MARYLAND
GEOLOGICAL
SURVEY

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LETTER OF TRANSMITTAL

To His Excellency PHILLIPS LEE GOLDSBOROUGH,

Governor of Maryland and President of the Geological Survey Commission,

Sir:—I have the honor to present herewith the fifth volume of a series of reports dealing with the systematic geology and paleontology of Maryland. The preceding volumes have dealt with the Eocene, Miocene, Pliocene and Pleistocene, and Lower Cretaceous deposits and the remains of animal and plant life which they contain. The present volume treats of the Lower Devonian deposits and their contained life, a knowledge of which is very important from an educational and scientific standpoint. I am, Very respectfully,

WM. BULLOCK CLARK,
State Geologist.

JOHNS HOPKINS UNIVERSITY,
BALTIMORE, *January*, 1913.

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ILLUSTRATIONS

PREFACE

The present volume is the fifth of a series of reports dealing with the systematic geology and paleontology of Maryland, the Lower Cretaceous, Eocene, Miocene, and Plio-Pleistocene deposits having already been fully described.

The present volume is devoted to a consideration of the Lower Devonian deposits and their contained faunas. The Devonian rocks are represented in western Maryland by a very thick series of limestones, sandstones, and shales, often containing abundant remains of the marine life that flourished at the time they were deposited in the varying seas that covered the present site of the Alleghanies.

The discussion of the Lower Devonian is the combined work of a number of individuals, most of whom are specialists in their respective fields of research. It also embodies the results of dissertations submitted to the Johns Hopkins University by Dr. R. B. Rowe, since deceased, by Dr. D. W. Ohern, now State Geologist of Oklahoma, and by Dr. T. P. Maynard, formerly Assistant State Geologist of Georgia.

Dr. Charles Schuchert of Yale University has contributed a chapter on Devonian Geography and the systematic parts treating of the Lower Devonian Echinodermata and most of the Brachiopoda.

Dr. Charles S. Prosser of the Ohio State University has prepared the historical review and bibliography.

Dr. Charles K. Swartz of the Johns Hopkins University has revised the stratigraphic results of the various contributors both in the field and in the office. He has edited the work of the different authors and has written the chapter on correlation, as well as the systematic account of the Cœlenterata.

The Maryland Geological Survey has had the benefit of the cooperation of the United States Geological Survey. Mr. George W. Stose of that organization has cooperated in the field work, and also furnished several of the photographs used in the present volume.

Especial acknowledgment is due to Dr. John M. Clarke, Director of the New York State Geological Survey, not only for advice and assistance, but for the use of a large number of drawings first employed in the classic volumes on the Paleontology of New York.

The authors are also greatly indebted to Dr. Edward O. Ulrich of the United States Geological Survey for his constant interest in the progress of the work and his very material assistance in connection with many disputed points in the discussion. Dr. Ulrich and Dr. R. S. Bassler, of the United States National Museum, have also prepared the systematic portions relating to the Bryozoa and Ostracoda.

INTRODUCTION

BY

C. K. SWARTZ

CHARLES SCHUCHERT

AND

CHARLES S. PROSSER

A. Hoen & Co. Lith. Baltimore, Md.

INTRODUCTION

BY

C. K. SWARTZ, CHARLES SCHUCHERT, AND CHAS. S. PROSSER

GENERAL RELATIONS OF THE DEVONIAN [1]

Murchison, eminent among the early students of the geology of Great Britain, recognized a series of strata in western England rich in remains of marine life, to which he applied the name Silurian System. These beds are succeeded by others, red in color, continental in origin, and characterized by a fauna comprising many species of fishes and eurypterids, the latter being primitive Arthropoda (Merostomata) that at times attained great size. The red beds were termed the Old Red Sandstone. They are overlain in turn by the rocks of the Carboniferous System.

Murchison and Sedgwick later visited Devonshire, England, where they found a series of intricately folded and faulted rocks penetrated by numerous igneous injections, and which hence differ greatly from the less deformed strata of western England. To these rocks they gave the name Devonian System from the locality in which they were found. The strata contain a meager marine fauna which is poorly preserved owing to the metamorphic character of the rocks. Lonsdale, who studied the corals, came to the conclusion that the Devonian fauna is intermediate in age between the Silurian and Carboniferous systems of western England, basing his deduction upon the fact that the fossils found in it possess a development of life intermediate between that of the Silurian and Carboniferous systems. The Devonian strata of southwestern England were thus shown to be of the same general age as the Old Red Sandstone of the

[1] Contributed by C. K. Swartz.

more northern districts, a conclusion which has been abundantly verified by later investigations.

Murchison and Sedgwick subsequently visited the lower valley of the Rhine in Germany where they found a far better development of Devonian strata, abounding with the remains of marine life. These beds which they and their successors have shown to be of the same age as the Devonian of England, have become in reality, if not in name, the type of the Devonian System of the world.

The Sandberger brothers later studied the Devonian of the Rhine in greater detail and showed that it may be divided into three parts which they termed the Lower, Middle, and Upper Devonian. These divisions differ both in their lithology and their contained faunas. The Lower and Upper Devonian consist chiefly of sandstones and shales, while the Middle Devonian is formed more largely of limestone.

The limits of the Devonian were not clearly defined by the earlier students. This arose from the conditions in the regions where the system was first studied. In western England the marine fossiliferous Silurian passes by numerous transition beds into the almost unfossiliferous red rocks of the Old Red Sandstone, affording no sharp line of division. In Devonshire also, the base of the Devonian is poorly shown. Hence the relation of the Silurian and Devonian is not well defined in the localities where they were first named. In the Rhine Valley the contact of the Silurian and Devonian is also poorly exposed and the Silurian is absent over much of that area.

There are extensive series of strata, rich in marine fossils, in the Hartz Mountains and in Bohemia that were referred by early students to the Silurian System. The strata of Bohemia are particularly profuse in organic life and have been made famous by Barrande in his great work, "Systeme Silurien du Centre de la Bohéme." Keyser, following a suggestion of von Beyrich, established the Devonian age of the upper part of the supposed Silurian strata of these regions, basing his correlation upon a detailed comparison of the organic life of the Lower Devonian beds of the Hartz, Bohemia and the Rhine Valley. His general results have remained secure although modified in many details by later workers.

The Devonian of Europe thus presents two very distinct types of sedimentation. The northern, or continental type of sediment, is best exhibited in northern England and Scotland and consists of red rocks usually unfossiliferous but containing locally numerous remains of fresh or brackish water fishes. The fish fauna was early made famous by the studies of Hugh Miller upon the Old Red Sandstone of Scotland. The southern type consists of marine limestones, sandstones, and shales, containing an extensive fauna. It outcrops in numerous areas between Devonshire on the west and Russia on the east, extensive exposures occurring in Belgium, the Ardennes, the Rhine Valley, the Hartz Mountains, and in Bohemia. It probably extends under cover with little interruption between the limits named.

Turning to North America the Devonian is found in two widely separated areas, an eastern and a western. The western region, situated east and west of the Rocky Mountains, contains strata which differ so greatly from those of the east in the character of their contained organisms that no further discussion of them is necessary in this connection.

The Devonian of eastern America was first critically studied by James Hall and his associates of the New York Geological Survey. Hall recognized the following Devonian formations referring them to the Devonian and upper part of the Silurian in his later work.

Catskill
Chemung
Ithaca
Portage
Genesee
Tully
Hamilton
Marcellus
Upper Helderberg
Cauda-Galli Grit
Oriskany
Lower Helderberg

In his earliest work Hall placed the base of the Devonian at the base of the Catskill which closely resembles the Old Red Sandstone of England, and referred the underlying marine fossiliferous strata to the Silurian although he subsequently placed it at a lower horizon. In 1845 de Verneuil visited North America. He examined the sections in New York in company with James Hall and placed the base of the Devonian at the base of the Oriskany at which point it long remained in most works on American geology. Keyser in his study of the Devonian strata of the Hartz and Bohemia pointed out the Lower Devonian age of the Helderberg of North America, a conclusion which has been more fully established by the labors of Clarke and Schuchert. The base of the Devonian is drawn at the base of the Helderberg[1] in the present volume, in harmony with the work of the latter investigators.

The Devonian of Maryland is divided into the following formations and members:

<table>
<tr><td rowspan="6">Devonian</td><td rowspan="2">Upper</td><td colspan="2">Catskill red sandstone formation</td></tr>
<tr><td>Jennings sandstone and shale formation</td><td>Chemung sandstone member
Parkhead sandstone member
Woodmont shale member
Genesee black shale member</td></tr>
<tr><td>Middle</td><td>Romney shale formation</td><td>Hamilton shale member
Marcellus black shale member
Onondaga shale member</td></tr>
<tr><td rowspan="2">Lower</td><td>Oriskany sandstone formation</td><td>Ridgely sandstone member
Shriver chert member</td></tr>
<tr><td>Helderberg limestone formation.</td><td>Becraft member
New Scotland member
Coeymans member
Keyser member</td></tr>
</table>

The Devonian of Maryland forms a part of the Appalachian Province which extends from New York southward in the Appalachian Mountains and Plateau. The resemblance of the formations to those of the northern part of the area is so close as to establish their essential identity both in lithology and fauna, and hence the similarity of the conditions under

[1] See the more extended discussion by Schuchert.

which they were deposited, the chief difference being the development of the Keyser limestone in Maryland, an earlier phase of the Helderberg than has hitherto been recognized in New York, and the profusion of life in the Oriskany. In Lower Devonian time[1] the Helderberg and Oriskany seas stretched southward from New York to beyond Maryland. The Middle Devonian was ushered in by a slight deepening of the seas in Maryland, clays being deposited near the shore in Onondaga time, while limestone was formed in the open sea farther west. The shales were long believed to be of Marcellus age but have since been shown by Kindle to have been formed in Onondaga time. The Marcellus and Hamilton sediments of Maryland so closely resemble those of New York in their lithology and their forms of life as to leave little doubt that they were deposited in the same basin and under similar conditions.

The Upper Devonian introduces one of the most interesting chapters of the history of this period. At the beginning of Upper Devonian time a fauna appears comprising few species, one of which, *Hypothyris cuboides,* is found at such widely separated points as New York, northwestern America, the Rhine Province, Russia, and China. It seems, therefore, to have encircled the northern hemisphere in its journeys. The cuboides fauna lasted but a short time. In later Middle Devonian time the sea had deepened throughout the west in North America. The descendents of the Middle Devonian shore-loving brachiopods of the eastern area continued to live in the shallower waters where they received new species from the Atlantic and by their combination formed the Ithaca fauna. The deeper waters off shore were invaded by forms that differed greatly from all that preceded them in this region. They consist chiefly of goniatites (cephalopods with angular sutures), and minute pelecypods. The rarity of brachiopods is conspicuous. This assemblage, termed by Clarke the Naples fauna,[2] is believed by him to have journeyed from its home in northeastern Arctic Russia via northwestern America to New York and eastward to the Rhine Valley where it is found in a similar position, its route being indicated by the progressive develop-

[1] See Schuchert's discussion of Paleogeography in this volume.

[2] N. Y. State Mus. Mem. No. 6, 1903. This fauna is also known as the Intumescens fauna from its guide species, *Manticoceras intumescens.*

ment of the species. An early colony arrived in New York in Genesee time while the main body appeared in Portage time. The accompanying map (fig. 1) shows the conditions in New York as interpreted by Clarke. The Naples fauna inhabited the Genesee province in the west and the Ithaca fauna dwelt in the Ithaca province in the central part of the state, while

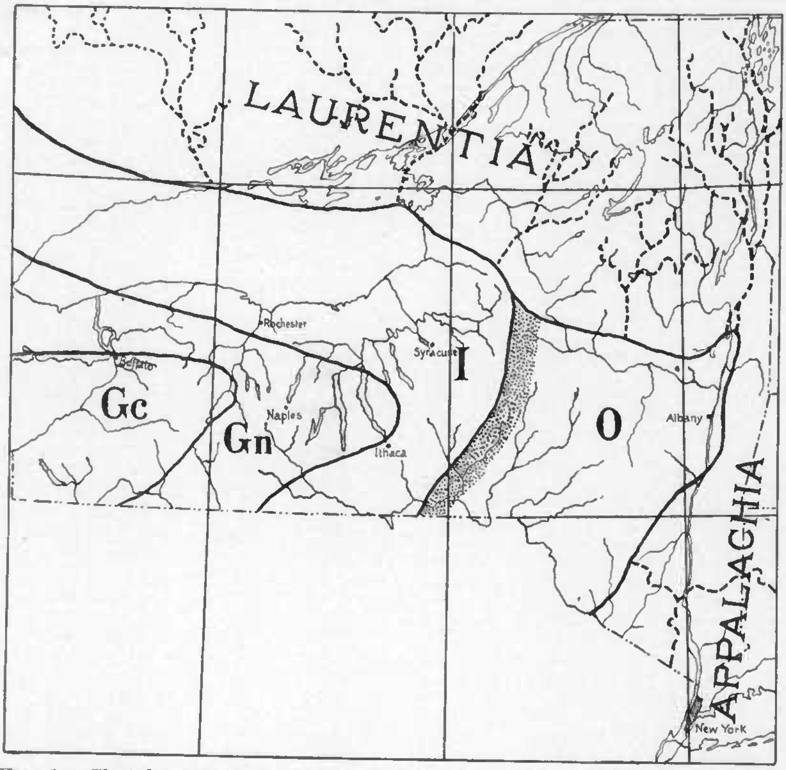


FIG. 1.—Sketch map showing the biologic provinces of the Upper Devonian sea in the New York area. (After Clarke.) O = Oneonta Province; I = Ithaca Province; Gn = Genesee Province, Naples subprovince; Gc = Genesee Province, Chautauqua subprovince.

an embayment, closed in the northeast, existed in the vicinity of Albany in which lived fresh and brackish water species. The last is termed the Oneonta province by Clarke. As the level of the sea oscillated, leading to the interleaving of the two types of containing sediments in central New York, the Naples and Ithaca faunas migrated back and forth. That these faunas ranged southward into Maryland is shown by the occurrence of the Naples fauna in abundance in the Genesee and lower beds of the Woodmont member of the Jennings formation of the western sections and the replacement of the Naples fauna by the Ithaca fauna in the upper beds of the Woodmont member in the eastern sections, while it still continued to live in the west, indicating conditions essentially similar to those that existed in New York at this time.

It results that three independent faunas coexisted in this province in early Upper Devonian time, their range being determined by the physical conditions under which they dwelt, while they migrated back and forth as

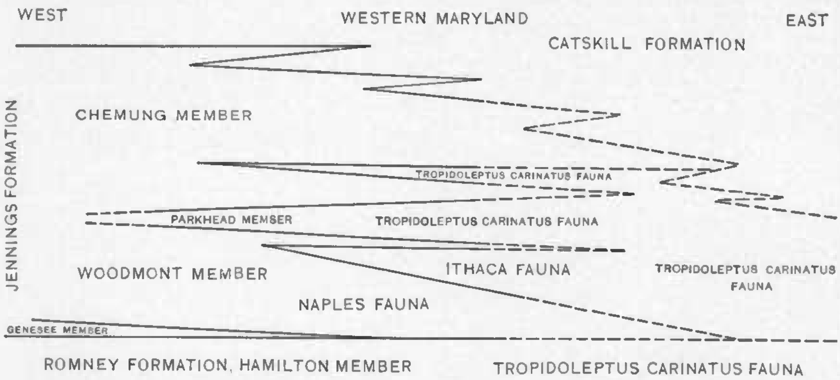


FIG. 2.—Diagram showing probable relations of the Upper Devonian faunas and sediments in Western Maryland and adjacent areas.

these conditions varied. These faunas were succeeded in the Maryland region by species of purer Hamilton type, characterized especially by the presence of *Tropidoleptus carinatus,* one of the dominant forms of life of the Hamilton. This assemblage, termed the Parkhead fauna, probably arrived before the disappearance of the Naples fauna from western New York. The Naples fauna of western New York and the Parkhead fauna of Maryland were finally displaced by the arrival of the Chemung fauna which differed greatly from the Naples fauna and had many points of resemblance with species of Middle Devonian time. That species of purer Hamilton type continued to live somewhere in the adjoining regions is shown by the temporary return of the *Tropidoleptus carinatus fauna* in

Chemung time, following a shallowing of the sea. This recurrence was, however, of brief duration and the Chemung species again became dominant, occupying the region until the close of marine conditions. The shifting and migrating of these faunas with the varying physical conditions constitutes one of the most remarkable aspects of Devonian history. The relations of the sediments and faunas in western Maryland and adjacent areas in Upper Devonian time is shown in the accompanying text figure.

