably extends from New Jersey into Ulster county. At the Nearpass section, 3 miles south of Port Jervis, its entire thickness is shown to be slightly more than 12 feet. It directly overlies the Poxino Island shale and in lithologic features it much resembles some thin banded layers of the Manlius limestone. This is the lowest member of the Ontaric formation in this section that is fossiliferous, but even this is only sparingly so. Leperditia altoides Weller is found quite abundantly in several of the thin layers in the upper 2 feet of the limestone. Besides the Leperditia a single individual of the genus Oncoceras was found. This species is in some respects similar to O. ovoides Hall, but is smaller and probably a distinct species. The Bossardville limestone is regarded by the writer as a late representative of Salina time.

Decker Ferry formation

The term Decker Ferry formation as recently applied by Weller in the New Jersey section includes all the strata between the Bossardville limestone and the Rondout waterlime. The upper 6 feet of the formation as described by Weller may, however, be definitely correlated with the Cobleskill limestone, as typically developed in Schoharie county. The lower part of the formation is the equivalent of what has been termed Salina waterline and Wilbur limestone in a previous report.[1]

FOSSILIFEROUS SECTIONS

The following fossiliferous sections extending from the well known locality of the Decker Ferry formation, as exposed 3 miles south of Port Jervis, and extending northeastward into Ulster county will serve to show the stratigraphic relations of the fossiliferous beds up to the Coeymans limestone.

Nearpass section 3 miles south from Port Jervis N. Y.

1 **Poxino Island shale.** In an excavation a little distance above the base of the cliff there is an exposure of a bed of buff shale 1 foot in thickness. This exposure is being rapidly covered by talus. No fossils.

2 **Bossardville limestone.** Thin banded limestone of alternate light and dark colored laminae. On account of the shaly nature of the rock, the entire thickness of slightly more than 12 feet can be readily examined; Leperditia altoides Weller found abundantly in layers near top; Oncoceras cf. ovoides Hall the only other fossil observed.

3 **Decker Ferry.** The lower 24 feet of this formation consists of several layers of hard crystalline limestone with some shaly beds. This portion of the section is highly fossiliferous and from the specially characteristic fossil Chonetes jerseyensis Weller, it has been designated the Chonetes jerseyensis zone. Though found in the other zones of the Decker Ferry formation and rarely in the Cobleskill limestone of Schoharie county, Atrypa reticularis Linn. is very abundant in the lower portion of the Decker Ferry, and farther north in Ulster county it is so plentiful as to make a distinct band in the Wilbur limestone.

4 **Decker Ferry.** Red crystalline limestone 2 feet. This layer is characterized by the species described by Weller as Ptilo-

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[1] N. Y. State Paleontol. An. Rep't 1903, p. 1142.

dictya frondosa and is designated as the Ptilodictya frondosa zone. This limestone by reason of its distinctive lithologic and faunal features can not be confused with any other bed. No outcrop of this rock has been observed in New York.

5 **Decker Ferry.** The 15 feet of limestones and shales lying above the red crystalline limestone have no characteristic fossil to mark it as a distinct zone. Rhynchonella? lamellata occurs abundantly, but this fossil has a considerable vertical range and in some sections extends up into the Rondout. This zone may be regarded as transitional into the Cobleskill limestone. Its stratigraphic position is that of the lower cement bed of the Rondout section, but in the Nearpass section there are no cement beds.

6 **Cobleskill formation.** Six feet of limestone characterized by an abundance of corals, such as Prismatophyllum inequalis Hall, Halysites catenulatus Linné. This zone by reason of similarity in lithologic features and fossil contents may be definitely correlated with the Cobleskill limestone of Schoharie county where it is typically developed, with a thickness of 6 feet.

7 **Cobleskill formation?** Above the 6 feet of limestone designated the Cobleskill there are 4 feet of limestone in thin beds separated by shaly layers. Though containing Cobleskill fossils, the abundance of ostracodes present indicates a change in the nature of sedimentation, due perhaps to the introduction of brackish water conditions which lasted throughout Rondout time.

8 **Rondout formation.** Above the Cobleskill limestone in the Nearpass quarry section there are 39 feet of shales and limestones. In general lithologic features this formation resembles the Rondout as developed in New York State, but the cement bed so characteristic at the base of the formation farther north is absent here. With the exception of several species of Leperditia, fossils are extremely rare. Future studies may show that the 4 feet of limestones and shales at the base of this formation and which have been provisionally included with the Cobleskill belong to the Rondout.

9 **Manlius limestone.** This formation which is nearly 35 feet thick carries a typical Manlius limestone fauna. The fossils in some cases are not well preserved. This is specially true of Tentaculites gyracanthus Eaton, of which well preserved specimens are rare. From the Nearpass section, however, on the reverse side of a thin slab collected for specimens of Megambonia aviculoidea Hall, there was found Tentaculites gyracanthus equally as abundant as in the sections farther north in New York State. They are however in a very poor state of preservation and may readily be passed unnoticed.

ORANGE COUNTY SECTIONS

In the section a short distance southeast of Port Jervis at Carpenters Point neither the Cobleskill nor the Decker Ferry formations can be observed, though several members of the Helderbergian are shown at this locality. About 2 miles farther north from Carpenters Point the Erie Railroad crosses these formations but they are all too deeply covered to show any outcrops.

The best place in Orange county for the examination of the Cobleskill and Decker Ferry formations is in the valley of the Neversink about 8 miles north of Port Jervis and 1 mile east of Cuddebackville. Here there are a number of parallel ridges which include not only the Cobleskill and Decker Ferry formations, but the Rondout and Manlius together with the Helderbergian members of the Devonic.

About 1 mile southeast from Cuddebackville there is an old quarry with a limekiln near by. The beds here are nearly vertical, and just to the east of the quarry the Cobleskill together with the upper part of the Decker Ferry formation is shown. The rock is here much sheared and is traversed by mineral veins. This outcrop of the Cobleskill and others in the vicinity of the same horizon are noted by Ries[1] and are included by him with the Tentaculite (Manlius) limestone. The lower part of this outcrop is not favorable for collecting but in the upper part

[1] N. Y. State Geol. 15th An. Rep't. 1898. p. 430, 433.

of the Cobleskill limestone close to the face of the quarry the following species were obtained.

1 Prismalophyllum inequalis *Hall*
2 Cyathophyllum *cf.* hydraulicum *Simpson*
3 Favosites helderbergiae *var.* praecedens *Schuchert*
4 Atrypa reticularis *Linné*
5 Camarotoechia litchfieldensis *Schuchert*
6 Leptaena rhomboidalis *Wilck.*
7 Orthothetes interstriatus *Hall*
8 Rhynchonella ? lamellata *Hall*
9 Stropheodonta bipartita *Hall*
10 Whitfieldella nucleolata *Hall*
11 Pleurotomaria ? *cf.* subdepressa *Hall*
12 Calymmene *cf.* pachydermatus *Barrett*
13 Dalmanites *sp.*
14 Leperditia *cf.* jonesi *Hall*

At this locality specimens of Leptaena rhomboidalis are plentiful and unusually well preserved. At the top of the Cobleskill in the portion that is transitional into the Rondout there are found thin bands of limestones separated by shaly partings. The shaly layers weather to a drab color and are easily removed from the face of the quarry. These thin layers contain quite abundantly Orthothetes interstriatus Hall and Leperditia scalaris Jones. The limestone bands are crowded with Whitfieldella sulcata Van. and Spirifer vanuxemi Hall. Orthothetes interstriatus Hall and Leperditia scalaris Jones are also found in the limestone bands. In the Nearpass section south of Port Jervis at the top of the Cobleskill there are found similar limestone bands characterized by many Beyrichias of which there are several species. In the latter section in these limestone bands brachiopods are also found, but Leperditia has as yet not been observed.

Northeast from this outcrop the Cobleskill and Decker Ferry formations are obscured for about a mile, but the Decker Ferry formation is again seen on the farm of Mr Cuddeback just in rear of the house. The Rondout is shown a little higher up on the ledge and the Manlius and Coeymans limestones a short distance farther to the west. A short distance to the west of the house of Mr Case and north of the outcrop back of Mr Cuddeback's house the upper part of the Decker Ferry formation is shown and the following species were obtained.

1 Favosites *sp.*
2 Atrypa reticularis *Linné*
3 Camarotoechia litchfieldensis *Schuchert*
4 Chonetes jerseyensis *Weller*
5 Leptaena rhomboidalis *Wilck.*
6 Rhynchonella ? lamellata *Hall*
7 Spirifer *sp.*
8 Stropheodonta bipartita *Hall*
9 Pterinea *cf.* emacerata *Con.*
10 Dalmanites *sp.*
11 Proetus pachydermatus *Barrett*
12 Beyrichia *sp.*

The Cobleskill limestone is obscurely exposed in the field beyond, where also were found the thin limestone bands crowded with Whitfieldella sulcata Van. and Spirifer vanuxemi Hall, and which mark the upper limit of the Cobleskill.

Passing from this station northeastward into Sullivan county no outcrops of the Cobleskill have been observed. Throughout Sullivan county there is but little opportunity for the examination of the Siluric and Helderbergian rocks. The cliffs so prominent north from Port Jervis between the Neversink river and Shawangunk mountain become low in Sullivan county and almost entirely disappear. Outcrops in the valley are but rarely seen. There is an old limekiln on the land of John Olcott a short distance north from Wurtsboro located near the outcrop of the Esopus shales. There is however no outcrop of limestone in the vicinity, the rock used for burning lime being gathered from the fields.

Just over the county line north from Spring Glen station[1] in Ulster county, there is an old quarry near the east bank of the now abandoned Delaware and Hudson canal. The rock as here exposed is a thin bedded limestone with some layers of shale and appears to belong to the lower portion of the Manlius.

Two miles southwest from Ellenville there is a small but conspicuous outcrop of Helderbergian limestones which rise above the general level of the valley. The outcrop is near Sanborn creek on the land of L. F. Hall. Lime is burnt at this place but only in small quantities. A similar outcrop is seen at John Hornbeek's quarry a short distance south of the Eastern Reformatory

[1]This outcrop and the two following are noted by Mather. Geol. N. Y. 1st Dist. 1843. p. 322-33.

at Napanoch. The presence here of Leptaenisca adnascens Hall & Clarke is indicative of the New Scotland age of these beds.

In passing northward from Ellenville the first outcrop favorable for the examination of the Cobleskill is on the land of Joseph Chipp ¼ mile north from Kerhonkson. The rock is shown in the base of an old quarry on the left of the highway leading to Accord. The locality is not favorable for collecting but the following fossils were obtained.

1 Favosites helderbergiae *var.* praecedens *Schuchert*
2 Atrypa reticularis *Linné*
3 Orthothetes interstriatus *Hall*
4 Spirifer corallinensis *Grabau*
5 S. *cf.* vanuxemi *Hall*
6 Whitfieldella nucleolata *Hall*
7 Leperditia jonesi *Hall*

The Rondout is not well shown in this section. About 16 feet of Manlius limestone is exposed in the quarry of Lincoln McConnell on the opposite side of the highway. The combined thickness of the Rondout and Manlius at this place is 70 feet.

One of the most favorable localities for the examination of the Decker Ferry and Cobleskill formations is in the cut of the recently constructed Kingston branch of the Ontario & Western Railroad, ½ mile southwest from Accord. The railroad passes in succession over the formations, from the shales underlying the Decker Ferry to the Coeymans limestone which is exposed near the station at Accord, but only the shales, the Decker Ferry and the Cobleskill are shown in the cut. The shales which are exposed in this cut are considered to be of Salina age and are exposed for a thickness of 18 feet. The beds are soft, argillaceous with bands of mineral matter and so far as known without fossils.

The Decker Ferry formation is 12 feet thick and in layers which are quite massive. The basal layer is arenaceous and gradually changes and becomes more calcareous above. The formation is fossiliferous throughout. The red crystalline limestone which forms such a conspicuous layer in the Nearpass section has not been observed here, and whether its absence is due to thinning out or failing through overlap of the succeeding deposits, in which case only the upper part of the Decker Ferry formation would be represented in this section, has not been determined. It seems probable that since the period was one of submergence, the latter view is more nearly correct, though in this section Chonetes jerseyensis, which is the characteristic fossil of the lower Decker Ferry formation in the Nearpass section, is here equally as abundant and in size averages larger. This fossil, in the cut at Accord, is sometimes so plentiful as to make a band a fraction of an inch in thickness. From the railroad cut the following species were obtained.

1 Favosites *sp.*
2 Monotrypa corrugata *Weller*
3 Rhynchonella? lamellata *Hall*
4 A. reticularis *Linné*
5 Chonetes jerseyensis *Weller*
6 Rhipidomella *cf.* preoblata *Weller*
7 Rhynchonella deckerensis *Weller*
8 R. litchfieldensis *Schuchert*
9 Spirifer *cf.* corallinensis *Grabau*
10 Spirifer *sp. undet.*
11 Stropheodonta bipartita *Hall*
12 Pterinea emacerata *Hall*

A favorable place for the collection of fossils from the basal arenaceous layer is at Fiddlers Elbow on the Delaware and Hudson canal a short distance from the railroad cut. At this place the canal is partly excavated in the shales and the limestone is found a little higher up by the canal bank. At some points the underlying shales have weathered away leaving the limestone above as a slightly projecting ledge. From the basal arenaceous layer the following species were obtained.

1 Favosites *sp.*
2 Monotrypa corrugata *Weller*
3 Atrypa reticularis *Linné*
4 Gypidula *cf.* galeata *Dalman*
5 Stropheodonta bipartita *Hall*
6 Spirifer *sp.*

At this place a number of rather poorly preserved specimens of a pentameroid were found. They approach closely Gypidula galeata of the Coeymans limestone and may prove to be identical with it.

The Cobleskill limestone is exposed a little higher near an old limekiln. The rock is here much weathered and fossils are readily obtained though not in a well preserved state. A feature of the collection from the Cobleskill obtained at this point is the large number of gastropods and cephalopods found, and the fauna is more nearly like the normal fauna of the Cobleskill of Schoharie county than at any other section that has been studied in eastern New York. Ilionia sinuata not recorded from the Cobleskill farther southwest and in the Nearpass section is quite abundant here. The following species were obtained.

1 Favosites *sp.*
2 Atrypa reticularis *Linné*
3 Rhynchonella? lamellata *Hall*
4 R. litchfieldensis *Schuchert*
5 Whitfieldella nucleolata *Hall*
6 Ilionia sinuata *Hall*
7 Bellerophon auriculatus *Hall*
8 Kionoceras darwini *Billings*
9 Orthoceras (large)
10 Leperditia jonesi *Hall*
11 Calymmene camerata *Hall*

In the railroad cut the Cobleskill is also exposed but not so favorably for collecting as in the last named locality. The thickness in the cut is about 6 feet. The contact with the Rondout could not be observed at this station. The formations exposed at Fiddlers Elbow and in the railroad cut can be readily traced to a short distance east of Accord, where they form a clearly defined cliff. The base of the cliff is mostly covered with talus and the outcrops are not favorable for collecting.