Toward the close of the Devonian the continent was elevated on the northeast. Upon the surface of the low western land were numerous lakes and embayments in which thick deposits of red clays and sands were formed, which progressively encroached southward and westward upon the waters of the neighboring seas. These sediments are termed the Catskill formation in the Appalachian Province because of their extensive development in the Catskill Mountains of New York. The formation has variable significance in different localities and is expressive of sedimentation rather than of a definite unit of time. It is a significant fact that land conditions were ushered in at the beginning of Devonian time in extreme northwestern Europe, in Middle Devonian time at Gaspé on the St. Lawrence Gulf, and in Upper Devonian time in Maryland and eastern New York. Continental conditions appear later and later in passing westward until west of the Appalachians marine conditions prevail entirely. The transition from marine to non-marine conditions was not abrupt but was attended by numerous oscillations. In this manner the red sediments of the eastern United States thin towards the west where they are interpenetrated and replaced by marine deposits. In all these areas the continental deposits are similar red, and occasional green, beds bearing macerated remains of plants and fragments of fishes. The Devonian was finally terminated by a subsidence of the continent and a new invasion of the Mississippi seas introducing Lower Carboniferous time.

The accompanying table shows the correlation of the Devonian deposits of Maryland with those of Pennsylvania, New Jersey, and New York.

The State of Maryland is divisible into three main topographic provinces. The eastern division is a flat coastal plain but recently elevated

RELATION OF THE DEVONIAN FORMATIONS OF MARYLAND TO THOSE OF PENNSYLVANIA, NEW YORK AND NEW JERSEY

	Maryland		Pennsylvania[1]	New York[2]	New York[2]	New Jersey[3]
Upper Devonian	Catskill formation		Catskill formation	Catskill formation		Skunnemunk conglomerate
	Jennings format'n	Chemung member		Chemung formation		
		Parkhead member	Chemung formation Portage formation	Portage formation	Enfield member	
		Woodmont member: Ithaca fauna			Ithaca member	Bellvale shale
		Woodmont member: Naples fauna			Sherburne member	
		Genesee member	Genesee formation	Genesee formation		
Middle Devonian	Romney format'n	Hamilton member	Hamilton formation	Hamilton formation		Monroe shale
		Marcellus member	Marcellus formation	Marcellus formation		
		Onondaga member		Onondaga formation		Newfoundland grit
						Onondaga limestone
Lower Devonian	Oriskany format'n	Ridgely member	Oriskany formation	Oriskany formation		Oriskany sandstone
		Shriver member	Stormville shale	Port Ewen formation		Kingstone shale
	Helder-berg format'n	Becraft member	Lower Helderberg formation (upper part)	Becraft formation		Becraft limestone
		New Scotl'd member		New Scotland formation		New Scotland limestone
		Coeymans member		Kalkberg formation[4]		Stormville sandstone[4]
				Coeymans formation		Coeymans limestone
		Keyser member		Hartnagel[5]	Ulrich[5]	Manlius limestone[6]
				Manlius[6] of east'n N. Y.	Transition beds	
				Rondout	Rondout	Rondout cement beds
				Cobleskill	Decker Ferry	Decker Ferry limestone
				Rosendale		
				Wilbur		

[1] Lesley, 2d Geol. Surv. Pa., Final Report, vol. ii, 1892.
[2] Hartnagel, N. Y. State Mus., Handbook No. 19, 1912. The Upper Devonian is compared with the section near Ithaca, N. Y. See discussion elsewhere in this volume.
[3] Weller, Pal. N. J., vol. iii, 1903.
[4] The equivalence of the Kalkberg and Stormville sandstone is not here affirmed.
[5] Hartnagel and Ulrich present divergent views concerning the correlation of the formations lying below the Coeymans in New York. The reader is referred to the chapter upon the correlation of the Helderberg for a discussion of this subject.
[6] Hartnagel and Weller consider this formation to be Upper Silurian. Ulrich believes the Decker Ferry and overlying strata are Lower Devonian.

from beneath the sea, containing sediments of Mesozoic and Cenozoic age. The central is the Piedmont Plateau consisting largely of ancient, greatly deformed rocks. The western division is known as the Appalachian Province and is formed largely of Paleozoic rocks. It is in this division that the Devonian strata are found. The Appalachian Province is divisible into the Appalachian Valley and the Appalachian Plateau. The Appalachian Valley subprovince embraces most of the present Appalachian Mountains, extending from the eastern foot of the mountains to the high escarpment of the Alleghany Plateau on the west. The sediments of this subprovince were elevated above the sea at the close of Paleozoic time and folded, producing the ancient Alleghany Mountains which are quite distinct from the present mountains of this region. The ancient mountains were reduced by erosion nearly to the level of the sea, the resulting surface being a plain of great extent—the Schooley peneplain. This plain was subsequently uplifted by successive stages to form a great dome whose surface was dissected by streams. In this manner deep valleys were cut, separated by high divides, forming the present Alleghany Mountains upon whose level-topped crests are still to be seen traces of the ancient peneplain. The present mountains are thus the result of stream erosion.

The Appalachian Plateau occupies the western portion of the State and lies at an elevation of nearly 3000 feet above the sea. It is a portion of the same ancient plain which has undergone less extensive dissection owing to the fact that its strata are but slightly folded and its drainage descends by gentle declivities toward the west. The Devonian strata form a large part of the surface of the Appalachian Valley subprovince and occupy a lesser portion of the Appalachian Plateau. Their study presents much difficulty because the strata are involved in the intricate folding of the ancient Appalachian Mountains and are extensively covered by the forests which clothe the slopes of the present ridges. Many admirable sections are, however, exposed in the valleys cut by the existing streams.

The Appalachian Province presents scenes of great beauty and dignity. To one who climbs the mountain summits the ridges with their even skylines, due to the preservation of the ancient peneplain upon their crests, frequently appear as great waves fixed upon a sea which stretches as far as the eye can reach. The less rugged scenery of the Appalachian Plateau is at times scarcely less attractive.

The thickness of the Devonian of Maryland is about 11,000 feet, compared with 2400 feet for the Silurian and 3200 feet for the Carboniferous.

PALEOGEOGRAPHY OF THE DEVONIAN[1]

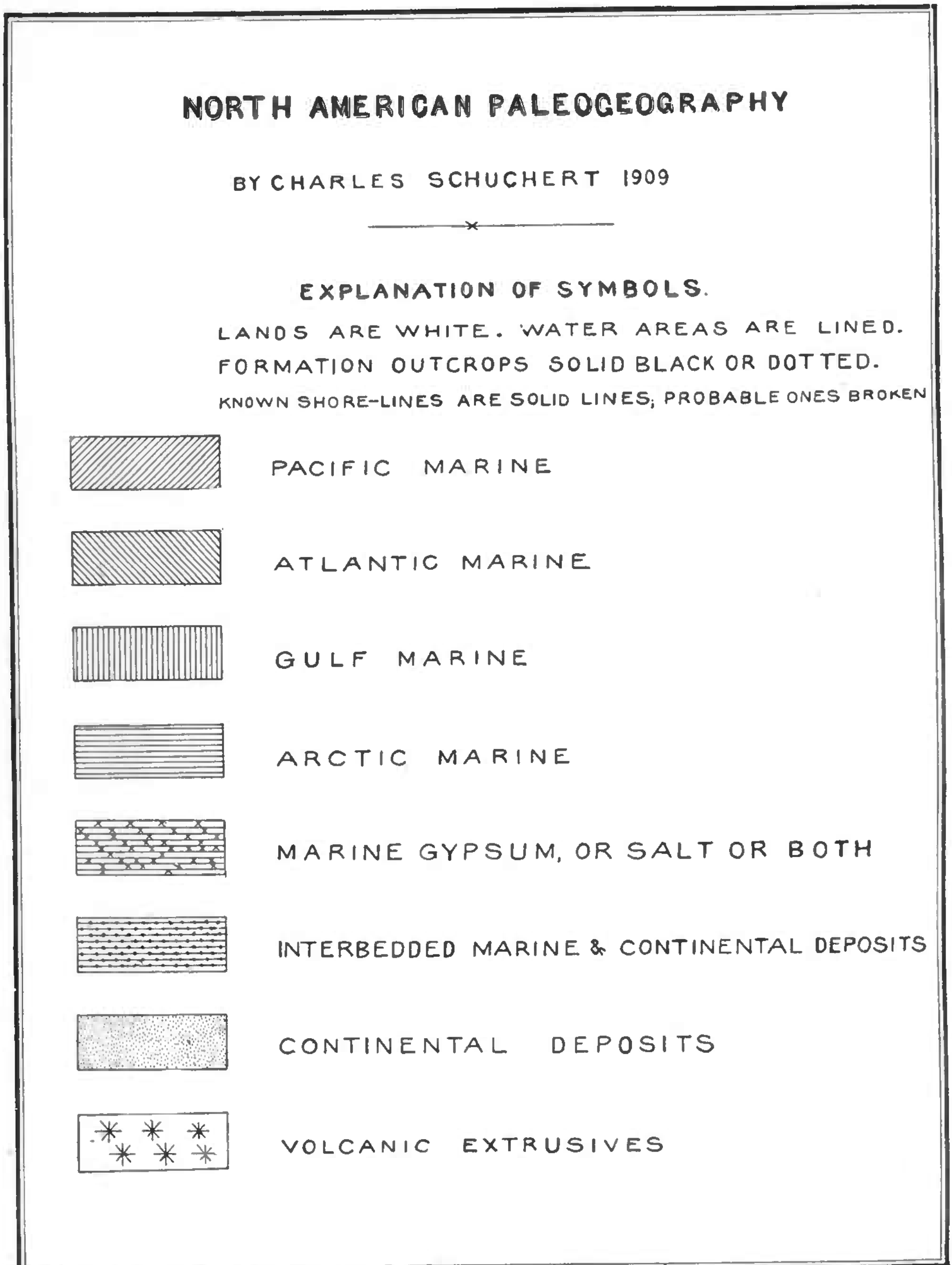
Paleogeography treats of ancient or geologic geography, the word having been first used by the English paleontologist Robert Etheridge, in his presidential address before the Geological Society of London in 1881. Paleogeographic maps, however, were made long before the word originated, the first one having been constructed in 1863 by the late Professor James D. Dana. Since that time upward of 350 such maps have been published, about half of which relate more or less directly to North America.

If restricted to base maps of the State, the paleogeography of Maryland would teach very little. To understand the various ancient invasions of the seas and oceans into this region, it is necessary to know the connections with marine waters that have at different times flooded the North American Continent. These constitute extensions of the Gulf of Mexico and the Atlantic, Arctic, and Pacific oceans. In the study of any fossil fauna, either from the biologic or evolutionary or from the time or stratigraphic side, its marine source or genetic relationship must be known; until this is ascertained there can be no certainty regarding stratigraphic correlations with "standard sections." To this end, information has been accumulating for a century, and it is now possible to make preliminary paleogeographic maps. Like all pioneer work, however, those here offered will doubtless undergo considerable change, yet it is believed that such changes will not be fundamental in character, but rather those in which the plotted shore-lines will be altered, thus causing the continental seas to take on other forms than the ones here illustrated.

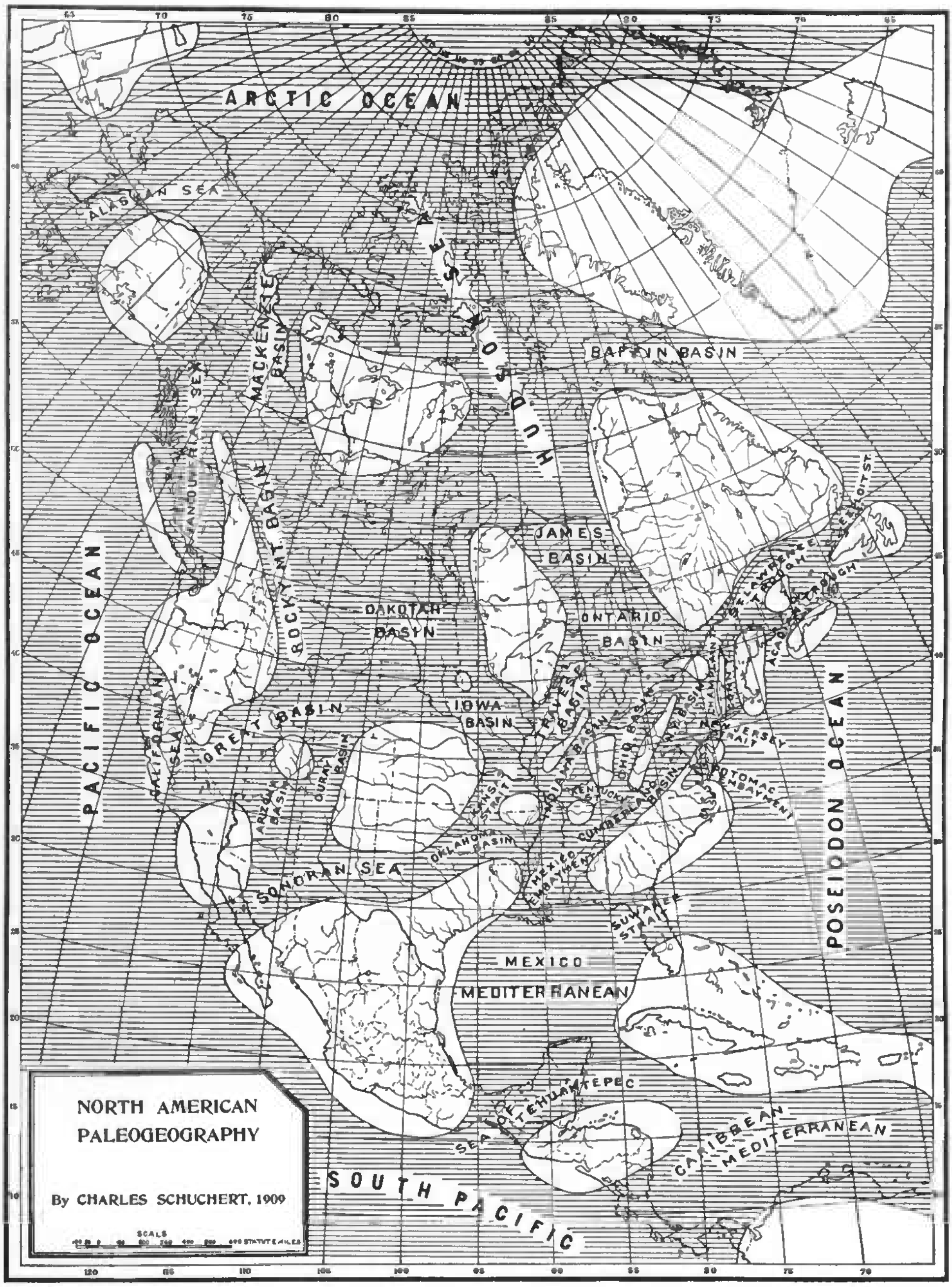
[1] Contributed by Charles Schuchert.

In a general way the present outline of the North American Continent has been maintained since the beginning of the Paleozoic era. It is probable, however, that throughout the Paleozoic the eastern margin was of wider extent, since almost no rocks of this era are known along the Atlantic slope of the old land mass Appalachia. To the north of this ancient land was another known as Acadia (includes Taconia and Nova Scotia, see Plate IV). This has been subjected to much lateral pressure and during the Paleozoic it was undoubtedly mountainous, the Atlantic often invading the region between the ranges. Many times during that era these lands were thrust upward and landward by the settling or deepening of the Atlantic Ocean, due to the periodic shrinkage of the earth, Acadia being more frequently thus acted on than Appalachia. The thrustings again and again renewed the elevation of the lands, enabling the rejuvenated streams that flowed from the latter to deposit their loads of muds, sands, and lime, which are now seen as the shales and slates, sandstones and quartzites, limestones and marbles, throughout the State of Maryland. During most of the Paleozoic, eastern Maryland figured as part of Appalachia and what was here worn away by weather and rain was dumped by the then existing streams into the Appalachian Sea. The eastern shore of this interior sea was originally some miles east of Harper's Ferry, and by the time the Devonian was reached it had made its way west to North Mountain. From late Ordovician time to near the close of the Mesozoic era, Maryland was land east of Harper's Ferry, to far east of the present shore. The lands within the Paleozoic continental seas of North America and those bounding them are shown on Plate IV. It should be understood, however, that this map is a synthetic one and does not illustrate any definite period. The areas designated are those least subject to the invasion of Paleozoic continental seas.