In the vicinity of Accord no beds suitable for making cement have been observed. This place is but 6 miles from High Falls where cement has been quarried from the dark Rosendale beds which at the latter place have a maximum thickness of 22 feet. It will thus be seen that the lower cement bed so extensively developed in the Rosendale region and which extends to High Falls, becomes too calcareous to be used for cement before Accord is reached. At Rosendale the lower cement bed, with the exception of Leperditia, which is sometimes found near the base, is so far as known, entirely without other fossils. When however High Falls is reached the cement bed, specially near its base, becomes fossiliferous. From the cement rock at this place some corals, Atrypa reticularis Linné, Ilionia sinuata Hall, and Nucleospira cf. ventricosa Hall have been obtained. The Cobleskill can be readily recognized near the brink of the falls on both sides of the stream. The cement bed is about 14 feet thick, and at its base and resting on the quartzites below, is a fossiliferous band of shaly limestone 4 to 10 inches thick, in a previous report[1] referred to the Wilbur limestone, which in the type section, as at High Falls, underlies

[1] N. Y. State Paleontol. An. Rep't. 1903. p.1146.

the lower cement bed. A good view of the falls is given by Darton[1] in his report on the Geology of Ulster county. At High Falls the thin layer above referred to contains unmistakable Decker Ferry species, the most characteristic of which is Monotrypa corrugata Weller. The fauna obtained follows:

1 Favosites *sp.*
2 Monotrypa corrugata *Weller*
3 Atrypa reticularis *Linné*
4 Pterinea emacerata *Conrad*
5 Orbiculoidea *cf.* tenuilamellata *Hall*
6 Orthoceras *sp. undet.*

The study of the sections at High Falls and Accord and a comparison of them with the sections farther south indicate quite clearly that the lower cement bed at Rosendale and the lower cement bed and Wilbur limestone at High Falls are of the same age as the Decker Ferry formation as developed to the southwest of these localities. It is also believed that the cement bed which holds the stratigraphic position of the Bertie waterlime of western New York is of the same relative age as the latter, both underlying the Cobleskill limestone. In western New York the Bertie limestone is characterized by an Eurypterus fauna. The absence of Eurypterus from the formation in eastern New York is attributed to the fact that this section of the State belonged to another sea-province. We therefore propose to meet this difference in the east by introducing for the lower cement bed in Ulster and adjoining counties the term Rosendale cement. The transition to the Cobleskill from the underlying fossiliferous beds in eastern New York has been shown. In western New York the transitional features are somewhat more complex and obscure. Still enough is known to show an intimate relationship between the Cobleskill and Bertie formations.

In the Eurypterus-bearing waterlime beds of western New York (Bertie) Cobleskill fossils are rarely found associated with Eurypterus. However Orthothetes interstriatus Hall and Leperditia scalaris Jones are occasionally found on the same slab with Eurypterus. In beds which are strictly referable to the Cobleskill and which contain Cobleskill fossils the writer has never found an Eurypterus. The condi-

[1]N. Y. State Geol. 13th An. Rep't. 1894. pl. 10 facing p.342.

tions however which are found and which show the intimate relation of the two formations are as follows.

In western New York usually underlying the Oriskany sandstone is found the Cobleskill dolomite which at Buffalo, Dr Grabau[1] has shown, contains a fauna similar to the Cobleskill and which later studies have shown to be identical with the Cobleskill. In Ontario county at Phelps below the Oriskany sandstone is found the Cobleskill or "bullhead" rock as it is known in western New York. This rock here and farther west at Victor and beyond, contains the Cobleskill fauna. Beneath the "bullhead" rock in Ontario county in a thin bed of waterlime, fragments of Eurypterus are found and at Victor a large number of fragments from this horizon were obtained. Beneath this layer of waterlime in Ontario county we find again in the dolomite layer another Cobleskill or "bullhead" fauna in which Lichas ptyonurus Hall is found and Cyathophyllum hydraulicum Simpson is quite abundant. Beneath this second dolomite layer containing Cobleskill fossils, waterlime beds again occur in which Eurypterus are found.

From the above conditions it would appear that while the Decker Ferry fauna was living in eastern New York the Eurypterus fauna was still to be found in the Salina sea in the western part of the State, and that there were invasions from the eastern sea which at first were only temporary, but which finally caused the retreat or destruction of the Eurypterus fauna.

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[1]Geol. Soc. Am. Bul. 1900. 11:363.

TABLE SHOWING RELATIONS OF THE ONTARIC OR SILURIC SECTIONS OF NEW YORK AS DEVELOPED ON BOTH SIDES OF THE HELDERBERG

MISSISSIPPIAN SEA				HELDERBERG	CUMBERLAND BASIN		
Buffalo	Ontario county	Herkimer county	Schoharie county	Albany county	Rondout	High Falls	Port Jervis
Oriskany	Oriskany	Coeymans	Coeymans	Coeymans	Coeymans	Coeymans	Coeymans
		Manlius	Manlius	Manlius	Manlius	Manlius	Manlius
		Rondout	Rondout	Rondout	Rondout	Rondout	Rondout
Cobleskill	Cobleskill	Cobleskill	Cobleskill		Cobleskill	Cobleskill	Cobleskill
Salina	Salina	Salina	Salina		Salina	Salina	Salina
Bertie	Bertie	Bertie			Rosendale	Rosendale	
Camillus	Camillus	Camillus			Wilbur	Wilbur	Decker Ferry
	Syracuse					Binnewater quartzites	Bossardville
							Poxino Island
						High Falls shales	High Falls shales?
Vernon	Vernon	Vernon					
Pittsford (?)	Pittsford						
Guelph	Guelph						
Lockport	Lockport	Lockport					
Rochester	Rochester	Rochester ?				Shawangunk	Shawangunk
Clinton	Clinton	Clinton					
Medina	Medina	Medina					
Oswego	Oswego	Oneida					
Lorraine	Lorraine	Lorraine	Lorraine	Lorraine	Normanskill ?	Normanskill ?	Normanskill ?

EXPLANATION OF PLATES

PLATE 1

Carabocrinus geometricus sp. nov.

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1 View from posterior interradius. x4

2 View of tegmen showing the straight line on which the radials meet and the acute angle at both ends as if for the insertion of a triangular deltoid. The angles in the figure are not all as acute as in the specimen. x4

Malocystites emmonsi sp. nov.

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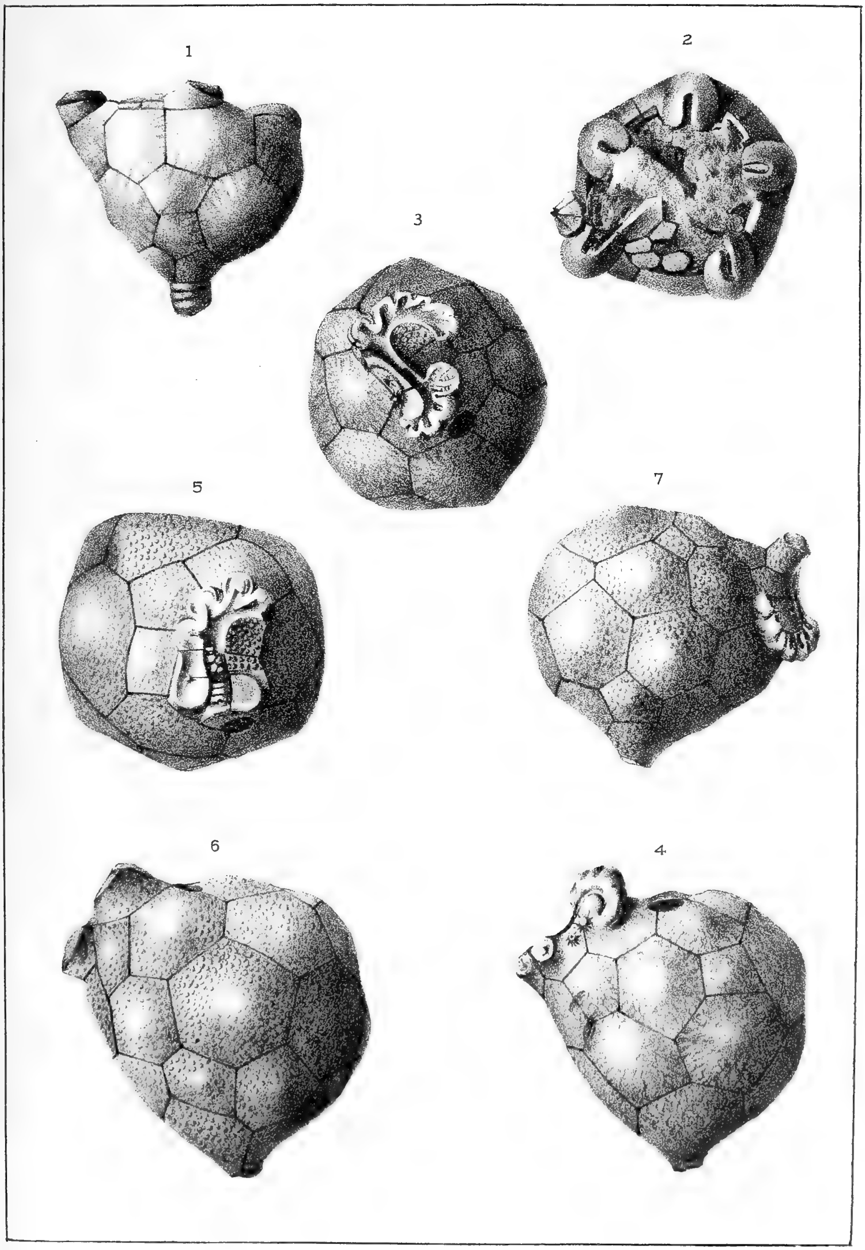
3, 4 Oral and side views of specimen A, the type. Figure 4 shows clearly the position of the genital pore and madreporite. The axis used in the description is here the vertical axis of the figure x4

5, 6 Oral and side views of specimen B. x4

7 Specimen C, a form with the sigma much nearer the stem. x4

Rep Paleontologist 1903 | Plate 1.



G. S. Barkentin. del. W. S. Barkentin. lith.

PLATE 2

Rhaphanocrinus gemmeus sp. nov.

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1 View of base. x4

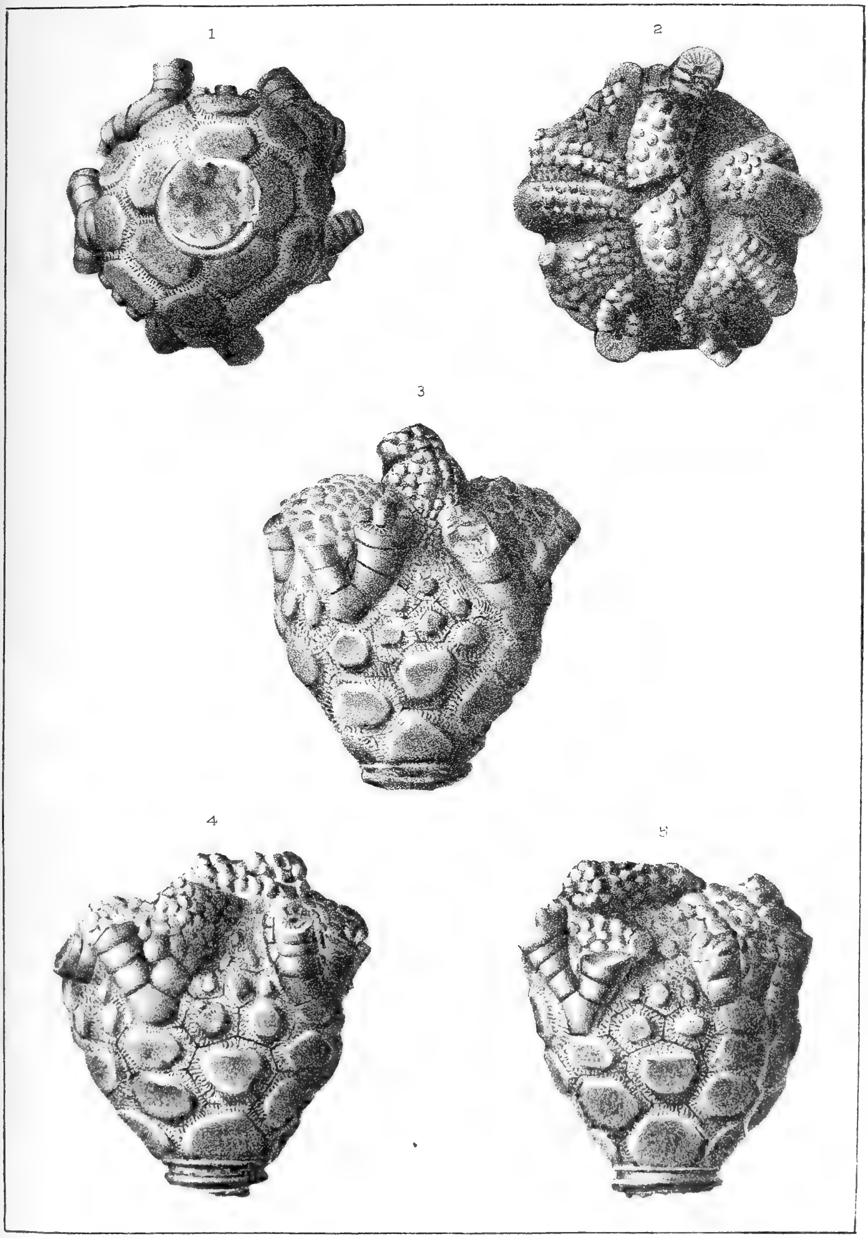
2 View of oral surface with anal tube

3 View of posterior interradius. x4

4 View of right posterior interradius. x4

5 View of left anterior interradius. x4

Rep Paleontologist 1903 Plate 2



G S Barkentin del W S Barkentin lith

PLATE 3

Lyriocrinus beecheri sp. nov.