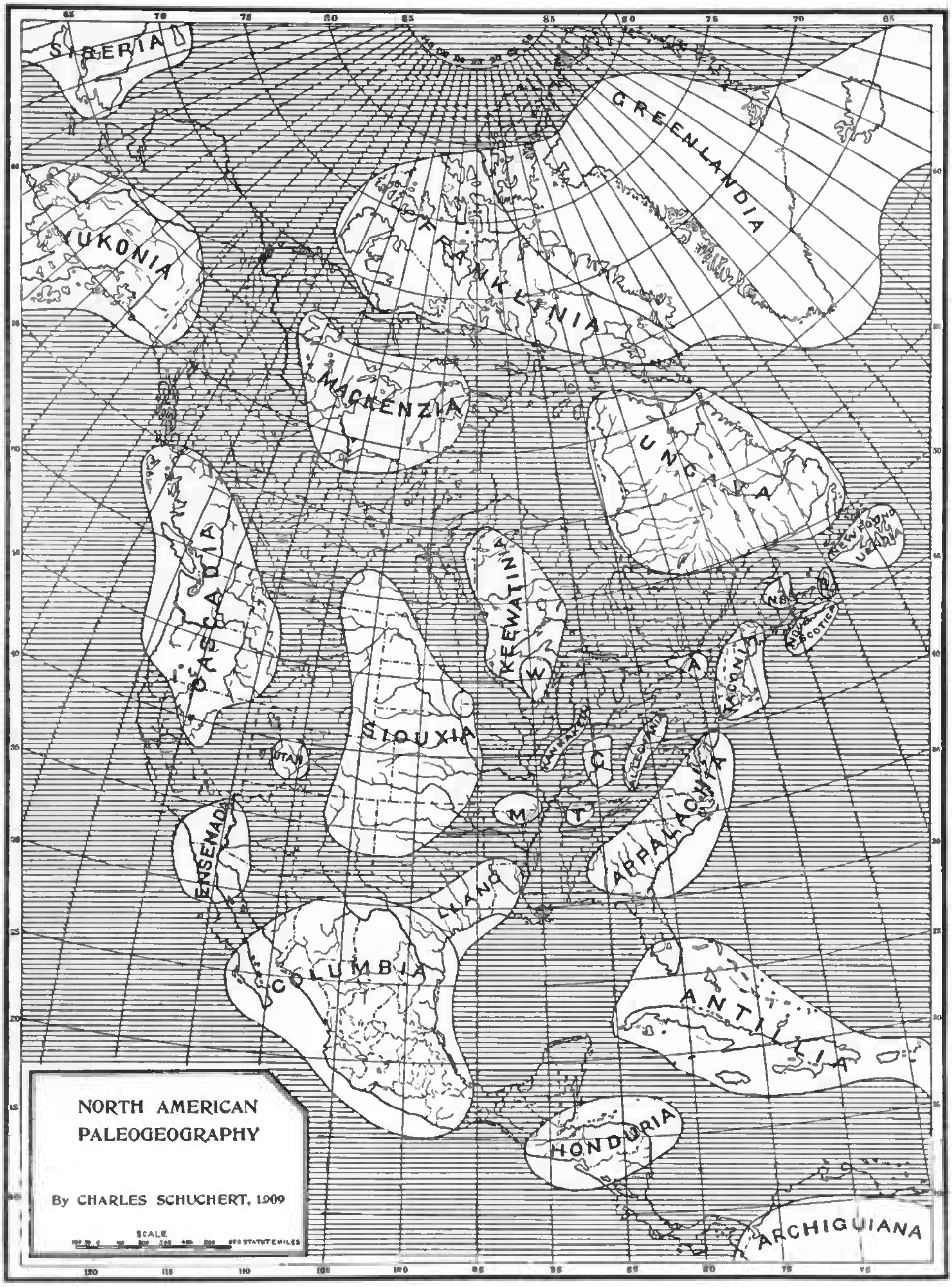
The marine waters that have invaded Maryland are extensions of the oceans, in the east as more recent overlaps of the Atlantic and in the west as the Appalachian Sea of Paleozoic age. The latter body of water at times connected with the Atlantic but more often with the Gulf of Mexico and other waters that came from the Pacific and Arctic oceans. These overlaps and seas were all shallow, and constitute the continental seas of Dana, so named because they lie on the continent and not in an abyssal



EXPLANATION OF SYMBOLS.



CONTINENTAL SEAS OF PALEOZOIC TIME.



PALEOZOIC POSITIVE ELEMENTS.

basin between the continental masses as do the oceans and mediterraneans. These seas are illustrated on Plate III, this map being synthetic like the previous one. The various continental seas of Paleozoic time which covered western Maryland, were very shallow, probably never more than two to five hundred feet deep. Into these basins the streams unloaded deposits of great thickness, in Pennsylvania amounting to about 30,000 feet during the Paleozoic era. At no time, however, was the Appalachian Sea a deep sea, certainly not in the sense that the Atlantic Ocean is deep, and it is now well known that continental seas subside gently under loading, maintaining a fairly constant depth; at times, also, they are completely filled by detrital matter from the land.

These continental seas are not constant like the oceans, but periodically overflow the land along more or less definite areas. The flood is at first small, but gradually spreads farther and farther until in most cases the waters of two or more oceans become united. The invasion then begins to disappear, accomplishing this far more rapidly than in extending over the land. These phenomena constitute the submergences or transgressions and the emergences of stratigraphers, there being eleven such cycles in American Paleozoic formations.

Some of these floods are due to the subsidence of the land flooded, this being particularly true of the Appalachian Sea, but in most areas there is no movement of the land. The waters of the oceans rise and flow more or less widely over the stationary continents. In great part this may be accounted for by the wearing away of the lands and the distribution of this eroded material in the water areas. Suess has well said: "Every grain of sand which sinks to the bottom of the sea expels, to however trifling a degree, the ocean from its bed." If the present continents above sea-level were unloaded into the ocean, the strand-line would become elevated or positive to the height of 650 feet. Such a displacement of the sea would inundate North America in areal extent not unlike the submergence of the Devonian transgression, illustrated in the paleogeographic map of the Late Hamilton (Plate IX).

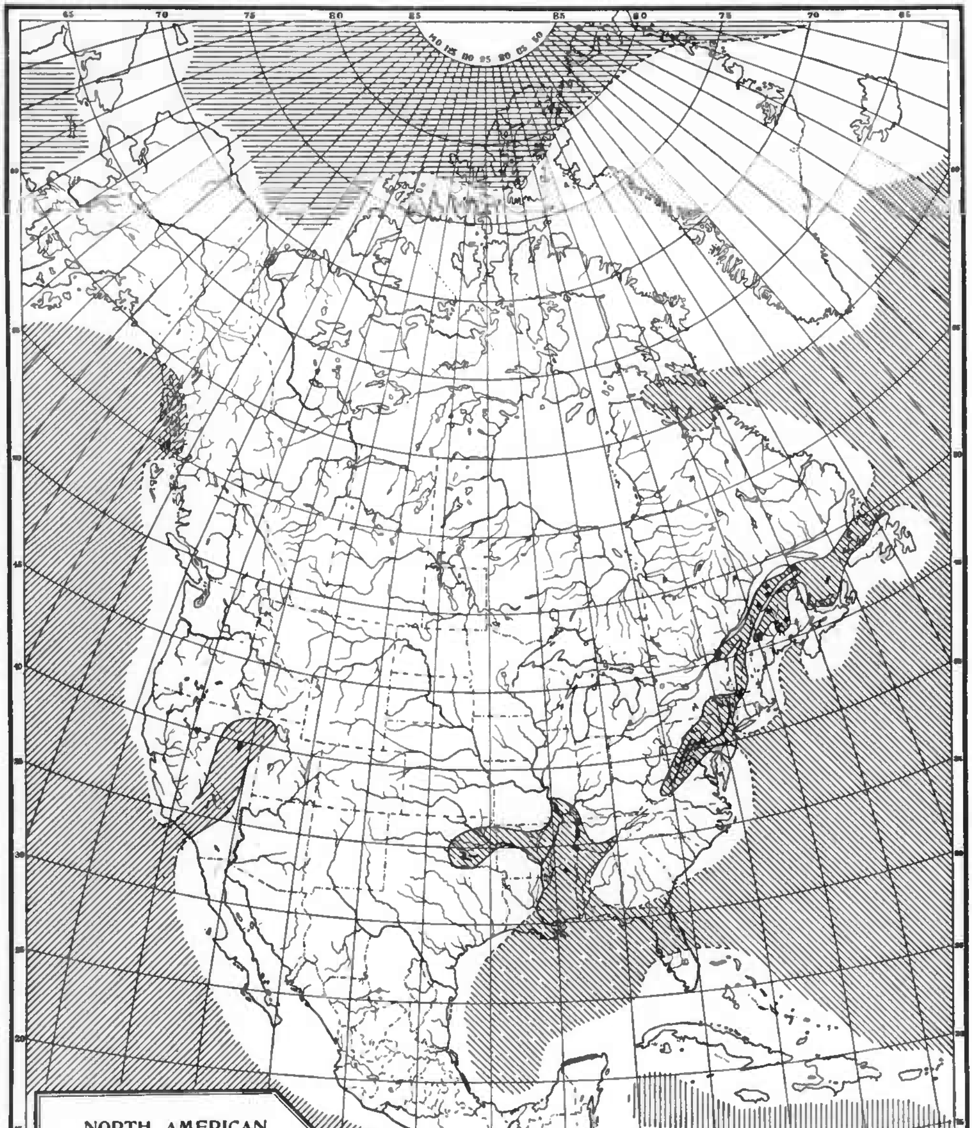
While the seas and oceans are slowly loading through the wearing away of the rocks of the continents, the internal mass of the earth is also shrinking, and the accumulating stresses thus set up finally reach the breaking point. The oceans then begin slowly to subside, drawing away the continental seas from the lands and establishing new ranges of mountains or rejuvenating the old ones along the continental borders. Further, as the earth's diameter periodically lessens, the planet attains a somewhat quicker daily revolution, the days are thus progressively shortened, and the oceanic waters flow toward the equatorial zone during the period of shrinking, being drawn away mainly from the polar regions. It has been computed by Barrell "that a general shrinkage of the earth to the extent of one mile in mean radius will result in an increase of equatorial over polar radius of about 95 feet; a shrinkage of ten miles will result in a relative increase of about 950 feet. . . . . The equatorial bulging for each mile of radial shrinkage may therefore be spoken of as from 90 to 100 feet. In latitude 35° the water level will suffer no change. At the poles it will sink some 60 feet, and at the equator it will rise about 35 feet."[1]

These cycles of land submergence and emergence are world wide and most of them are thought to be recorded more or less definitely in most continents. That there are exceptions is well known from the geology of Africa. This continent has almost no marine Paleozoic record; only the Oriskany equivalent is present in a limited region along the southeast coast. In all lands where there is a marine record, however, it is thought that the formations will naturally arrange themselves into diastrophic cycles, and that these cycles represent the systems of rocks or the periods of time of geology.[2]

It has long been known that the Devonian succession and faunas vary greatly in different regions of North America. The succession along the Appalachian Mountains, from New York to central Virginia, is harmonious, but when these formations and faunas are contrasted with those of Ohio and Indiana, and especially with those of Missouri and Iowa, great differences are found to exist. The Appalachian region and that of Missouri-Iowa have almost no species in common. These marine differences are due to isolation and different oceanic connections, the western

[1] Bull. Geol. Soc. America, vol. xx, 1910, pp. 507-508.

[2] Those wishing to study this subject in greater detail are referred to a memoir by the writer entitled: Paleogeography of North America, Bull. Geol. Soc. America, vol. xx, 1910, pp. 427-606, pls. xlvi-ci.



LOWER DEVONIAN (NEW SCOTLAND).

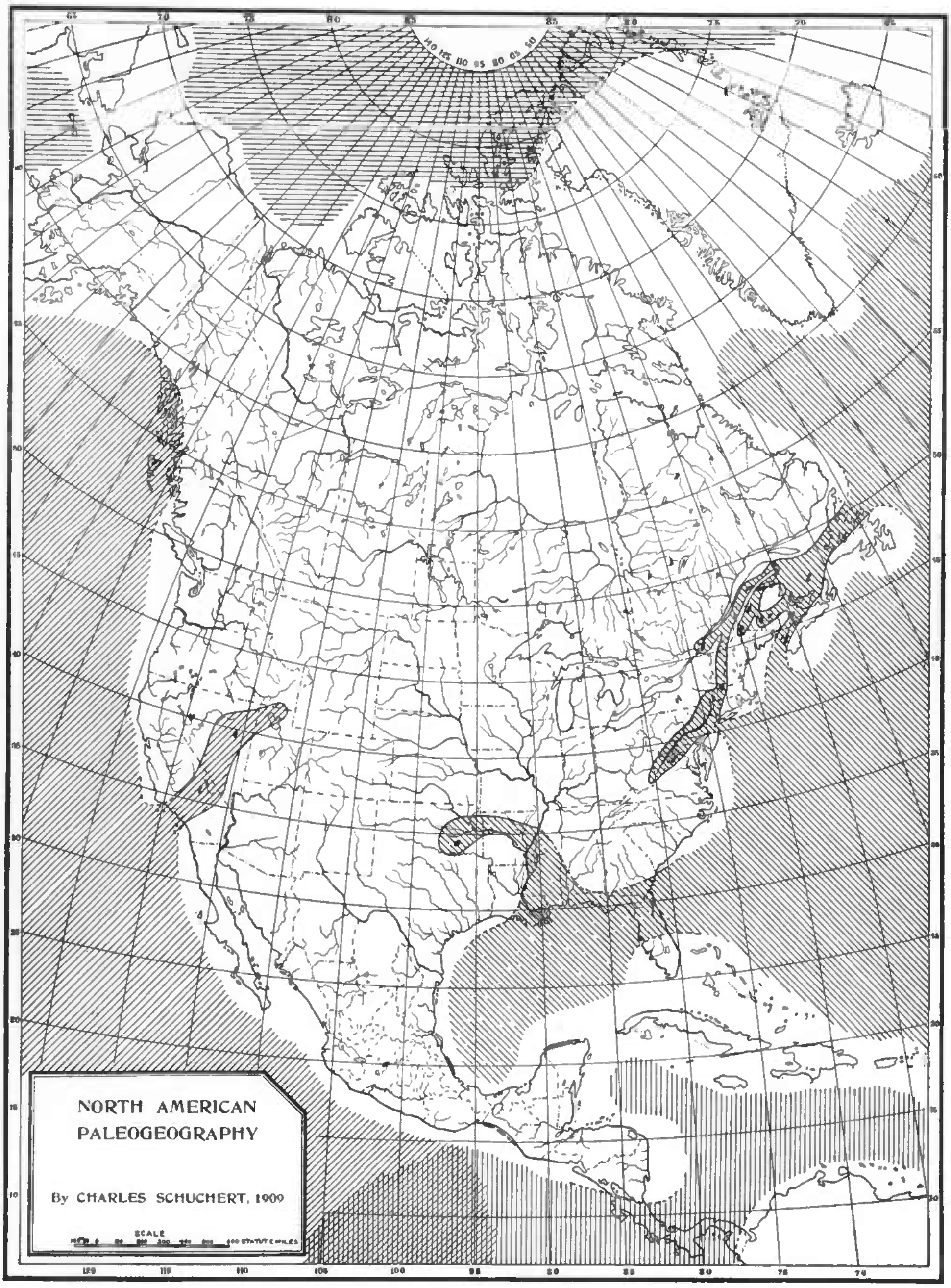
waters having had their origin in the Arctic and Pacific oceans, while the eastern seas were in communication with the Atlantic and Gulf of Mexico. To discover these connections is the work of paleontologists, as the record to be deciphered is mainly contained in the fossils entombed in the strata. The formations of the Appalachian region have faunas and species that are often quite like those of Europe, yet at other horizons these are very different. The European connections are more frequently from the northern portion of that continent, but every now and then Mediterranean affinities are discovered. In the former case the faunas traveled back and forth along the North Atlantic shores, while those of the Mediterranean region migrated via Gondwana, a vast transverse land that in the Paleozoic and probably throughout the Mesozoic united India, Madagascar-Africa, and the Brazilian portion of South America.

An examination of the six paleogeographic maps of Devonian time here presented shows that the Appalachian Sea had two connections with the Atlantic Ocean. In the north, throughout the Lower Devonian, the St. Lawrence Sea opened into the Appalachian trough, and in the former waterway are seen the distinctive northern European faunas which Clarke has so clearly described.[1] Many of the species are also found in Maryland, yet the Oriskany faunas of this sea when contrasted with those of the Mississippi Valley are found to be wholly dissimilar. The latter are of South American origin, best known in central Brazil. In the medial Atlantic region there was another opening into the Atlantic during the greater part of the Devonian. On the accompanying maps it is represented as crossing New Jersey, because these deposits, which are of considerable thickness and are found in most horizons, are here nearest the ocean. This break into the Atlantic could not have been farther to the north, though it may have occurred more to the south, even as far south as the headwaters of the Chesapeake. Present evidence, however, places it best across New Jersey. Through this opening came many of the Middle and Upper Devonian species described from Maryland, besides a considerable number of the Lower Devonian forms. The Tropidoleptus fauna of the later Devonian for a long time swarmed through New Jersey

[1] Memoir 9, N. Y. State Mus., 1908.

Straits. Another most marked oceanic opening was the Gulf of Mexico embayment of the Mississippi Valley, but until late Middle Devonian time none of its faunas reached Maryland. Then and subsequently the influence of this embayment was slight as far as the composition of the Appalachian faunas was concerned. The Helderberg life of Oklahoma, Alabama, Tennessee, and Illinois, however, closely resembled the typical development in the Appalachian Sea but was very different from that of the St. Lawrence Sea. In northern Europe the Helderberg faunas are unknown, but in southern Europe, in Bohemia, they are present in the Konieprusian limestone. While but few species are common to the two sides of the Atlantic, it is certain that all belong to the Atlantic realm and that the southern migration took place along the northern shore of Gondwana. The same general fauna, but much changed, doubtless by latitude and somewhat cooler waters, occurs in the St. Lawrence Sea. These forms may have distributed themselves around the shores of the North Atlantic, this surely being the path of migration during the Oriskany. Clarke has termed these migrations "the Coblenzian invasion," its faunas being well known in northern Europe.