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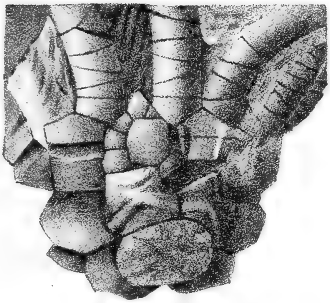
1 View with the vertical interradius of figure 4 (text) a little to the left. x4

2 View showing lower left interradius of figure 4 (text). x4

3 View of base showing in part the plate ridges. x4

CHAZY FOSSILS

2



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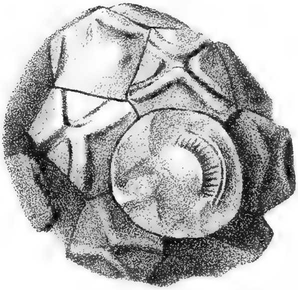

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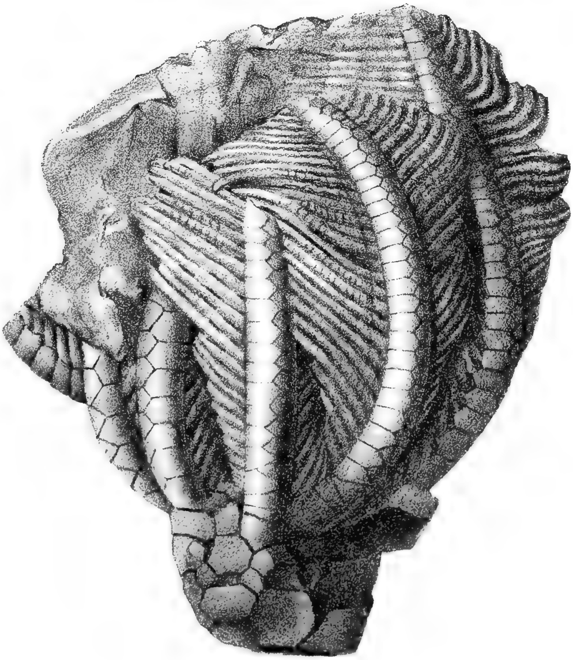

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PLATE 4

Subulites raymondi sp. nov.

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1, 2 Views of the type specimen. x4

Holopea microclathrata sp. nov.

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3 View of the type specimen. x4

4 A portion of body whorl of same. x12

Eunema historicum sp. nov.

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5 View of the only specimen found. x4

Eunema epitome sp. nov.

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6, 7 Different views of the only specimen found. x4

Modiolopsis subquadrilateralis sp. nov.

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8, 9 Different views of the type specimen. x4

Cyrtodonta? lamellosa sp. nov.

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10 View of left side of type specimen. x3

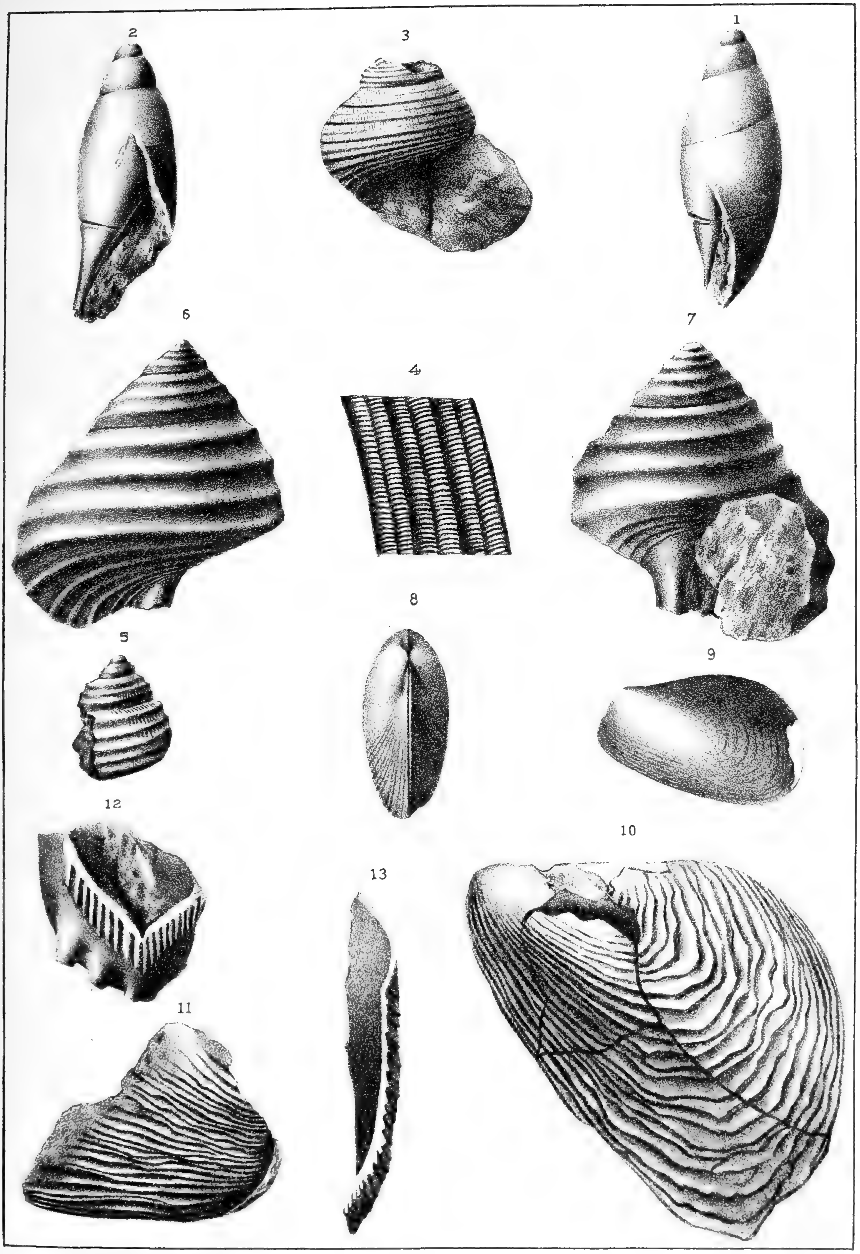
11 Anterior portion of shell of same specimen, viewed from right side. x4

12 View of broken edges of the valves about the middle of the ventral margin to show the relative size and arrangement of the lamellae. The right valve here incrusted by a bryozoan. x4

13 Fractured margin of valve showing thickening as posterior margin is approached. x4

CHAZY FOSSILS

Rep Paleontologist 1903 Plate 4



G S. Barkentin. del. W. S. Barkentin lith.

PLATE 5

Cheirurus mars sp. nov.

Page 293

1, 2 Views of the type specimen. x2

Eunema altisulcatum sp. nov.

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3 View of the type specimen. x4

Straparollina harpa sp. nov.

Page 292

4, 5 Views of two specimens. x4

Schizambon duplicimuratus sp. nov.

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6, 7 Pedicle valves of two specimens. x4

Syntrophia multicosta sp. nov.

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11, 12 Two views of the type specimen. x2