The Helderberg Map (Plates V and VI).—The Helderberg series begins with the Keyser limestone and continues through the New Scotland into the Becraft. Underlying these in the Appalachian trough of Maryland is a thick series of limestones—McKenzie, Wills Creek, and Tonoloway formations—of late Silurian time. Both series are characteristic of the southern Appalachian trough, but are unknown over the greater portion of the North American Continent. The Helderberg faunas, as such, do not make their appearance before the New Scotland, yet even in the upper part of the Tonoloway, forms occur, which ancestrally are clearly allied to those of the formation first mentioned. As the New Scotland and Becraft faunas, however, are almost identical with those of eastern New York, the typical area for the Helderberg, and are somewhat unlike those of the southern states, the areas evidently had no direct intercommunication, although both belong to one faunal realm—the South Atlantic in connection with the Mediterranean. The Maryland Helderberg faunas came into this region by way of the New Jersey



LOWER DEVONIAN (BECRAFT).

Straits, while the southern faunas are distinctly of Gulf of Mexico origin.

The small Appalachian Sea of Lower Devonian time varied considerably in area. The later Silurian formations extend to Tennessee, but the New Scotland is not known south of central Virginia. Toward the close of the latter formation this trough was also much reduced in width, since the Becraft limestone is known only in the eastern portion, from Virginia to the Helderbergs. The reduction was continued into the early Oriskany, as south of Pennsylvania the latter series rests in the western part of the trough on different horizons of the eroded Helderberg.

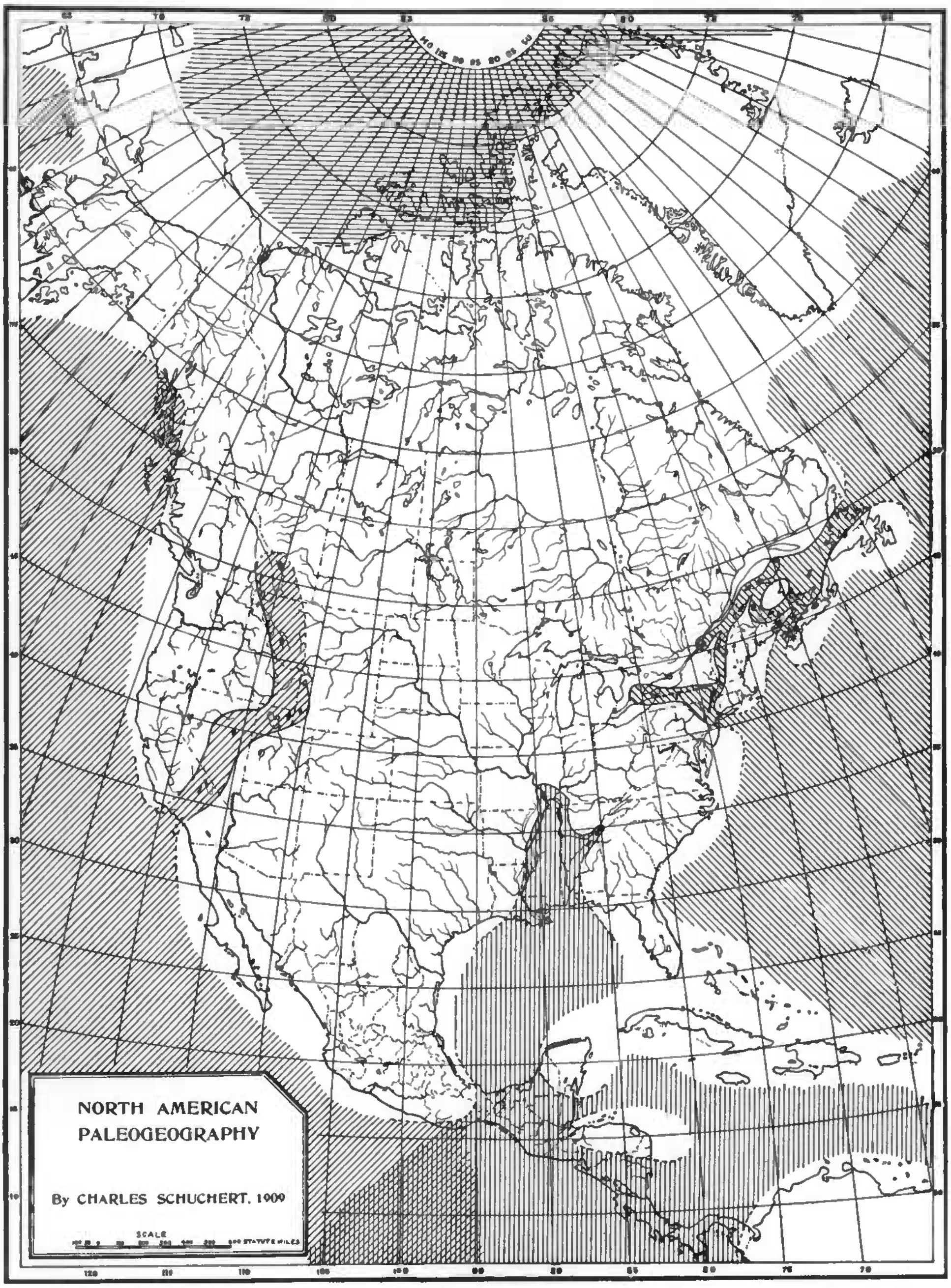
The Oriskany Map (Plate VII).—Very early in Oriskany time the restricted sea in the eastern Appalachian trough again spread westward and attained to southern New York, which had been completely drained in the Helderberg Mountain area after the Becraft of Helderberg age. These early Oriskany faunas are direct developments from the previous Helderberg elements of southern Atlantic derivation. With the extension of this increasing sea, evolution of marine life became rapid, and the record is probably more complete in Maryland and the adjoining states than elsewhere. Toward the end of the Oriskany the sea grew shallow south of New York, more North Atlantic forms (Gaspé) appeared, and finally the waters were withdrawn for a time from the southern Appalachian trough. North of Pennsylvania the late Oriskany faunas were continued in those of the true Oriskany sandstone and the Esopus grit. The New York Basin at last moved westward through New York, and the close of the eastern Oriskany series is seen in the Decewville formation of Ontario. These local differences in the strata, their varying position, and the accumulation of sandstones and black cherts bear witness to the unrest of Appalachia and to its elevation during the later portion of the Lower Devonian. The trough south of New York then remained land from the latest Oriskany until the late Onondaga of Middle Devonian time. While at this time Appalachia was not much elevated, Acadia began to undergo more and more severe crushing, with considerable mountain making.

The southern or Gulf embayment presents in the Camden formation only the latest stage of the Oriskany. This fauna, which continues unbroken into the southwestern Onondaga of the Middle Devonian, is wholly unlike the eastern or Appalachian one. It is clearly linked with the Brazilian Devonian sea, the faunas of which spread north by way of the southern Pacific into the Gulf of Mexico, across Central America. Only a few species are common to this southern and the Appalachian faunas, these being cosmopolitan brachiopods.

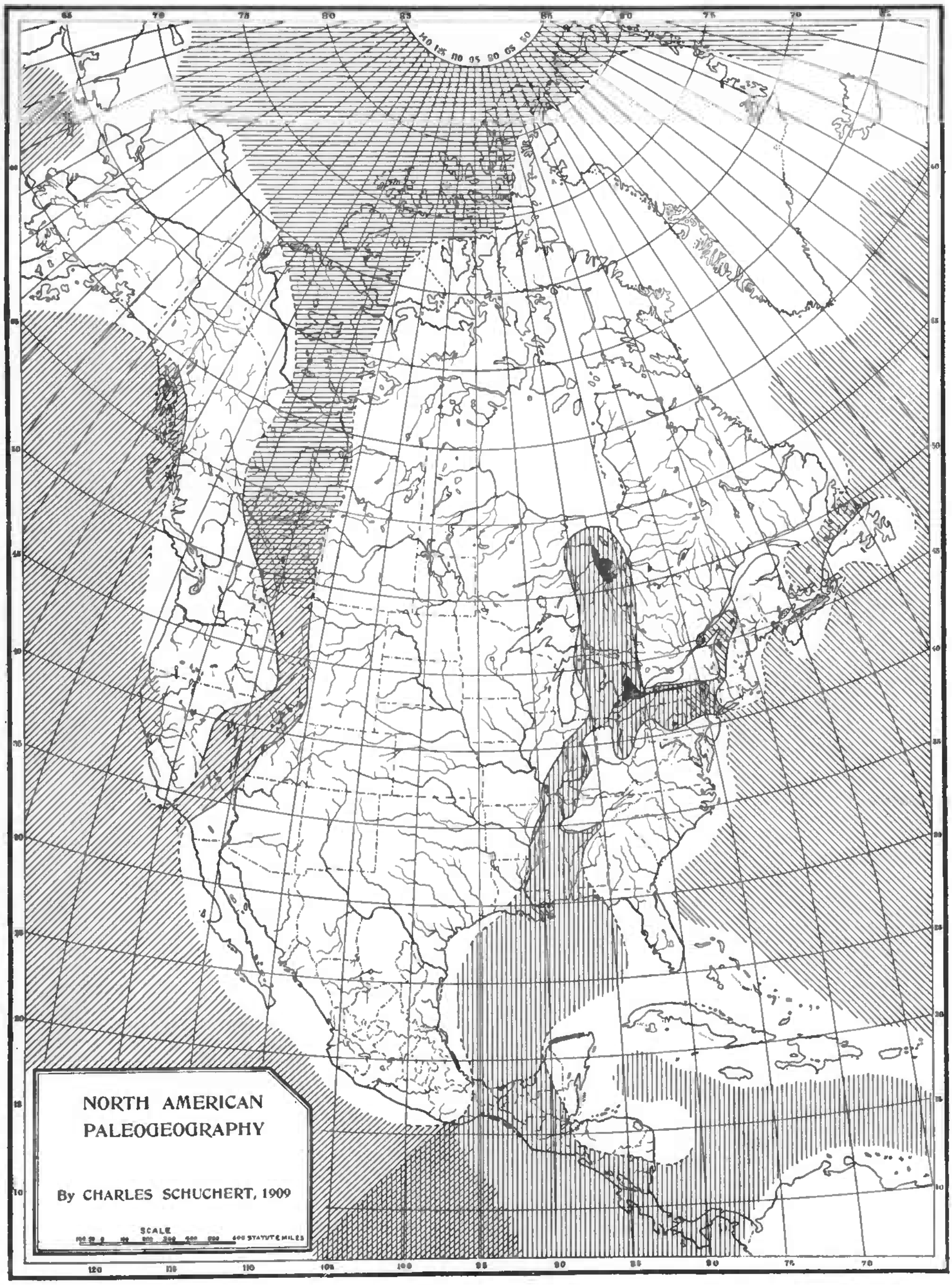
The Middle and Upper Devonian Maps (Plates VIII, IX, and X).—The extension of the late Oriskany seas was continued into the Onondaga, the southern embayment spreading most rapidly over featureless America, along the western side of the Cincinnati Axis. When these southern waters reached Ontario and northeastern Ohio, they met those of the North Atlantic, and the faunas of the two areas are found mingled at the base of the Onondaga, in western New York, Ontario, and the James Bay region. With these warmer waters appeared a horde of reef-making corals, their best development occurring at Louisville, Kentucky; Columbus, Ohio; in western New York, and across the Niagara River in Ontario; north far less abundantly in James Bay, and east in the Connecticut trough as far north as Lake Memphremagog.

The Onondaga submergence was continued, and in the Marcellus stage of the Middle Devonian the southern waters spread across the medial region of the Cincinnati Axis in Kentucky into the southern Appalachian trough, and thus again united with the New York Basin.[1] In the eastern area, the sea was turbid, depositing in the main black carbonaceous muds, with a meager fauna of Atlantic derivation. The mountain ranges of Acadia had been rejuvenated through elevation, and the rivers flowing from this land dumped their heavy loads into the northern portion of the Appalachian Sea. In northeastern Pennsylvania the coarse detrital deposits of the Middle and Upper Devonian are about 10,000 feet thick and in Maryland the series is not much less in thickness, but farther south in the Virginias the strata thin out rapidly. To the north in eastern New York this series also decreases in thickness, most of the Catskill Mountains,

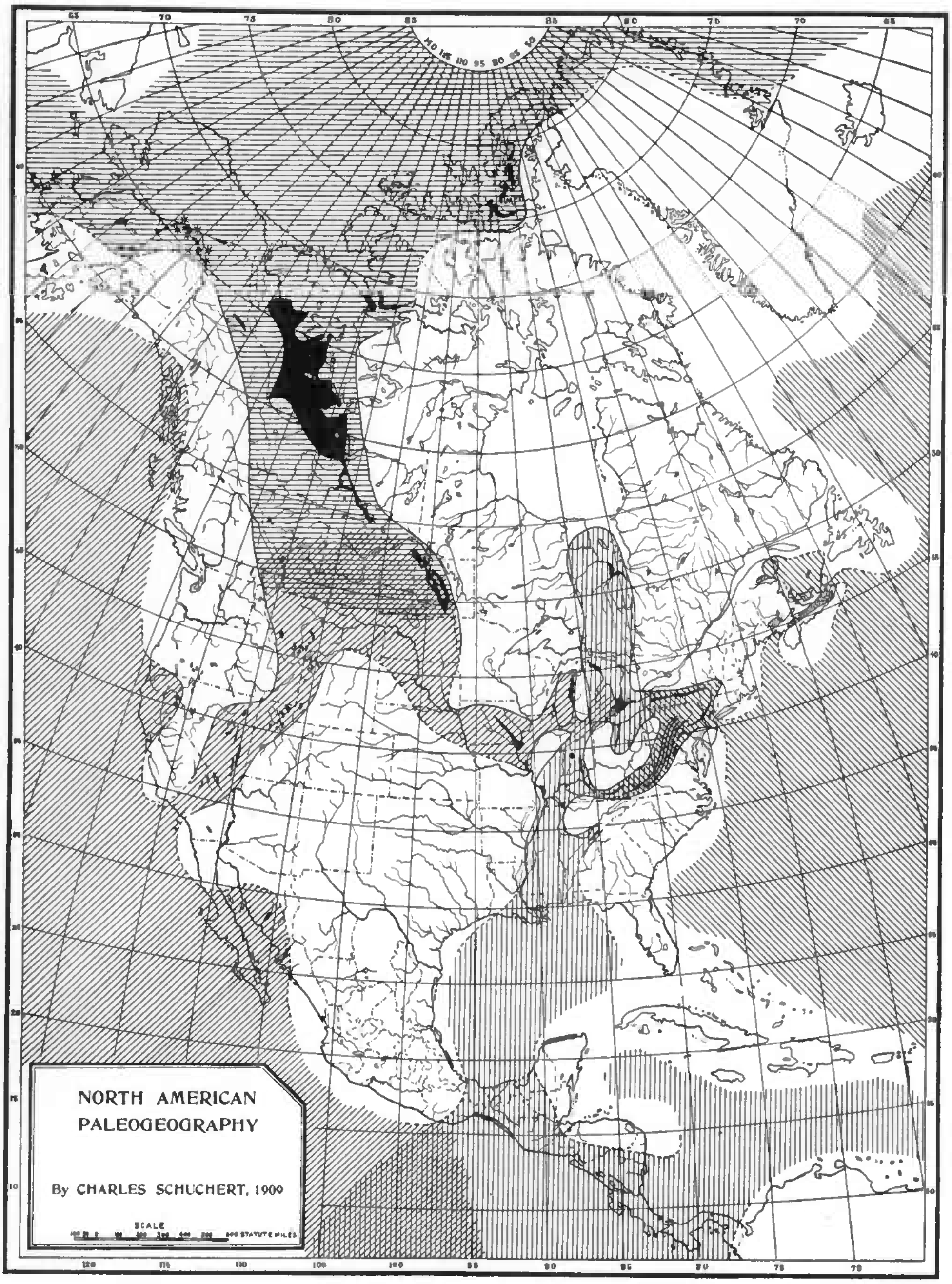
[1] Since the map of Onondaga time, pl. viii, was made, Kindle has shown that the later Onondaga sea was present in western Maryland, and that the Appalachian trough was invaded somewhat earlier than Marcellus time.



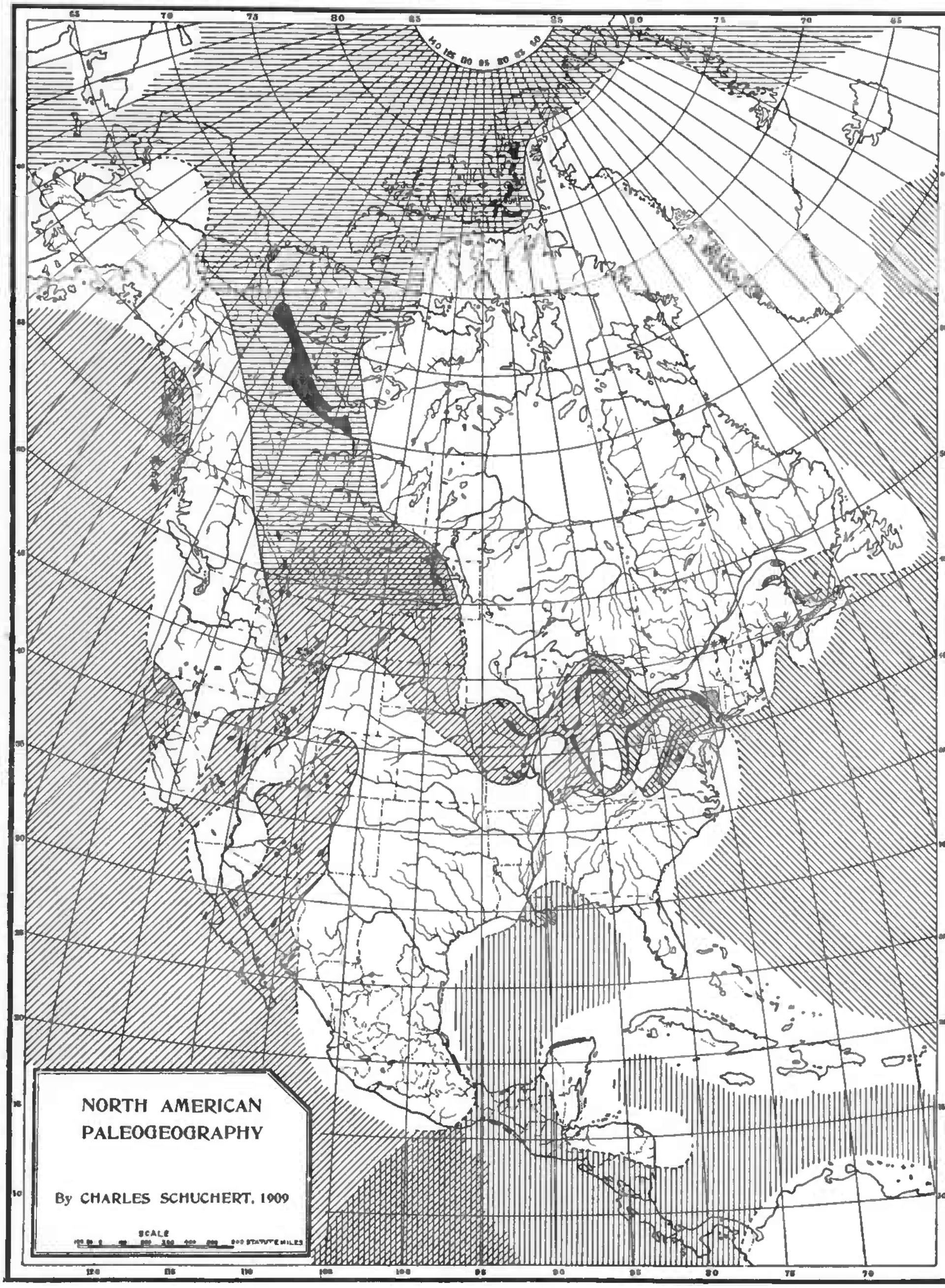
LOWER DEVONIAN (DECEWVILLE).



MIDDLE DEVONIAN (ONONDAGA).



MIDDLE DEVONIAN (LATE HAMILTON).



UPPER DEVONIAN (ITHACA-CHEMUNG).

which are about 4000 feet in elevation, serving as the monument that bears witness to the industry of the rivers of this area and time. The New Jersey Straits were still open, through which into the Appalachian trough the slowly changing *Tropidoleptus carinatus* faunas repeatedly migrated. In Maryland one finds but little of the life of the southern or Mississippian Sea.

In the southern Appalachian trough the greatest abundance and variety of Middle Devonian life occur in the Hamilton member of the Romney formation, the equivalent of the Hamilton formation of New York, but this habitat was an unfavorable one owing to the extraordinarily rapid accumulation of sand and muds. These faunas were repeatedly snuffed out by the great quantity of silt that settled upon them, and it is probable that only during the periods of smaller stream discharge and clearer seas could the permanent region of life—the Atlantic Ocean—again and again distribute its migratory species and the free-swimming larvæ of the abyssal more or less sessile forms. The muds and sands finally accumulated to such an extent that the Appalachian Sea was no longer a fit habitat for marine life, and before the close of the Devonian great areas were exposed as river deltas. Any fresh or brackish water or land forms that were stranded or died on these flats were oxidized and completely destroyed by the air, a fact proved by the barren muds and sands, often red in color, indicating the completeness with which the carbonaceous materials of the organisms had been removed. In places, however, the Atlantic still continued to communicate with the Appalachian trough, even into the time of the next higher series, the Bradford of the Mississippian period, its organic remains being found in northwestern Pennsylvania and eastern Ohio. Subsequent to the Bradford all Atlantic connections ceased in the Appalachian trough, and during the rare intervals when marine waters appeared in Maryland they were derived from the Mississippian Sea with Gulf of Mexico connections.

HISTORICAL REVIEW AND BIBLIOGRAPHY[1]

The prominent physiographic features of western Maryland have long been known, since it was on the route of the early trails and roads from the Atlantic to Fort Cumberland and thence across the Alleghany Plateau to the Ohio Valley. In the early years of the nineteenth century the construction of the National Road and later the surveys for the Chesapeake and Ohio Canal and the Baltimore and Ohio Railroad were instituted, all of which added to the knowledge of the topography of the country and to some extent to its geology.

The earliest attempt to classify the formations of western Maryland and correlate them with the geologic column as then established in Europe was made by William Maclure in 1809. Maclure accepted the Wernerian classification and divided the rocks of this country into the Primitive, Transition, Flœtz or Secondary, and Alluvial. Apparently all of the Maryland rocks now referred to Devonian were included in Maclure's Transition. This article was subsequently revised, enlarged and published in book form in 1817. In this work the highest mountains in western Pennsylvania, Maryland, and a portion of Virginia were referred to the Transition rocks as well as a strip along the banks of the Potomac in western Maryland. It contains a colored geologic map of the United States extending from the Atlantic coast to the western line of Louisiana, Arkansas, and Missouri. The line separating the Secondary and Transition rocks crosses Maryland to the east of Cumberland, all west of that line being referred to the Secondary age, while the Transition rocks extend eastward to or beyond the Blue Ridge. The map published the following year in the Transactions of the American Philosophical Society covers a larger area and the line of separation between the Transition and Secondary rocks crosses Maryland considerably west of Cumberland, so that only the extreme western part of the State is represented as of Secondary age.

James Shriver in his account of the surveys and examinations for the Chesapeake and Ohio Canal in 1824, described to some extent the physiography of Garrett County and made slight reference to its geology.

[1] Contributed by Charles S. Prosser.

In 1834 Professor William E. A. Aikin, of Mt. St. Mary's College, Emmitsburg, Md., published "Some notices of the Geology of the Country between Baltimore and the Ohio River, with a section illustrating the superposition of the rocks." The section follows the route of the National Road from Baltimore through Hancock and Cumberland to Wheeling, West Virginia. This is one of the earliest attempts to explain the geologic structure of the mountains and correlate the different formations. It contains some general account of the limestones and shales to the east and west of Cumberland termed Transition, which are now referred to the Devonian.

The "Report of a Geological Reconnoissance made in 1835" by G. W. Featherstonhaugh contains considerable information regarding the geology of the eastern part of the United States. Featherstonhaugh was a U. S. Geologist and while en route westward evidently crossed the Paleozoic formations of Washington and Allegany counties by way of the National Road. He was among the first to note the fossiliferous beds in these counties and reported them about nine miles west of Clear Spring and at Flint Stone twelve miles from Cumberland. He also describes Shriver Ridge.

A number of the eastern states organized official surveys during the thirties and one of the first was Maryland which in 1833 appointed J. T. Ducatel State Geologist. The Geological Survey of Virginia[1] was organized in 1835 with Professor William B. Rogers, of William and Mary College, as State Geologist, that of Pennsylvania in 1836 with his brother, Henry D. Rogers, as State Geologist, and the same year that of New York. The latter State was divided into four districts with William W. Mather, Ebenezer Emmons, Timothy A. Conrad, and Lardner Vanuxem as Geologists; but the following year Conrad retired from active field work on account of ill health becoming State Palæontologist, Vanuxem became the Geologist of the Third District and James Hall of the Fourth or western New York District.

[1] This was prior to the separation of West Virginia from Virginia which occurred in 1863, consequently the survey covered what is now known as Virginia and West Virginia.

In the annual reports of the Rogers brothers a series of numbers were used to designate their subdivisions of the Paleozoic rocks. The first annual report of Henry D. Rogers, published in 1836,[1] stated that "the detailed examination of the Appalachian region was begun in the southern part of Bedford County, and prosecuted during the residue of the season in this, and the rest of the counties between the Maryland state line and the Susquehanna River, in one direction; and in the Cumberland Valley and the ridge of the Alleghany Mountain, in the other." Professor Rogers reported that the rocks of this region instead of being in the Transition class, as generally believed, belonged in the Secondary epoch. He divided the rocks of the Appalachian region into twelve sets of rocks to which he gave Arabic numerals in ascending order, applying 1 to the oldest division, and concluded that "For the classification, the most convenient and natural arrangement that offers itself, is a subdivision of the entire series into two systems, grouping together the three upper rocks under the name of the *Carboniferous system,* and the lower nine under that of the *Appalachian system*" (*loc. cit,* p. 12). The rocks considered in this volume as Devonian were described under the numbers 6, 7, 8, and 9; and in general No. 6 included those now called the Helderberg, No. 7 the Oriskany, for which Rogers suggested the name "*fossiliferous sandstone,*" No. 8 the Romney and Jennings formations, which he called the "*olive slate stratum,*" and No. 9, the Catskill. In Rogers' second annual report, published in 1838, he definitely introduced the name "Formation" for each of these divisions, changed from Arabic to Roman numerals and described thirteen formations.

This system of classification of the Pennsylvania rocks appears to have been closely followed by William B. Rogers in Virginia and in his report of 1837, published in 1838, he describes the members west of the Blue Ridge. The rocks which are now referred to the Devonian are described under the numbers 6, 7, 8, and 9 and there are frequent references to their exposures to the south of the Potomac River in the northern counties of what is now West Virginia. His report for 1839, published in 1840, correctly referred the arch of Wills Mountain to formation IV and for the

[1] Rogers, First Annual Rept. of State Geologist [of Pennsylvania], 1836, p. 10.

first time identified the succeeding formations from this mountain westward nearly to the summit of Dans Mountain.

Ducatel's reports of Maryland considered mostly the topography of western Maryland and its economic rather than stratigraphic geology. The report for 1840, published in 1841, gives a description of the physical geography of Allegany (which then included Garrett) and Washington counties together with some account of their geology. It contains a topographic map of western Maryland from South Mountain to the western border, a "Geological profile of the Cumberland and National Roads" and states that between Sideling Hill and Dans Mountain the prevailing rocks are limestone, red sandstone, and slate.

On the "Geological map of the Middle and Western States" accompanying Professor James Hall's report of the Fourth District of New York, published in 1843, the southwestern continuation of certain New York formations is shown across Pennsylvania, Maryland, and Virginia. Four different colors are used to represent those formations now referred to the Devonian, all of which cross western Maryland, and the following names and grouping are given in the legend: Helderberg limestones including grits and sandstones, Hamilton group including Tully limestone and Genesee slate, Portage and Chemung groups, and Old Red Sandstone. The outlines of the formations in Maryland are credited to the State Geologist, Professor J. T. Ducatel.

The Geology of Pennsylvania, or Professor Henry D. Rogers' final report, was finished in 1858 and in this work in addition to the Roman numerals for the formations, appeared what has been called the transcendental nomenclature of Rogers. He stated that "it became apparent to the State Geologists of Virginia and Pennsylvania, Professor W. B. Rogers and myself, that none of the existing systems of nomenclature—neither the imported British ones, nor the narrowly local geographical ones of New York—were applicable to our strata."[1] The Paleozoic rocks were divided into fifteen formations or series for which he used terms significant of their relative age "the words employed suggesting metaphorically the different natural periods of the day."[2] In this classifica-

[1] Geology of Pennsylvania, vol. i, Preface, p. vi.
[2] *Ibid.*, p. vii.

tion No. I became the Primal (Dawn) series; while the series now referred to the Devonian with their New York equivalents as correlated by Professor Rogers were the Pre-meridian (Forenoon) or Lower Helderberg limestone of New York; the Meridian (Noon) or Oriskany sandstone; the Post-meridian (Afternoon) or the Cauda-Galli and Schoharie grits and Upper Helderberg limestone; the Cadent (Declining Day) or Marcellus slate, Hamilton group and Genesee slate; the Vergent (Descending Day) or the Portage flags and Chemung group and the Ponent (Sunset) or Catskill group.[1] The Second Geological Survey of Pennsylvania, however, under the directorship of Lesley abandoned this fanciful nomenclature, correlated the majority of the Pennsylvania formations with those of New York and used the New York names.

Professor Hall visited Cumberland in 1856, examined to some extent the geology of the region and a large collection of fossils owned by Mr. Andrews, which, later, he purchased. The following year he published in the Tenth Regent's Report the preliminary description of fifteen species obtained from the Lower Helderberg limestone, Oriskany sandstone and Hamilton shales in the vicinity of Cumberland.

In 1859 the text of volume iii of the Palæontology of New York was published, followed by the plates in 1861. This was the first work in which a large number of fossils from the Devonian of Maryland were described and figured and it marked a great advance in the knowledge of the paleontology of the State. Sixty-two species and one variety are reported from the Lower Helderberg and Oriskany sandstone of Cumberland, of which six species and one variety were described and figured for the first time from the Lower Helderberg and twenty-six species from the Oriskany. Another species confined to Cumberland, Maryland, was described and figured from the Lower Helderberg and six additional ones were reported from that locality. The Oriskany also contained eight additional described and figured species which were confined to Cumberland and fifteen more were reported from that locality.

Philip T. Tyson, the State Agricultural Chemist of Maryland, in 1860 published his first report, which shows a decided advance over the earlier

[1] *Ibid.*, pp. vii and 107, 108.

geological reports of the State. He divided the rocks of the entire State into 24 divisions, some of which were again divided, and each one was called a formation. In general the formations extending into Pennsylvania and New York were correlated with the formations of those States, the Pennsylvania name being given first, followed by that of the New York reports. Those now included in the Devonian System are as follows: Formation No. 15a, Pre-meridian limestone of Pennsylvania, Lower Helderberg of New York; formation No. 15b, Meridian series of Pennsylvania, Oriskany sandstone of New York; formation No. 16a, Cadent slates and shales of Pennsylvania, Marcellus slate, Hamilton group and Genesee slate of New York; formation No. 16b, Vergent series of Pennsylvania, Portage flags and Ithaca and Chemung groups of New York and formation No. 17, Ponent series of Pennsylvania, Catskill group of New York. It also contains the first colored geological map of Maryland on which is shown the distribution of the different formations. There are three colors for what is now recognized as Devonian, the Pre-meridian and Meridian being grouped together as No. 15, the Cadent and Vergent as No. 16 and the Ponent or Catskill as No. 17. There is also a structural section extending from the western line of the State due east to Hancock and thence southeast to Chesapeake Bay.

Hall in volume iv of the Palæontology of New York, published in 1867, reported eleven species of brachiopods from the Hamilton of Maryland. Most of the succeeding volumes of this great work have contained descriptions and figures of new species from the Maryland Devonian, figures of Maryland specimens or reported the occurrence of other species in that State.

In 1876 Mr. Jed Hotchkiss published a work on Virginia containing a colored geological map of Virginia and West Virginia, which had been colored by Professor Wm. B. Rogers in 1873. The Devonian rocks are shown by a single color; but apparently only formations VIII and IX are referred to this system.

In 1880 Mr. Howard Grant Jones published a paper on the Cumberland or Potomac Coal Basin containing a section from the Lower Barren Measures down to what he called the Pocono sandstone. This section differed so strikingly from the generally accepted correlation and structure of this region that the following spring Dr. I. C. White reëxamined the Potomac River section from Piedmont to the summit of Knobly Mountain on the West Virginia side of the river to the east of Keyser. Dr. White's paper is a valuable addition to the knowledge of the structural and stratigraphical geology of western Allegany County and shows conclusively that the quartzose sandstone capping Wills Mountain, which Mr. Jones called the Pocono, is the White Medina (Tuscarora), while the red beds below instead of representing No. IX (Catskill) as Mr. Jones supposed, are the Red Medina (Juniata). The 440 feet called the Lower Mountain Limestone by Jones, is identified by White as the Lower Helderberg and the lower 2000 feet of red shale on the Potomac which Jones supposed to be a repetition by folding of No. XI (Mauch Chunk) is correctly referred by White to the Catskill (Hampshire).

The geology of Bedford and Fulton counties, Pennsylvania, bordering those of Paleozoic Maryland, was published in 1882 by Prof. John J. Stevenson who fully adopted the New York classification and whose accurate correlation has given this work a permanent value.