8–10, 14 Different views of the pedicle valve of another specimen. x2

13, 15 External and internal views of different brachial valves. x2

CHAZY FOSSILS

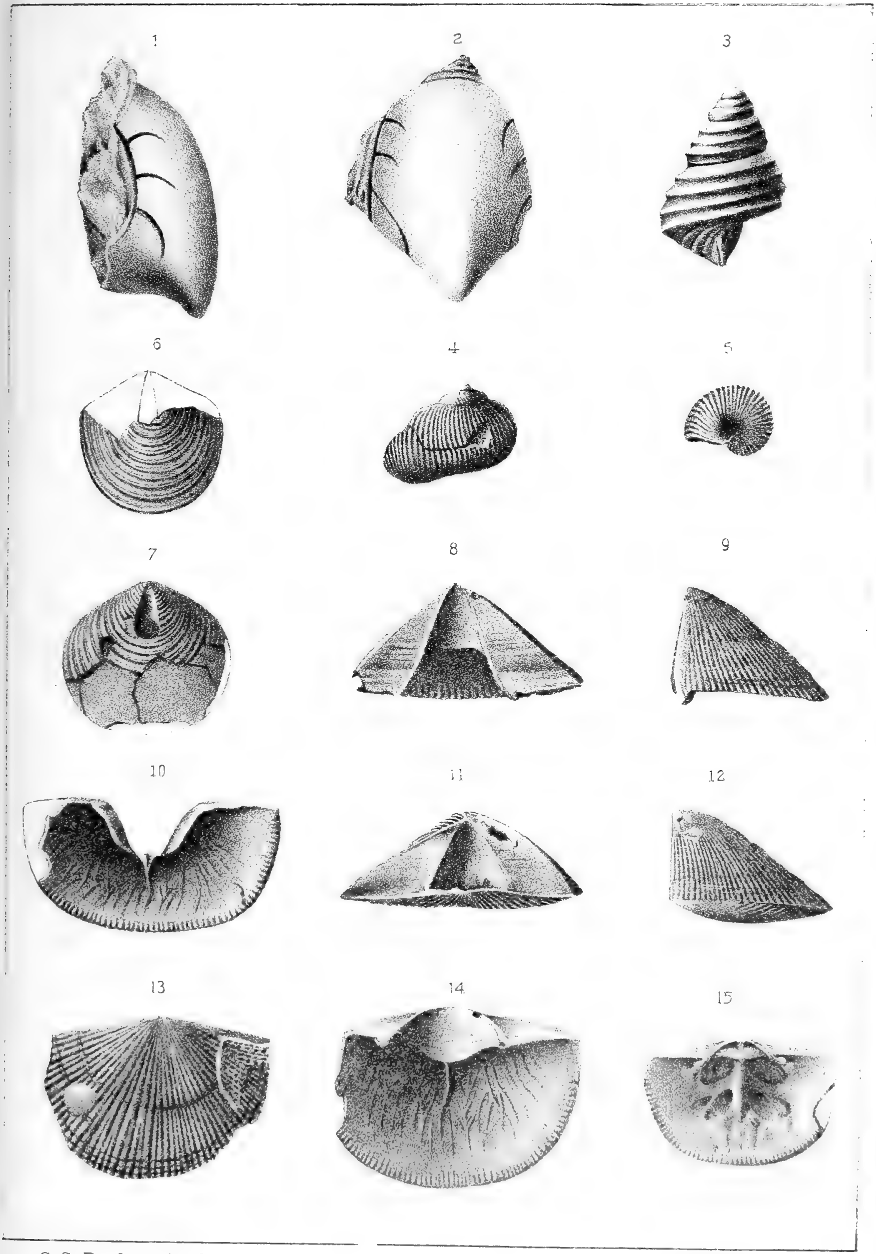

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PLATE 6

Cameroceras (Proterocameroceras) brainerdi Whitfield (sp.)

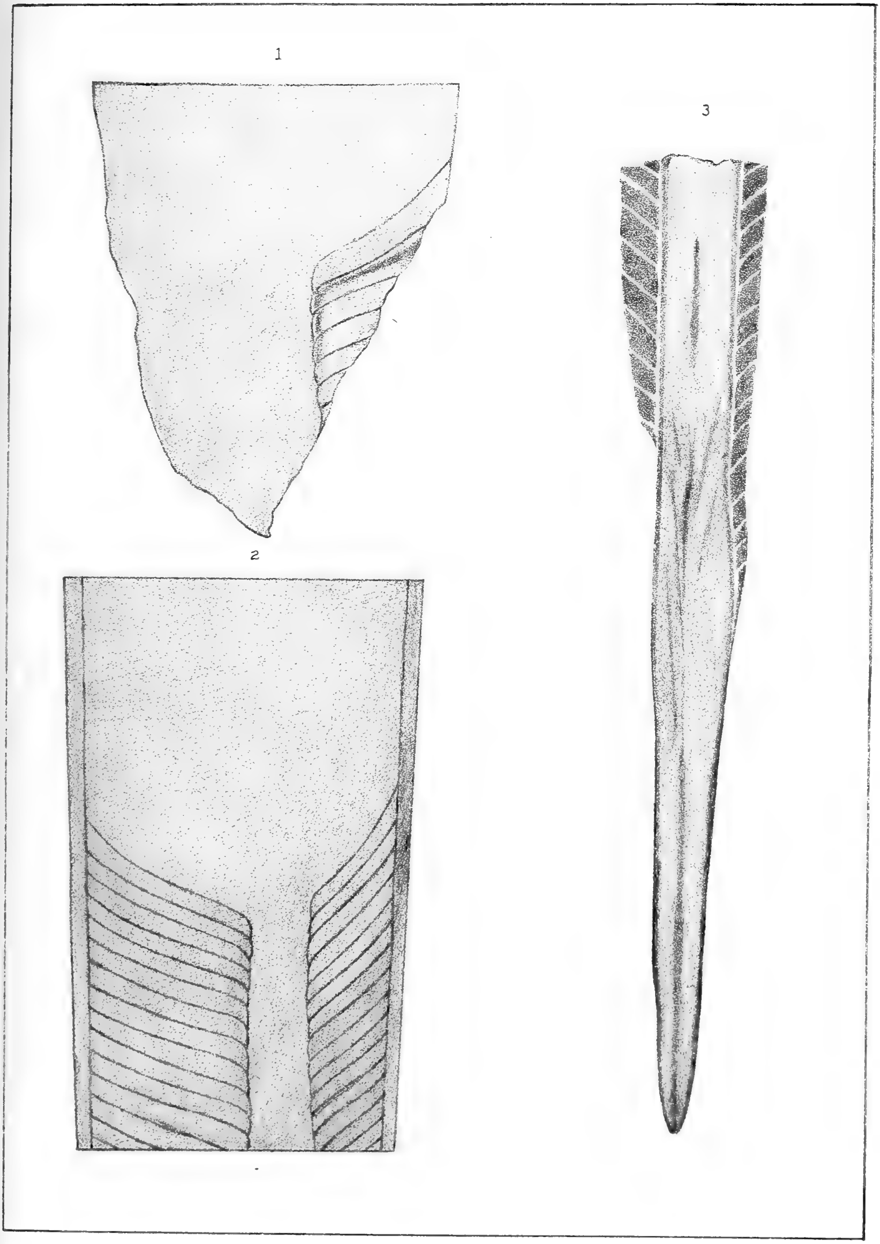
1 Natural section of fragment showing the passage of the siphuncle into the living chamber and the absence of the endosipholining in the anterior part of the siphuncle (endosiphocylinder). Natural size

2 Natural (slightly oblique) section through posterior part of living chamber and anterior part of the endosiphocylinder, showing the structure of the ectosiphuncle (length of septal necks and absence of endosipholining). Natural size

3 Natural section of nepionic bulb and posterior part of phragmocone, showing the length and form of the nepionic bulb, the slight constriction at the beginning of the phragmocone (where on the right side the first four small septa are left out in the drawing); the cicatrix at the apical end, the endosipholining, the endosiphotube and some of the endosiphosheaths. Natural size

Originals from the Beekmantown limestone at Valcour N. Y.