Professor Wm. B. Rogers prepared the list of geological formations found in Virginia and West Virginia for the first edition of MacFarlane's Railway Guide published in 1879, in which he gave the New York names first place, while in two parallel columns are given the equivalents in the Roman numbers of the Pennsylvania and Virginia annual reports and the names of the Pennsylvania final report. The same scheme of classification was used in explaining the colors on "Hotchkiss' Geological Map of Virginia and West Virginia." The geology by Prof. W. B. Rogers, published in 1884, is a reproduction, with some changes, of the one published in 1876. The Devonian is given as composed simply of Nos. VIII and IX and is represented by a single color.

In the second edition of MacFarlane's Railway Guide, published in 1890, I. C. White prepared the "Table of geological formations in West Virginia" (p. 337) in which he fully adopted the New York names, although the Pennsylvania numbers are given in another column, but the names of Rogers' final report are not mentioned.

Professor G. H. Williams in 1891 described briefly the formations in the vicinity of Hancock and Cumberland, illustrated by figures the geological structure and used the New York names for the formations. The same number of the Johns Hopkins University circulars contained a preliminary catalogue of the Paleozoic fossils of Maryland by Charles R. Keyes, and a large majority of the species are credited to the Lower Helderberg, Oriskany, and Hamilton formations.

Mr. Darton published in 1892 "Notes on the Stratigraphy of a portion of Central Appalachian Virginia" in which new names are proposed for many of the Paleozoic formations of the Virginias. This paper contained the first description of the Monterey sandstone, the Romney shales and the Jennings and Hampshire formations.

The geological portion of the World's Fair Book on Maryland written by Professors G. H. Williams and W. B. Clark and published in 1893, contains a description of the Devonian geology of the Appalachians proper and the Alleghany Plateau (pp. 46-49) in which in general the New York names are used for the Maryland Paleozoic formations, although in the legend of the geological map, which was edited by Prof. Williams, the names of the New York formations are followed in parenthesis by the equivalent ones proposed by Mr. Darton. Four divisions of the Devonian are represented on the map. These are the Helderberg (Lewistown) limestone; Oriskany (Monterey) sandstone; Chemung-Hamilton (Jennings-Romney) slates and shales, and the Catskill (Hampshire) red sandstone. The map also gives a structural section from east to west across the State.

Mr. Darton stated in his paper of 1892 that the names proposed for the Paleozoic formations had been selected for the geological maps of Appalachian Virginia to be published by the U. S. Geological Survey. The Piedmont folio was published in 1896. It covers the southern part of Garrett County in which the Jennings and Hampshire formations of that area are mapped and described, and the southwestern corner of Allegany County. The following formations, now referred to the Devonian, are represented on the map and classified as Lewistown limestone and chert-lentil forming the upper part of the Silurian, Monterey sandstone given as transitional, and the Devonian composed of the Romney shale, and the Jennings and Hampshire formations.

In 1897 the first volume of the Maryland Geological Survey appeared in which Prof. Clark described the Maryland formations and gave first the name adopted by the U. S. Geological Survey, for its Virginia and West Virginia folios, followed in parenthesis, by the name of the equivalent New York stage or series. On the geological map the rocks now referred to the Devonian are represented by four different colors with the following explanation: Lewistown (L. Helderberg-Niagara), Monterey (Oriskany), Jennings-Romney (Chemung-Hamilton), and Hampshire (Catskill). Later and more complete investigations have shown that in all essential characters the majority of the Paleozoic formations of Maryland agree with those of New York and Pennsylvania.

Prof. Charles Schuchert published a paper in 1900 on the "Lower Devonic aspect of the Lower Helderberg and Oriskany formations" which contains a section of the Helderberg limestone and Oriskany sandstone as shown at the "Devil's Backbone" on the Baltimore and Ohio Railroad to the northwest of Cumberland. In a subsequent paper he changed to some extent his identification of the subdivisions of the Helderberg limestones bringing them more nearly in harmony with the results obtained by Dr. Rowe and the writer. The former paper gave an extended review and discussion of the Lower Devonian of Europe and America.

The same year Dr. John M. Clarke again reviewed the evidence regarding "The Devonic age of the Helderbergian fauna and the base of the Devonic System in New York" and considered the arguments "from correlation," "from the intrinsic character of the fauna," and "from stratigraphy." In this review Dr. Clarke stated that "the strongest demonstration of its Devonic affinities is intrinsic" and derived from the study of the New York Helderberg fauna.

In 1900 "The Geology of Allegany County," by Dr. C. C. O'Harra, was published in the Allegany County report. It contains a full description of the formations of Allegany County together with an account of their stratigraphy, areal distribution, and of the character and origin of their sediments. The Devonian is given as composed of the Helderberg (its first appearance in the Devonian in the Maryland reports), Oriskany, Romney, Jennings and Hampshire formations, the detailed description of which is given on pp. 94-109. The nomenclature and classification of the formations are those adopted by Messrs. Clark, Prosser, and Rowe for the Maryland formations. The accompanying map gives the areal distribution of the formations described in the county, while the legend gives their thickness together with a very condensed account of the geology and soils of the county.

During the same year Bailey Willis published his paper on "Paleozoic Appalachia or the History of Maryland during Paleozoic time" in which land and water areas are discussed and illustrated by maps. Under the Devonian its early shallow waters and lowlands and the later highlands are described. This includes a description of the wide extent of the Devonian lowland, the character and thickness of the deposits, the topography of the highlands and the character of the Devonian deformation.

In 1901 the writer published an article on "The Palezoic formations of Allegany County, Maryland." The different formations of the county, ranging from the Juniata of the Ordovician to the Dunkard of the Permian are described and correlated with the formations of New York and Pennsylvania, as far as they are represented in those states. The Coeymans, New Scotland, and Becraft formations of the Helderberg series of New York are identified and described for the first time in Maryland. The Romney formation is described as composed of the Marcellus shale and Hamilton beds of New York, the Jennings formation as composed of the Portage and Chemung of New York and the Hampshire as representing at least part of the Catskill formation of New York. The Helderberg limestone, Oriskany sandstone, Romney, Jennings, and Hampshire formations are referred to the Devonian System.

In 1902 Dr. George C. Martin published an account of the geology of Garrett County in which he fully discussed its stratigraphy, structure and the interpretation of its sedimentary record, and gave the areal extent, lithologic description and taxonomy of its various formations. Only two of the Devonian formations, the Jennings and Catskill, are exposed in the county, and these are described on pp. 85-90. The Atlas contains a map showing the areal distribution of the different formations and soils, while the legend gives the thickness and a very condensed description of the geology and soils. Schuchert in 1903 published a paper "On the Lower Devonic and Ontaric formations of Maryland" in which the deposits of the Cumberland Basin are quite fully described. Under the Devonian the Coeymans, New Scotland, and Becraft limestones of the Helderberg and the Oriskany formation are discussed in considerable detail and paleontologic evidence given for their correlation. It contains a complete composite section from the Juniata formation to the base of the Marcellus shale, in which the thickness and description of zones, locality of sections and correlation with New York formations are given.

In 1903 H. S. Williams' bulletin on The Correlation of Geological Faunas appeared. This contained a brief discussion of the Romney formation of western Maryland. Professor Williams found all of the dominant species of the *Tropidoleptus carinatus* fauna in the list of Romney species furnished him by the writer and concluded that "This is sufficient to establish the extension of the *Tropidoleptus* fauna, in its integrity, as far south in the Appalachian trough as Maryland."

In 1904 the writer published an article entitled the "Description and Correlation of the Romney formation of Maryland" which gave a condensed description of the formation together with some account of the evidence favoring the correlation of the lower member with the Marcellus shale and the upper with the Hamilton beds of New York. The European equivalents and the general distribution was also discussed.

In 1906 Dr. E. M. Kindle published a paper on the Faunas of the Devonian section near Altoona, Pa., a locality about 65 miles northeast of Cumberland. This paper recognizes the Oriskany, Marcellus, Hamilton, Nunda (Portage), and Chemung faunas near Altoona and therefore is important in corroborating the correlation of the Maryland Devonian formations with those of New York.

The Physical Features of Maryland, by Professors Clark and Mathews, published in 1906, contains an accurate condensed account of the Devonian period. The Lower Devonian is divided into the Helderberg formation, composed of the Coeymans, New Scotland, and Becraft members, and the

Oriskany formation; the Middle Devonian is divided into the Romney formation made up of the Marcellus and Hamilton members; while the Upper Devonian consists of the Jennings formation composed of the Genesee, Portage, and Chemung members, and the Hampshire formation. This report was accompanied by a new geological and agricultural soil map of the State bearing date of 1907, on which the distribution of the Devonian formations, viz., Helderberg, Oriskany, Romney, Jennings, and Hampshire is shown.

Dr. C. K. Swartz published a preliminary article on "The Ithaca Fauna in Maryland" in 1907 which was followed in 1908 by a more extended one on the succession of faunas in the Portage and Chemung formations of Maryland. These two papers contain the first account of the Ithaca fauna in Maryland which, together with the subjacent Naples fauna, occurs in the Portage member of the Jennings formation.

In the Mercersburg-Chambersburg Folio of the U. S. Geological Survey, published in 1910, the area in Pennsylvania just to the north of Washington County, Maryland, is described by George W. Stose. The Helderberg limestone is considered the youngest formation of the Silurian System which is shown in the southwestern part of the Mercersburg quadrangle, the one located directly northeast of the Hancock quadrangle. From this area certain species of fossils are listed which "are referred to the Coeymans ('Lower Pentamerus') horizon of the Helderberg limestone of New York," while from the upper part of the limestone other species were obtained which are stated to be "undoubtedly a New Scotland ('Delthyris shaly limestone') fauna." Furthermore it was stated that "A Becraft fauna was also found in this formation in the Hancock quadrangle by the Maryland Geological Survey, so that correlation of the formation as a whole with the New York Helderberg is positively established."[1]

Under the Devonian System it is stated that "Few outcrops of the Oriskany formation are present in the Mercersburg quadrangle," from which but three Oriskany species were reported and from just outside (west) of the quadrangle eight additional ones, and this is stated to be

[1] *Loc. cit.*, Field Edition, p. 86.

"a typical upper Oriskany fauna, and other Oriskany species are found in adjoining areas, so that correlation with the Oriskany of New York is established."[1] The Romney and Portage shales, which are apparently recognized as two formations, "are faulted out at the surface" in the Mercersburg quadrangle. The northwestern corner of the quadrangle is covered by higher rocks which are referred to the Chemung formation. Only "*Spirifer mesistrialis, Chonetes scitula, Schuchertella chemungensis arctostriatus,* and undetermined Bryozoa" were obtained from these rocks in this quadrangle; but nine species are listed from the Hancock quadrangle. Mr. Stose states that "These forms are not all diagnostic of the typical Chemung of New York, as recently restricted by Williams to the *Spirifer disjunctus* fauna. *Spirifer disjunctus* was not found in the Mercersburg quadrangle and its range was therefore not determined. In the Hancock quadrangle the lower part of this formation, characterized by the presence of sandy strata with granular sandstone beds, does not contain the typical Chemung or *Spirifer disjunctus* fauna but a recurrent Hamilton fauna characterized by *Spirifer mesistrialis*. In New York the sandy strata that characterize the Chemung at Chemung Narrows, the type locality, descend below the base of the *Spirifer disjunctus* fauna toward the east, and the Chemung formation there includes strata that contain a *Spirifer mesistrialis* fauna. The formation in the Mercersburg quadrangle is therefore mapped as Chemung."[2]

Finally, it is stated that "Red arkosic sand and shale of the Catskill formation occur just beyond the northwest corner of the Mercersburg quadrangle. . . . . No fossils except unidentified plant remains have been found in this formation, but its lithologic character and stratigraphic position establish its correlation with the Catskill of New York and northeastern Pennsylvania. It is undoubtedly a land or fresh-water deposit replacing the upper part of the marine Chemung."[3]

In 1910 Dr. C. K. Swartz published a paper on the recurrence of the Tropidoleptus fauna in the Chemung of Maryland, in which he shows that there are two recurrences of the *Tropidoleptus carinatus* fauna in the

[1] *Loc. cit.*, pp. 87, 88.
[2] *Loc. cit.*, p. 89.
[3] *Loc. cit.*, p. 90.

Upper Devonian of Maryland, one in the upper part of the Portage and the other about 600 feet above the base of the Chemung.

In 1911 Dr. E. M. Kindle's paper on "The southerly extension of the Onondaga Sea in the Allegheny region" appeared. It contains a brief statement of the paleontologic and stratigraphic data which the author considers as showing the continuation of the Onondaga fauna from the Delaware River southwesterly to Tennessee.

Kindle's detailed paper, of which the above was in the nature of an abstract, appeared in 1912 as Bulletin 508 of the U. S. Geological Survey under the title The Onondaga Fauna of the Allegheny Region.

The Pawpaw-Hancock Folio of the U. S. Geological Survey was published in 1912 in which the Lower Devonian was discussed by G. W. Stose and E. O. Ulrich, and the Middle and Upper Devonian by C. K. Swartz. The limits and correlation of the various divisions of the Devonian were substantially the same as those recognized in the present volume.

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THE LOWER DEVONIAN DEPOSITS OF MARYLAND

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INTRODUCTORY[1]

The typical development of the Silurian System was first made out in Wales and in the adjoining counties of England and described by Murchison. Here the prolific marine faunas of the shales and limestones gradually disappear in the upper series—the Ludlow. The strata by degrees take on a red color and seem to pass without break from brackish-water deposits into fluviatile sandstones and conglomerates. This great series of continental sediments is unfossiliferous, except for the eurypterid remains of *Pterygotus*, the "seraphim" of the quarrymen, and the varied array of fresh-water fishes. This series of coarse fragmentals is the Old Red Sandstone and is more than 10,000 feet in thickness. In the typical area of the Silurian system, therefore, there is no final marine fauna. Tho original Devonian also lacks a definite marine base. These conditions are further complicated by the fact that nowhere in western Europe is there a fairly complete succession of Silurian and Lower Devonian strata yielding abundant marine faunas. There is, however, a splendid section, rich in the fossils of these two systems in the Bohemian region, all of which Barrande referred to the Silurian. The dividing line between these two systems is there definitely drawn at the base of the Konieprusian, a

[1] Contributed by Charles Schuchert who states that all the faunal work was accomplished previous to 1904 while Assistant Curator in the U. S. National Museum, and all the writing was completed before the appearance of Clarke's Early Devonic History of New York and Eastern North America. All the new forms, however, have been reconsidered in order that no synonyms may appear in this volume.

horizon which is the probable equivalent of the American New Scotland but may also include the Coeymans. Below this zone was said to occur another member of the series, consisting of black flaggy limestones, with a strange fauna, in the main unlike those above and below, and characterized by the peculiar gastropod *Hercynella bohemica.* It has now been determined that, owing to widely dissimilar environment, these two Bohemian zones are different faunal and lithologic facies of one general horizon. As far as known, there is no transition between the zones of E representing the Silurian and those of F now placed at the base of the Devonian. Further, the Bohemian Silurian and Devonian faunas are derived from the southern or Mediterranean realm, while in northern Europe the Silurian had its origin in another province and in addition all was there land during the early stages of the Devonian. It probably is more accurate to state that the basal Devonian strata of the Rhineland are almost barren of marine life and that the little that has been discovered may be as old as the Helderberg, yet no safe data are revealed on which to base correlations between Europe and America. There is, therefore, as yet no accepted European standard section that unmistakably indicates the dividing line between the Silurian and the Devonian. In western Maryland, however, a long complete section extends through the later stages of the Silurian into the basal Devonian, but unfortunately all the members of the former series have not yet yielded a characteristic marine fauna. These beds, the Tonoloway and Wills Creek formations, do not represent a normal marine habitat, but are rather derived from very shallow seas accumulating both natural cement limestones and magnesian limestones. Above the latter appears the Helderberg formation, which at first is composed of nodular limestones (the Keyser member) which are succeeded by shaly limestones and shales and these by heavier bedded limestones. The lower strata of the Helderberg contain the earliest normal marine fauna, not a large one, but varied enough when described from the entire Appalachian region to be the basis for correlation. This horizon appears to introduce a new diastrophic cycle in that it lays the foundation for the great Devonian submergence of the North American Continent.

Previous to 1839 no Devonian System was known to geologists. In the Philosophical Magazine for July, 1835, Murchison had annnounced his conclusion that beneath the Old Red Sandstone, then the oldest known series of the Paleozoic era, lay a huge complex of rocks which he named Silurian, after an ancient tribe that inhabited Wales at the time of the Romans. Above was the great barren series of red rocks followed by the Carboniferous. About the same time, Lonsdale had obtained corals from certain limestones in Devonshire, England, which after careful study he announced to be intermediate in development between those of the Upper Silurian and the Carboniferous. He thus discovered the Devonian fauna and furnished the "most cogent reason" that led Sedgwick and Murchison to delimit a series of rocks that lay above the Silurian and beneath the Carboniferous limestone. In the Philosophical Magazine for April, 1839, these authors together proposed the Devonian System, in a paper entitled: On the Classification of the Older Rocks of Devonshire and Cornwall.