Rep Paleontologist 1903 Plate 6



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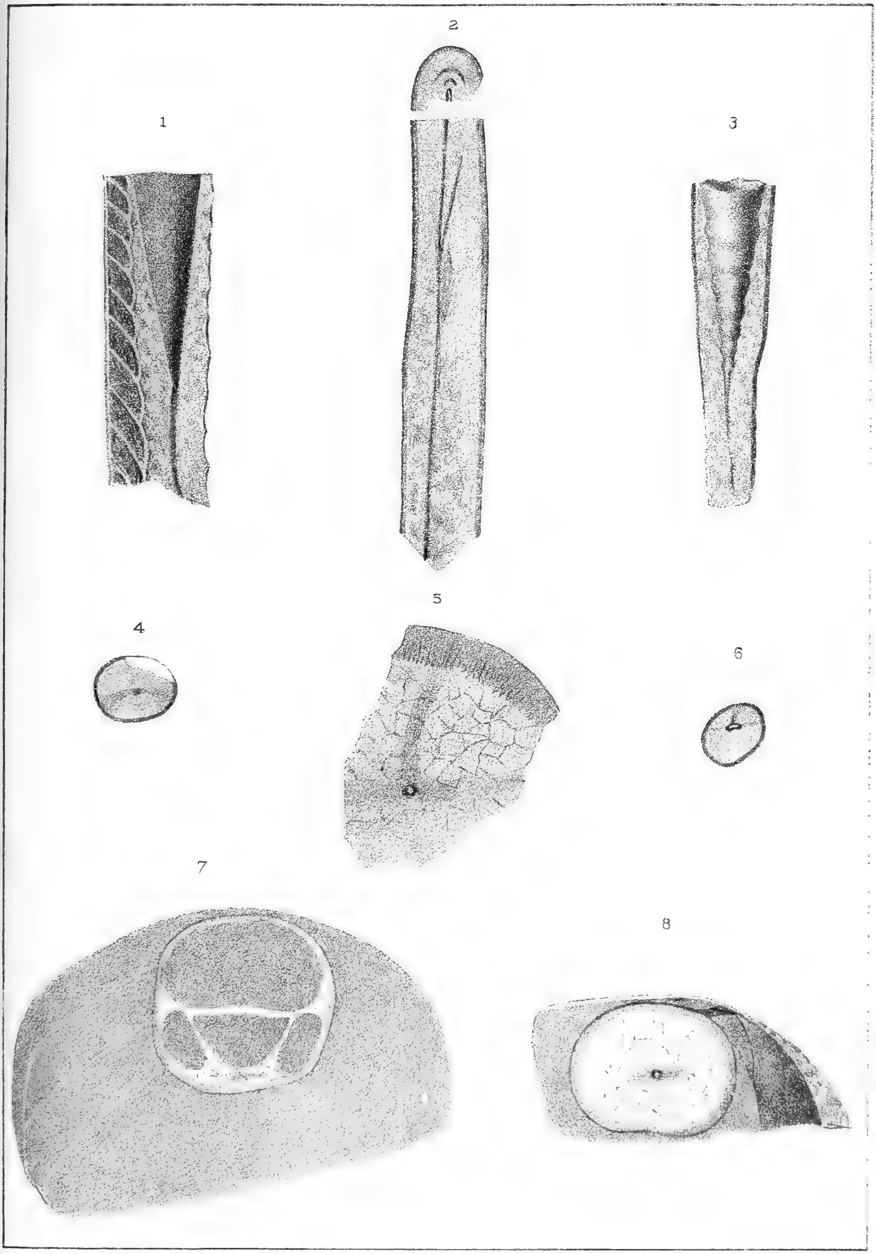

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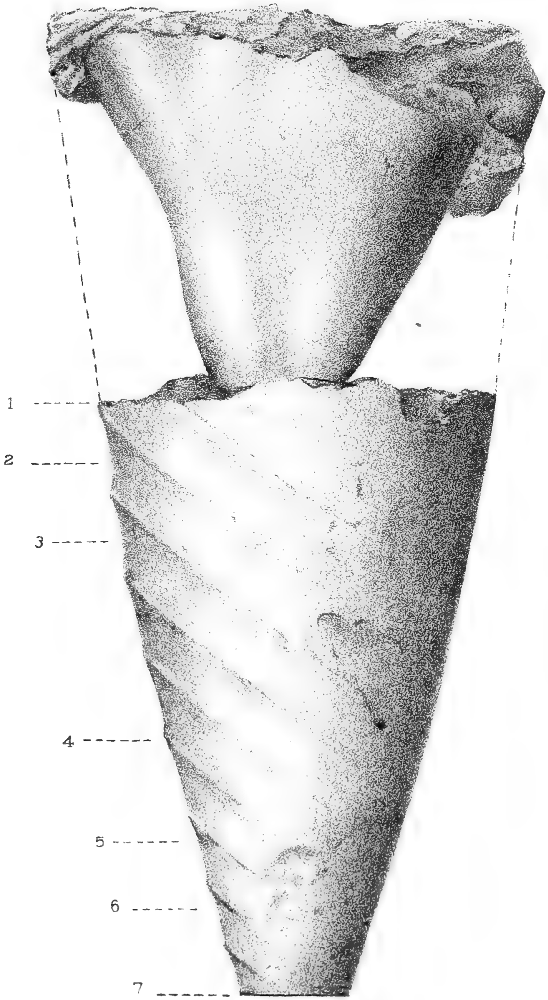
PLATE 10

Piloceras explanator Whitfield

A nearly complete siphuncle showing above a cast of the endosiphocone covered by the last endosiphosheath [*see* pl.13, fig.1] and below the exterior of the siphuncle with the very obliquely passing fracture lines of the septa along their flexures in the endosiphuncle. The numbers correspond to the sections made through this siphuncle and reproduced on plate 11. Natural size

The original from the Beekmantown beds at Fort Cassin Vt. (collected by C. Rominger 1888)

CEPHALOPODS



G. S. Barkentin. del. W. S. Barkentin. lith.

PLATE 11

Piloceras explanator Whitfield

1–7 Transverse sections through the siphuncle, figured on plate 10. Natural size

1 Showing the more distant earlier endosiphosheaths and more closely arranged last endosiphosheaths (of adult individual) and the endosiphofunicles.

2 The small flat endosiphocoleon in the center and a well developed system of endosiphofunicles extending from the first endosiphosheath to the outer wall. At the right hand side an endosiphofunicle, which is branching several times in outward direction (enlarged on plate 12, figure 1).

3 Shows another distinctly branching endosiphofunicle on upper side (enlarged on plate 12, figure 2), which well exhibits the relation of the endosiphosheaths to the endosiphofunicle.

4–6 Show the decrease in the number of endosiphosheaths (by resorption or alteration in calcite?) and of the endosiphofunicles in apical direction.

4 This section shows at the lower right hand side an endosiphofunicle which distinctly passes through an endosiphosheath that is bent outward at the point of intersection (enlarged on plate 12, figure 4).