The discovery of the Devonian System is an interesting one, and the history of its establishment as given by Murchison in his classic work Siluria (edition 1854, pp. 257-8) is here quoted:

"*Devonian rocks* (*the equivalents of the Old Red*) *in Devon and Cornwall.*—The crystalline and slaty condition of most of the stratified deposits in Devon and Cornwall, and their association with granitic and eruptive rocks and much metalliferous matter, might well induce the earlier geologists to class them as among the very oldest deposits of the British Isles. In truth, the southwestern extremity of England presented apparently no regular sedimentary succession, by which its grey, slaty schists, marble limestones, and silicious sandstones could be connected with any one of the British deposits the age of which was well ascertained. The establishment of the Silurian System, and the proofs it afforded of the entire separation of its fossils from those of the Carboniferous era, was the first step which led to a right understanding of the age of these deposits. The next was the proof obtained by Professor Sedgwick and myself, that the 'culm measures' of Devon were truly of the age of the carboniferous limestone, and that they graduated downwards into some of the slaty rocks of this region. Hence, in the sequel it became manifest, that the rocks now under consideration, were the immediate and natural precursors of the coal era, and stood therefore in the place of the Old Red Sandstone of other regions. The highly important deduction, however, of Mr. Lonsdale, that the fossils of the South Devon limestones, as collected by Mr. Austen and others, really exhibited a character intermediate between those of the Silurian system and of the carboniferous limestone, was the most cogent reason which induced Professor Sedgwick and myself (after identifying North and South Devon) to propose the term Devonian.[1] The inference that the stratified rocks of Devonshire and Cornwall, though of such varied composition, are really the equivalents of the Old Red Sandstone in the regions alluded to, has since, indeed, been amply supported and extended by the researches of Sir Henry De la Beche, Professor Phillips, and many other good geologists."[2]

Murchison and Sedgwick further state: "The most instructive of the sections published by my colleague and myself to illustrate the general structure of Devonshire, is that of which the diagram in page 256 is a compiled reduction. It is a section across North Devon from the Foreland on the British Channel, to the granitic ridge of Dartmoor on the south, and exhibits a copious succession of the Devonian rocks between Linton and Ilfracombe on the north, and Barnstaple on the south; the whole dipping under strata of the carboniferous age, on the opposite side of a wide trough of which, or on the north flank of Dartmoor, the Upper Devonian strata again rise to the surface.

"North Devon has thus been selected as affording, on the whole, the best type of succession of the rocks to which the name Devonian was applied; because it offers a clear ascending section through several thousand feet of varied strata, until we reach other overlying rocks, which are undeniably the bottom beds of the true carboniferous group."

These great English masters of geology soon realized that to unravel the North Devon sequence presented great difficulties, and they therefore

[1] See Reports of Brit. Assoc. for the Advancement of Science, 1836, Bristol meeting. Sedgwick and Murchison, Trans. Geol. Soc. London, vol. v, p. 633, and Phil. Mag., vol. xi, p. 311. Lonsdale, Trans. Geol. Soc. London, vol. v, p. 721.

[2] See Report on the Geology of Cornwall, Devon, and W. Somerset, by De la Beche, 1839, and the Palæozoic fossils of the same region, by Professor Phillips, 1841.

FIG. 1.—VIEW LOOKING UP THE POTOMAC RIVER FROM CACAPON MOUNTAIN SHOWING DEVONIAN TOPOGRAPHY.

FIG. 2.—VIEW FROM PROSPECT ROCK ON CACAPON MOUNTAIN SHOWING GAP IN SIDELING HILL.

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began the study of equivalent formations in Germany, along the lower Rhine Valley. In the end it was well that they were led to do this, for "the Devonian system was founded upon one of the most unfavorable and incomplete developments of that series of rocks and faunas known in any part of the globe; a more precise scope was given to it by the work of its founders, Murchison and Sedgwick, in the Rhineland, but even there no determination of its lower limit was made. This admitted hiatus in the typical succession of Devonian to Silurian, is the parent of the prolific discussions are 'post-Silurian' and 'Hercynian' faunas."[1]

In regard to the unraveling of the succession in Rhineland, the leading student of the German Devonian, Professor Kayser,[2] of Marburg University, states that Murchison and Sedgwick "first broke ground on the continent in the Rhenish Schiefergebirge and their westerly extension, the Ardennes, the largest and best developed Devonian area of western Europe, which even up to the present day continues to add more to our knowledge of the Devonian than any other [European] area.

"The famous essay of the two English observers devoted to the Rhenish mountains, appeared in 1842,[3] and its value was enhanced by the paleontological appendix contributed by d'Archiac and de Verneuil. In this classical work, a part of the Taunus and Hunsrück was considered as Cambrian; the chief mass of the Schiefergebirge as Silurian; a smaller part, including the Eifel Limestone formation, as Devonian; . . . . but the classification of the older beds has needed considerable alteration. The merit of undertaking this necessary revision is due to the 'Rheinischen Uebergangsgebirges' of Ferd. Roemer, appearing in 1844, in which the author shows that the chief mass of the Schiefergebirge must, according to its fossils, be correlated not with the English Silurian, but with the Devonian.

"The extent of the Devonian in the Rhenish Schiefergebirge, the accuracy of the observations made upon it, the completeness and variety of the series, and its richness in fossils," make it the most important area

[1] Clarke, Amer. Geol., vol. xiv, 1894, p. 122.

[2] Text-book of Comparative Geology. Translated by Philip Lake, London, 1893, pp. 89-91.

[3] Trans. Geol. Soc., 2d ser., vol. vi, p. 222.

for this system. "This mountain region, which in general has the form of a plateau, stretches from the Eder and Diemel to beyond the Meuse," and consists of "strongly compressed beds," with a "system of reversed folds. . . . . All these folds consist of Devonian rocks, altogether probably at least 20,000 feet thick.

"Within the Devonian rocks themselves no unconformity has yet been found, and the whole succession seems to have been deposited without any important check, and passes up without break into the overlying Culm."

After seeing the work of Roemer above mentioned, Murchison admitted the errors made by Sedgwick and himself in the Rhenish area, and in his famous book Siluria (1854) he writes as follows:

"The clear general views of that Nestor of geologists, D'Omalius d'Halloy, the remarkable work and map of M. Dumont, as well as the previous labors of Prussian geologists, including the maps of Leopold von Buch, Hoffman, von Dechen, and Öynhausen, unquestionably led the way in the succession of efforts, through which our present knowledge has been obtained. After the publication of the above works, Professor Sedgwick and myself endeavored to show (1839) that, like Devonshire and Cornwall, the Rhenish provinces contained a great mass of those strata, intermediate between the Silurian and Carboniferous deposits, which we had called Devonian; the equivalent, in our belief, of the Old Red Sandstone of Scotland and Herefordshire. Our contemporaries have admitted that, in our excursion of one long summer in Germany, we succeeded in proving the existence of such an intermediate series both in Prussia and Belgium, and also in showing how, on the right bank of the Rhine, the uppermost 'grauwacke' was divisible into lower Carboniferous and upper Devonian rocks. Misled, however, by an erroneous interpretation of some of the fossils (for at that time the Lower Devonian forms had been little developed), we adopted the belief, that the inferior 'fossiliferous grauwacke,' or that which has since been called the 'Spirifer Sandstein' of the Rhine, was an equivalent of the Upper Silurian. I have been convinced, through the palæontological labors of Ferdinand Roemer and the brothers Sandberger, that the types of that lower Rhenish subdivision are distinct from the Upper Silurian, and in harmony with the lowest Devonian group of other countries. And for some years I have been aware that, whilst our sections representing the succession of the mineral masses were correct, the interpretation or synonymy to be attached to the lower division was erroneous. . . . .

"It is, however, satisfactory to have ascertained in a recent visit to my old ground, that all the knowledge acquired in the fourteen years which have elapsed since our survey was made, has but led to a much more complete identification of the Rhenish provinces with Devonshire, than that which was proposed by my colleague and self. In short, it now appears that not some only, as we thought, but all the palæozoic strata of Devon have their equivalents on the banks of the Rhine. So, that, starting from the North Foreland of the British Channel, and ascending into the heart of the culm-fields, ... the geologist has before him the successive representatives of the Rhenish deposits.

"Those persons who may refer back to the sixth volume of the Geological Transactions of London, will, therefore, understand that all the Rhenish ground which is described or colored in the map and sections as Upper Silurian, is now embodied in the Devonian rocks; whilst to their admirable description of the fossils MM. d'Archiac and de Verneuil have but to add the one plate of the few so-called Silurian fossils, to their thirteen plates of true Devonian types, and all the general features of our labors will be in harmony with subsequent observations" (pp. 346-366).

As has been seen, a proper understanding of the Devonian faunal succession requires that its study should begin in the Rhineland and Devonshire. At the same time, if one is to learn the basis on which the Germans subdivide their Devonian System of formations into Lower Devonian, or Paleodevonian as it is now often called, familiarity with the results of their labors must first be acquired.

In regard to the Lower Devonian of the Rhine, Kayser states:

"This consists of at least 10,000 feet of sandy and clayey beds, almost entirely free from lime. The fossils which occur in it are almost always mere stone-casts. . . . . They are generally rare and are found only in isolated beds, which are often separated by many hundred feet of practically unfossiliferous rock. The fauna consists chiefly of Brachiopoda.

The only other important forms are Lamellibranchs, Crinoids, and some Trilobites and Gasteropods, whilst Cephalopods and Corals are few in number. Some species . . . . go through the whole or almost the whole series of beds, whilst others have a more restricted range. In general the constitution of the fauna points to a shallow sea, and the ripple-marks frequently met with at all horizons also speak in favor of this view." [1]

The present writer has seen the German sections and has studied the faunas, and it will here be sufficient to state that further comparison between this area and that of Maryland need not be instituted, as the faunas of the latter do not belong in the northern European Province. The Rhenish Lower Devonian begins with the Taunus and Gedinnian series having small faunas which are wholly unknown in America. Above follow the Siegen and the Coblenzian series, with a succession of faunas closely related to those of the outer St. Lawrence Sea at Gaspé, Percé, and Dalhousie, Canada. These American biotas have been recently described by Clarke,[2] and in them are several of the most characteristic Oriskany species also found in Maryland, indicating that in late Lower Devonian time the Appalachian trough was in direct connection with the St. Lawrence Sea.

The nearest European analogue of the earliest member of the Lower Devonian of Maryland is undoubtedly to be found in Bohemia, and is known as the Konieprusian. Its fossils have been described in great detail, with the finest of illustration, by Barrande, in various volumes of his great classic Système silurien du centre de la Bohème. The stratigraphic description of this Devonian is well set forth by Katzer, in his Geologie von Böhmen, second edition, Prag, 1902.

In 1900, the writer compared the Konieprusian fauna with that of the Helderberg and found the two to be very similar, in fact parts of one faunal realm. He also found that both appear to represent the oldest Devonian life. Close resemblances are seen among the brachiopods and the most important Helderberg forms have direct equivalents in the

[1] Text-book of Comparative Geology, 1893, p. 92.

[2] Clarke, J. M., Early Devonic History of New York and Eastern North America. Memoir 9, N. Y. State Mus., part i, 1908; part ii, 1909.

Konieprusian. In his paper on the Lower Devonic Aspect of the Lower Helderberg and Oriskany Formations, he stated: "Each region has, of course, its own development, and the common forms of one region may be rare in the other. For instance, in America the great development . . . . of Dalmanella and Rhipidomella" has but little variation in the Konieprusian, "while here the spire-bearing families Meristellidæ and Athyridæ have a far greater diversity. The same is also true for the Rhynchonellidæ, although these shells are varied and abundant in the Lower Helderberg. . . . . The great diversity of the fenestelloids" in the Konieprusian "is in harmony with a similar development" in the New Scotland. "The stromatoporoids are also in harmony with this view. The trilobites do not oppose this correlation, but two characteristic species of the Lower Helderberg—*Dalmanites micrurus* and *Acidaspis tuberculata*—find their equivalents in the next higher zone, or étage G. . . . . The writer therefore concludes that the Konieprusian (F_2) and the Lower Helderberg are the equivalents of each other and represent the best known lowest Lower Devonian faunas."[1]

The Oriskany equivalents are not present in southern Europe and if, as is probably true, this time is represented by faunas, they are very unlike the American development. Nor is the southern Oriskany life—the Camden of the Mississippian Sea—present in Europe, yet when the typical Oriskany and more especially the Gaspé faunas are compared with those of the Coblenzian of northern Europe, the faunal connections are at once convincing and indicate that migration between these areas took place by way of the north shore of Poseidon or the North Atlantic.

In reviewing the various efforts of American geologists to classify the formations now comprising the Lower Devonian, it is not necessary to go back farther than the year 1842. The epoch-making work of the New York State Survey was at that time completed, and the geologic section of that State has since been regarded as the "standard" of correlation for most of the other American and the Canadian Paleozoic areas. In the western part of New York State are to be seen the longest Devonian sections, yielding an abundance of organic remains. There is, however, almost no

[1] Schuchert, Bull. Geol. Soc. America, vol. xi, 1900, pp. 264, 265.

Lower Devonian in this region, which is best developed in the Helderberg Mountains in the eastern part of the State. This area of the "Third Geological District" was studied by Lardner Vanuxem,[1] who had attended the School of Mines at Paris, France, he being the only American then having had this advantage. The "New York System" embraced all the Paleozoic strata of the State which are divided into 30 named groups. The formations that are of particular interest in this connection are those termed the

Helderberg division.	Onondaga salt group [= Salina of modern geologists], Water-lime group [Rondout and Manlius], Pentamerus limestone [Coeymans], Catskill shaly limestone [Kalkberg, New Scotland, and Becraft], Oriskany sandstone, Caudagalli grit [Esopus], Schoharie grit, Onondaga limestone, Corniferous limestone [now included in Onondaga].

All these formations and the higher ones of the Erie division up to the Catskill were included in Murchison's Silurian System, while the Devonian embraced the Catskill at the top of the New York System. The New York State Geologists therefore did what Barrande was doing in Bohemia, that is, included all the Devonian of their respective localities in the Murchisonian Silurian. The change came a few years later, after de Verneuil's visit to America.

In 1843 appeared Hall's Survey of the Fourth Geological District and on page 18 is again seen the foregoing arrangement of formations into the "Helderberg series." Here also it is stated that the Silurian System "embraces the rocks and groups from the Utica slate to the Hamilton group" and that the Devonian corresponds "to the Chemung and Portage groups," and also includes "a portion of the Hamilton."

In 1846, Ed. de Verneuil,[2] one of the ablest paleontologists of his time, visited America to study the Paleozoic rocks. His preparation for making correlations was far in advance of that of any other scientist, as he had already studied the Paleozoic rocks of Russia and Sweden and was familiar

[1] Geol. N. Y., vol. iii, Surv. Third Geol. Dist., 1842, pp. 11-16.

[2] Bull. Soc. géol. de France (ii), t. iv, 1847, pp. 646-710. This paper was translated, condensed, and annotated by James Hall. Amer. Jour. Sci., vol. v, 1848, pp. 176-183, 359-370; vol. vi, 1849, pp. 45-50, 218-231.

with those of England and France. His purpose in coming to America was "to ascertain if the stratigraphical distribution of animals is the same there as in Europe." He became enthusiastic over the extensive development of the Paleozoic formations of this country, particularly of New York, and stated: "No country in Europe offers us so complete and uninterrupted a development of the Silurian and Devonian systems; to observe it, it is necessary to cross the Atlantic."

Hall recalls that de Verneuil "suggests a union of the water-lime, the *Pentamerus galeatus* limestone, the *Delthyris* shaly limestone, and upper *Pentamerus* limestone, as one group. In this not only do we readily acquiesce, but are happy to be sustained in what we have already done in effect, by so able and impartial an observer as M. de Verneuil" (p. 180). This corresponds nearly with the present usage of the serial term Helderberg, as defined by Clarke and Schuchert,[1] and would be identical with their delimitation if the "water-lime," now the Manlius, were excluded. Again, de Verneuil proposed to unite the Caudagalli grit (=Esopus) with the Schoharie grit, but in this Hall's view has proved to be the correct one. He states that "the Caudagalli grit commences with the termination of the Oriskany sandstone, contains no fossils except the peculiar 'enigmatical' one giving it the name, is coëxtensive in New York with the Oriskany sandstone" (p. 181).

In this paper it is found that de Verneuil step by step placed the lower boundary of the Devonian lower and lower, from Conrad's limit "below the Portage group" until finally the Oriskany was made the base of the American Devonian (Hall's translation, pp. 366-370). This was a great departure from the delimitation of the Silurian and Devonian systems then recognized. Hall states: "It appears clearly established, judging from the facts advanced and opinions expressed by M. de Verneuil, that the horizon recognized in Europe as the base of the Devonian system, finds its parallel at the base of our upper limestone series of the Helderberg, or at the bottom of the Schoharie grit. The Oriskany sandstone must remain for the present debatable ground" (p. 230). In 1849, therefore, Helderberg was Silurian, Oriskany remained debatable as to which

[1] Science, vol. x, 1899, pp. 874-878.

system it should be referred to, and the Devonian began with the Schoharie at the base of the Onondaga.