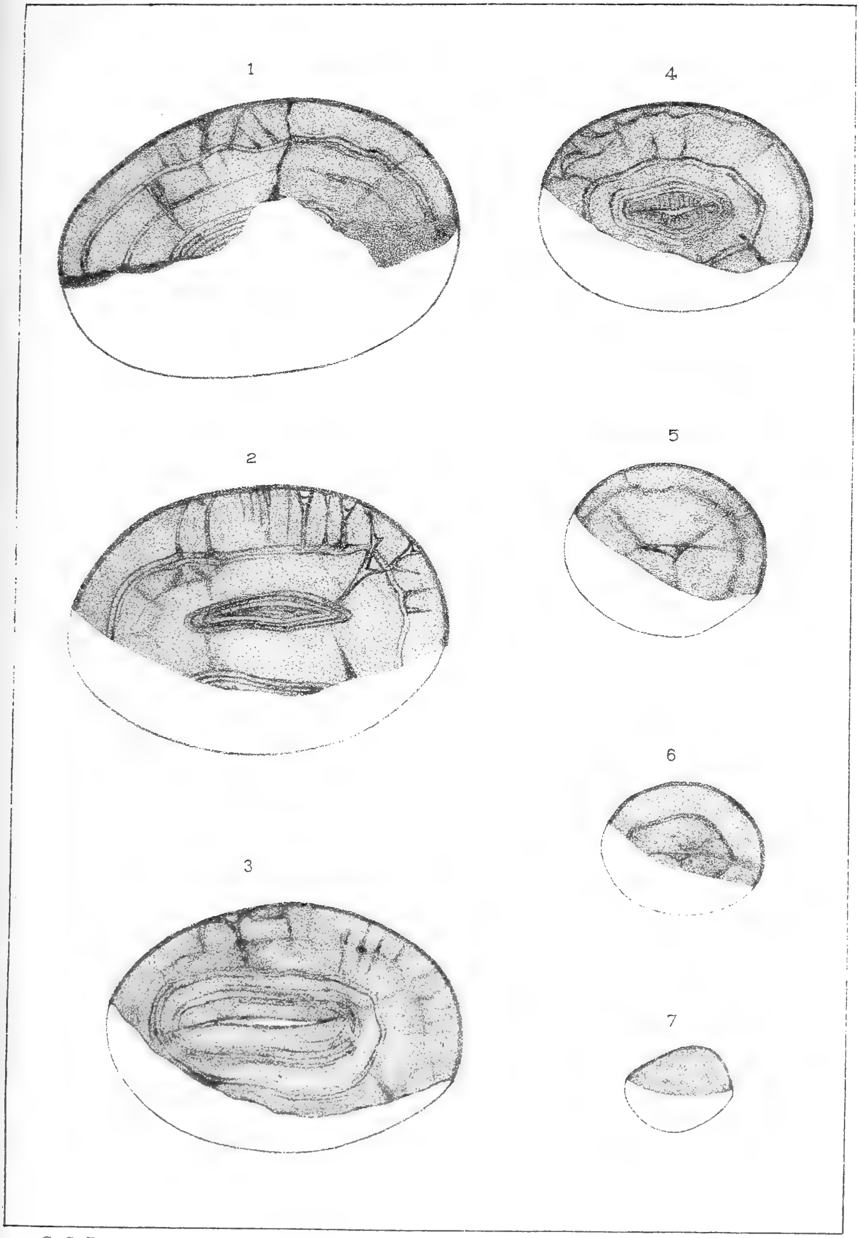
5, 6 Endosiphofunicles springing here principally from the corners of the endosiphocoleon.

7 The endosiphocoleon is not any longer shown since the center of the siphuncle is here worn away.

Originals from the Beekmantown beds at Fort Cassin Vt.

CEPHALOPODS

Rep Paleontologist 1903 Plate 11



G. S. Barkentin. del.

W. S. Barkentin lith.

INDEX

Page numbers referring to descriptions of fossils are printed in black face type. The superior figures tell the exact place on the page in ninths, e. g. 188^{3} means page 188, beginning in the third ninth of the page, i. e. about one third of the way down.

New York State Education Department

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Museum annual reports 1847-date. *All in print to 1892, 50c a volume, 75c in cloth; 1892-date, 75c, cloth.*

These reports are made up of the reports of the director, geologist, paleontologist, botanist and entomologist, and museum bulletins and memoirs, issued as advance sections of the reports.

Geologist's annual reports 1881-date. Rep'ts 1, 3-13, 17-date, O; 2, 14-16, Q.

The annual reports of the early natural history survey, 1837-41, are out of print.

Reports 1-4, 1881-84, were published only in separate form. Of the 5th report 4 pages were reprinted in the 39th museum report, and a supplement to the 6th report was included in the 40th museum report. The 7th and subsequent reports are included in the 41st and following museum reports, except that certain lithographic plates in the 11th report (1891) and 13th (1893) are omitted from the 45th and 47th museum reports.

Separate volumes of the following only are available.

Report	*Price*	*Report*	*Price*	*Report*	*Price*
12 (1892)	$.50	17	$.75	21	$.40
14	.75	18	.75	22	.40
15, 2v.	2	19	.40	23	*In press*
16	1	20	.50		

In 1898 the paleontologic work of the State was made distinct from the geologic and will hereafter be reported separately. The two departments were reunited in 1904.

Paleontologist's annual reports 1899-date.

See fourth note under Geologist's annual reports.

Bound also with museum reports of which they form a part. Reports for 1899 and 1900 may be had for 20c each. Since 1901 these reports have been issued as bulletins.

Entomologist's annual reports on the injurious and other insects of the State of New York 1882-date.

Reports 3-19 bound also with museum reports 40-46, 48-57 of which they form a part. Since 1898 these reports have been issued as bulletins. Reports 3-4 are out of print, other reports with prices are:

Report	*Price*	*Report*	*Price*	*Report*	*Price*
1	$.50	9	$.25	15 (En. 9)	$.15
2	.30	10	.35	16 (" 10)	.25
5	.25	11	.25	17 (" 14)	.30
6	.15	12	.25	18 (" 17)	.20
7	.20	13	.10	19 (" 21)	.15
8	.25	14 (En 5)	.20		

Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867-date.

Bound also with museum reports 21-date of which they form a part; the first botanist's report appeared in the 21st museum report and is numbered 21. Reports 21-24, 29, 31-41 were not published separately.

Separate reports 25-28, 30, 42-50 and 52 (Botany bulletin 3), are out of print. Report 51 may be had for 40c; 53 for 20c; 54 for 50c. Since the 55th these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st, 52d, 54th and 55th reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887-date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division:* (1) *geology, economic geology, mineralogy, general zoology, archeology and miscellaneous,* (2) *paleontology,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
G 1	48, v.1	Pa 1	54, v.1	En 7-9	53, v.1	Ar 3	52, v.1
2	51, v.1	2, 3	" v.3	10	54, v.2	4	54, v.1
3	52, v.1	4	" v.4	11	" v.3	5	" v.3
4	54, v.4	5, 6	55, v.1	12, 13	" v.4	6	55, v.1
5	56, v.1	7-9	56, v.2	14	55, v.1	7	56, v.4
Eg 5, 6	48, v.1	Z 3	53, v.1	15-18	56, v.3	Ms 1, 2	" v.4
7	50, v.1	4	54, v.1	Bo 3	52, v.1		
8	53, v.1	5-7	" v.3	4	53, v.1	Memoir	
9	54, v.2	8	55, v.1	5	55, v.1	2	49, v.3
10	" v.3	9	56, v.3	6	56, v.4	3, 4	53, v.2
11	56, v.1	En 3	48, v.1	Ar 1	50, v.1		
M 2	" v.1	4-6	52, v.1	2	51, v.1		

The figures in parenthesis indicate the bulletin's number as a New York State Museum bulletin.

Geology. G1 (14) Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. 7pl. 2 maps. Sep. 1895. *10c.*

G2 (19) Merrill, F: J. H. Guide to the Study of the Geological Collections of the New York State Museum. 162p. 119pl. map. Nov. 1898. [*50c*] *New edition in preparation.*

G3 (21) Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sep. 1898. *5c.*

G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. *25c.*

G5 (56) Merrill, F: J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Oct. 1902. *10c.*

G6 (77) Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. 98p. il. 15pl. 2 maps. Jan. 1905. *30c.*

Woodworth, J. B. Pleistocene Geology of the Mooers Quadrangle. *In press.*

——— Ancient Water Levels of the Champlain and Hudson Valleys. *In press.*

Cushing, H. P. Crystalline Rocks of the Northeastern Adirondacks. *In press.*

Ogilvie, I. H. Geology of the Paradox Lake Quadrangle. *In press.*

Kemp, J. F. Crystalline Rocks of Warren and Washington Counties. *In preparation.*

Woodworth, J. B. Glacial Geology of New York. *In preparation.*

Economic geology. Eg1 (3) Smock, J: C. Building Stone in the State of New York. 152p. Mar. 1888. *Out of print.*

Eg2 (7) —— First Report on the Iron Mines and Iron Ore Districts in the State of New York. 6+70p. map. June 1889. *Out of print.*

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