Hall[1] again maintained this view in 1861, when he published the text of the third volume of Paleontology of New York, and this arrangement was sustained until 1889, when Clarke[2] questioned Hall's classification. In his paper entitled The Hercynian Question, he reviews the various memoirs and discussions relating to the Lower Devonian faunas of Europe, and in the light of the results attained he then analyzes the Helderberg faunas, stating: "The foregoing data assuredly indicate a striking development in the typical Lower Helderberg fauna, of organic groups, which in their culmination are characteristic of the Devonian. This consists not merely in the inception here of Devonian types. . . . . In addition we meet here certain climacteric features of critical value, demonstrating equivalence with faunas whose age may be considered now as well established" (p. 435).

In 1900, the writer[3] restudied the entire Lower Devonian faunas of America, listing 459 Helderberg species. But 16 of these, or about $3\frac{1}{2}$ per cent, are derived from the Silurian. The New York Helderberg fauna has 397 forms, and of these more than 9 per cent pass into the Oriskany. These figures have since been increased. His final statements were: "From the foregoing summary of the Helderbergian fauna it is evident that most of the characteristic Siluric genera of trilobites, brachiopods, and crinoids are there absent. . . . . On the other hand, in some of the trilobites, Bryozoa, and pelecypods, many of the gastropods, but more particularly in the diversified brachiopods, are met organic groups, which in their culmination are characteristic of the Devonic. It cannot be denied that the Helderbergian fauna has a Siluric facies, yet these types either have greater differentiation in species or the forms attain a larger size. The fact that nearly 9 [now known to be about 12] per cent of the Helderbergian fauna pass into a generally accepted Devonic horizon, the Oriskany, outweighs the evidence of a Siluric facies and specific

[1] Nat. Hist. N. Y., Pal., vol. iii, 1859 (text published in 1861), pp. 32-43.
[2] Forty-second Ann. Rept. N. Y. State Mus., 1889, pp. 408-437.
[3] Schuchert, Bull. Geol. Soc. America, vol. xi, 1900, pp. 241-332.

FIG. 1.—VIEW SHOWING THE KEYSER MEMBER OF THE HELDERBERG FORMATION AT KEYSER, W. VA.

FIG. 2.—VIEW SHOWING THE CONTACT OF THE KEYSER MEMBER OF THE HELDERBERG WITH THE TONOLOWAY LIMESTONE AT KEYSER, W. VA.

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derivatives. The writer therefore concludes that the Helderbergian has a fauna unlike the Siluric, but one in harmony with the Devonic and its position near the base of that system" (pp. 277, 278).

In regard to the Oriskany, it was stated: "As a rule the Oriskany formation consists of littoral deposits, often of a very coarse nature. When it is remembered that, in addition to this fact, the formation has very limited, usually linear, exposures, it is remarkable that its fauna should consist of 185 species. Chief among these are the brachiopods, of which 97 species are known. They are the most abundant fossils, and their generally larger growth at once marks the Oriskany as one of the easily recognized American Paleozoic faunas.

"In spite of the characteristic expression of the Oriskany fauna, it is remarkable that it should be so intimately connected both with the Helderberg and with the Onondaga. . . . . Of the 185 species included in the Oriskany fauna, 31, or 17 per cent, come from the Helderbergian, while 54, or 35 per cent, pass into the Onondaga. . . . . These figures prove that the Oriskany is intimately connected with the Helderbergian and Onondaga. This is still more forcibly brought out when it is stated that of the Becraft fauna, the one immediately beneath the Oriskany, not less than 27 per cent of its species pass into the Oriskany. All these figures are in strong contrast with the very few species which pass from the Niagaran and Cayugan formations into the Helderbergian. Of these there are 9 persisting forms, or about 2 per cent, in a fauna of 459 described species" (p. 291). These figures are now all enlarged by the more recent work of Clarke,[1] thus more intimately binding the Helderberg and Oriskany, these with the Middle Devonian, and separating both series more distinctly from the Silurian.

The history of the American Lower Devonian is shown in the accompanying table:

[1] The Oriskany Fauna of Becraft Mountain; and Early Devonic History of New York and Eastern North America. Memoirs 3 and 9, N. Y. State Mus., 1900 and 1908.

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Vanuxem, 1842	Hall, 1843	de Verneuil, 1847	Hall, 1861	Clarke and Schuchert, 1899 New York	As arranged in this volume for Maryland
Erie division.	Erie division		Devonian	Middle Devonic	Middle Devonian
New York System: Corniferous limestone	New York System: Corniferous limestone	Devonian: Catskill to Cauda-Galli Oriskany		Esopus referred to Middle Devonic	
Onondaga limestone	Onondaga limestone		Last of Silurian: Oriskany sandstone	Lower Devonic: Oriskanian: Oriskany	Lower Devonian: Oriskany: Ridgely sandstone member; Shriver Chert member; Includes Kingston = Port Ewen
Schoharie grit	Schoharie grit				
Cauda Galli grit	Cauda-Galli grit				
Oriskany sandstone	Oriskany sandstone				
Helderberg division.: Catskill shaly limestone	Helderberg series.: Upper Pentamerus limestone	One series of Silurian: Upper Pentamerus limestone	Lower Helderberg.: Upper Pentamerus limestone; Crinoidal limestone	Helderbergian: Kingston; Becraft	Helderberg: Becraft member
	Encrinal limestone			New Scotland	New Scotland member
	Delthyris shaly limestone	Delthyris shaly limestone	Delthyris shaly limestone		Coeymans member
Pentamerus limestone	Pentamerus limestone	Pentamerus limestone	Pentamerus limestone; Stromatopora limestone	Coeymans	Keyser member
Water-lime group	Water-lime group	Water-lime	Tentaculite limestone	Manlius of Siluric	Silurian: Tonoloway
Onondaga salt group	Onondaga salt group				Wills Creek

The Lower Devonian rocks of western Maryland lie in two areas situated in Allegany and Washington counties respectively. The area in Allegany County may be called the Cumberland area and that in Washington County the Hancock area. Of these areas that of Cumberland is by far the larger and has long been famous as a collecting ground for fossils, especially those of Oriskany age.

In the Cumberland area the Lower Devonian formations lie around the Wills Mountain, Evitts Mountain, and Tusseys Mountain anticlines. The Potomac River and Wills Creek cut through the Wills Mountain anticline at Cumberland and render the sections there among the best in this region. About the Evitts Mountain anticline the exposures are less perfect. Flintstone Creek, in cutting through the Tusseys Mountain anticline, also affords some exposures of importance. Besides the larger outcrops in the Cumberland area there are three smaller ones. One of these, which exposes the Oriskany sandstone alone, begins opposite the South Branch of the Potomac River and extends in a narrow tongue up the Town Creek Valley. The others are along the Potomac at Fort Hill and Monster Rock in the southwestern part of the county near Keyser, West Virginia, and lie on the northern extension of the New Creek Mountain anticline.

The Lower Devonian is also exposed in three areas near Hancock. The largest of these is west of Hancock and extends in two narrow strips across the State about the northern end of the Cacapon Mountain anticline. The exposures are good where this anticline is cut by the Potomac, the finest being at Tonoloway Station, in the cut of the Western Maryland Railroad opposite Great Cacapon, West Virginia. A second exposure is about the southern end of the Cove or Tuscarora Mountain anticline, which is cut by Licking Creek along the Mason and Dixon line, some of the best sections of the Lower Devonian rocks in Washington County being found here. A third area is along the western slopes of Hearthstone and North mountains where the best exposures are again due to the cutting of the Potomac River at Cherry Run. The localities best adapted for study are described in the discussion of the local sections.

STRATIGRAPHIC AND PALEONTOLOGIC CHARACTERISTICS[1]

The Lower Devonian of Maryland is divided into the Helderberg and Oriskany formations, which will be considered in the order of their deposition.

THE HELDERBERG FORMATION

INTRODUCTORY

The Helderberg is essentially a limestone formation. Its lithological character varies not only in its different beds but also in the exposures of different regions. It ranges in color from dark blue to light gray, and in texture from a massive limestone to a calcareous shale. Interbedded with the limestone are numerous layers of black or white chert which occur at various horizons. A single bed of white quartzitic sandstone about 10 feet thick is present in it on Elbow Ridge, northeast of Hancock, while a gray argillaceous shale, 14 to 20 feet thick and free from calcareous matter, except fossils, occurs at its top in the Cumberland region.

The thickness of the Helderberg varies from 290 feet in the vicinity of Hancock to about 350 feet in the Cumberland area.

SUBDIVISIONS

The Helderberg formation is divisible into four members which are distinguishable both lithologically and faunally. Their sequence and diagnostic features may be summarized as follows:

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[1] Contributed by Charles K. Swartz, T. Poole Maynard, and R. B. Rowe. The Helderberg was first studied by R. B. Rowe who presented a discussion of the Lower Devonian of Maryland as a dissertation for the degree of Doctor of Philosophy in the Johns Hopkins University in 1900. This dissertation was intended for publication in this volume. The work was revised by Charles Schuchert in the course of his more extended studies of these strata.

The lower part of the Keyser member of the Helderberg was studied by T. Poole Maynard who offered a dissertation to the Johns Hopkins University for the degree of Doctor of Philosophy in 1909 in which he discussed the stratigraphy and paleontology of these beds. The work of these authors was revised and much of it rewritten by C. K. Swartz as a result of his later investigations. The discussion of the Keyser member of the Helderberg is based chiefly upon the investigations of C. K. Swartz and T. Poole Maynard. The remainder of the chapter is based upon the studies of Charles Schuchert, C. K. Swartz and R. B. Rowe.

Keyser Member.—Limestone, massive and very nodular in its lower part, more shaly and thin-bedded above. Contains numerous reefs of corals and stromatoporoids. Thickness 270-290 feet. Zone of *Spirifer modestus.*

Coeymans Member.—Massive crinoidal limestone. A sandstone occurs in the lower part of this division at Elbow Ridge. Thickness 9-13 feet. Zone of *Gypidula coeymanensis.*

New Scotland Member.—Consisting of two parts: (a) limestone, containing much white chert, the latter forming a large part of the whole; (b) a thick bed of shale forming the upper part of the member in the Cumberland area. Thickness 12-45 feet. Zone of *Spirifer macropleurus.*

Becraft Member.—Gray crystalline limestone containing much interbedded black chert. Thickness 80-125 feet. Zone of *Spirifer concinnus.* This member is present only in the eastern sections.

The Keyser Member

CHARACTER AND THICKNESS.—The Keyser member is named from Keyser, West Virginia, where the strata are admirably exposed in the quarries of the Standard Lime and Stone Company on the Baltimore and Ohio Railroad about ¾ mile east of the town.

The Keyser forms the major part of the Helderberg of Maryland. The lower beds are very nodular, while the upper beds are more shaly. Massive ledges of corals and stromatoporoids are present at several horizons, being especially prominent in the upper more shaly beds in the Cumberland area. A few strata contain chert. West of Hancock the thickness varies from 270 to 290 feet. Its precise thickness has not been ascertained east of that place.

FAUNA.—The Keyser contains a rich coral and brachiopod fauna, the composition of which will be considered more fully in the chapter on correlation.

KEYSER-TONOLOWAY BOUNDARY.—The lower limit of the Keyser member is well defined by a marked change in the character of the sediments, the rather massive and very nodular limestone of the lower beds of this member contrasting strongly with the platy, fissile, thin-bedded limestone of the underlying Tonoloway. The uppermost strata of the Tonoloway are commonly hard and resistant. The beds a little below the top of that formation on the contrary are usually very shaly and are often concealed, weathering to soil. At many places a massive stratum 18 inches to 2 feet thick lies immediately below the nodular limestone of the Keyser. This stratum is not nodular and diagnostic fossils have not been found in it. It is referred to the Tonoloway.

The Coeymans Member

CHARACTER AND THICKNESS.—The Coeymans was originally known to geologists as the Pentamerus limestone, later as the Lower Pentamerus limestone, in the lower part of which is the Stromatopora limestone. In 1899 Clarke and Schuchert changed this biologic term to the geographic name Coeymans limestone, after the village of Coeymans in Albany County, New York, through which the Helderberg escarpment extends, affording a fine exposure of this formation.

The Coeymans member of the Helderberg of Maryland consists of massive blue, crystalline limestone, commonly crinoidal and containing a small amount of chert. Thin bands of sandstone develop locally near its base in the Cumberland area, being especially well seen at Dawson, where they appear as raised brown bands upon the weathered surface of the rock. East of Hancock the Coeymans is at places a sandstone, which is especially prominent on Elbow Ridge. The strata of this member are very resistant to weathering and hence frequently form projecting ledges, a feature strikingly shown at Corriganville where it forms the "backbone" of the cliff termed the Devil's Backbone.

The Coeymans is quite thin, varying from 8 to 13 feet in thickness. It may be absent locally although this fact is not well established.

FAUNA.—The Coeymans is highly fossiliferous, abounding especially in *Gypidula coeymanensis* which is its guide fossil. A list of the species contained in it is given in the table showing the distribution of the species.

COEYMANS-KEYSER BOUNDARY.—The Coeymans-Keyser boundary is sharply defined, both lithologically and faunally. The upper beds of the Keyser are thin-bedded and many strata appear banded, consisting of thin gray laminæ which contain few fossils. The lower beds of the Coeymans present a marked contrast, being massive, blue, crystalline and highly fossiliferous. The base of this member often contains limestone pebbles while the line of contact with the Keyser member is usually somewhat sinuous. These features, together with its arenaceous character in some localities, as on Elbow Ridge, suggest the probable existence of an unconformity at the top of the Keyser.

The New Scotland Member.

Character and Thickness.—In New York the upper portion of the Coeymans limestone becomes thin-bedded and this character continues into the next higher zone. These thin-bedded limestones and the interbedded shales are abundantly fossiliferous. One of the common forms is *Spirifer perlamellosus* which in the days of the original New York State Survey was referred to the genus Delthyris; hence the name Delthyris shaly limestone. Until 1899 this was the recognized name, but it was at that time changed to New Scotland to conform to modern usage. The member is named from New Scotland in Albany County, New York.

The New Scotland of Maryland comprises two divisions. The lower beds consist of courses of limestone, usually 4 to 8 inches thick, containing numerous layers of white chert, which replace the limestone and form in many cases the larger part of the whole. The chert weathers out into large, very irregular, ragged pieces, which cover the surface of the soil. Owing to their resistance to solution the New Scotland and Oriskany cherts unite to form high ridges upon the summit of which they outcrop. These ridges are conspicuous features in the topography of Allegany County and adjoining parts of Pennsylvania and West Virginia.

The upper beds of the New Scotland member consist of soft, drab, fissile shale which contains but little calcareous material. The shale is seldom exposed, but its position is usually indicated by a slight depression visible upon the summit of the ridge between the Oriskany and New Scotland cherts. This shale is absent in the Hancock area.

Such lithologic characters are quite different from those in New York where the lower limestones are thin-bedded, with intercalated shales and are overlain by a great thickness of the latter. It is these physical differences which render it so easy to obtain the fauna of the New Scotland member in New York and so difficult to extract the fossils from the solid cherty limestones of Maryland. The thickness of the New Scotland varies from 12 feet at Tonoloway, where the shale is absent, to 43 feet at Keyser, West Virginia, the limestone beds being 29 feet thick and the shale beds 14 feet thick at the latter place.

FAUNA.—The New Scotland member abounds in fossils which are preserved in great perfection, especially in the chert. The fauna, as far as obtained, is a duplicate of that of New York in nearly all respects. Almost nothing of a local character has been found, but the reason for the rarity of bryozoa which are so profusely developed in New York has not yet been ascertained, although the heavy-bedded cherty nature of the limestone may account for the scarcity of the latter forms.

NEW SCOTLAND-COEYMANS BOUNDARY.—The New Scotland-Coeymans boundary is not so well defined lithologically as that between the Keyser and Coeymans. The lower 4 to 8 feet of the New Scotland contains less chert and is more or less transitional, both lithologically and faunally. At a number of localties a thin bed of shale is found at the horizon of most rapid change in the lithology and fauna. The base of this stratum has been selected as the base of the New Scotland member where it occurs.

The Becraft Member

CHARACTER AND THICKNESS.—In the early days of American geology, this division was known as the Upper Pentamerous limestone and also the Encrinal or Scutella limestone. Together these compose the Becraft limestone, so named by Darton[1] from Becraft Mountain an outlier of the Helderberg rocks on the east side of the Hudson River, a little south of Hudson, Columbia County, New York. The Becraft represents the closing stage of the Helderberg. In Maryland this member is an arenaceous limestone interbedded with much black chert. It occurs only in Washington County. Its thickness is about 85 feet.

FAUNA.—The Becraft member contains an abundance of organic remains, as yet not exhaustively collected. The guide fossil is *Rensselæria*

[1] 13th Ann. Rept. N. Y. State Geol., 1894, pp. 245, 246, 304.

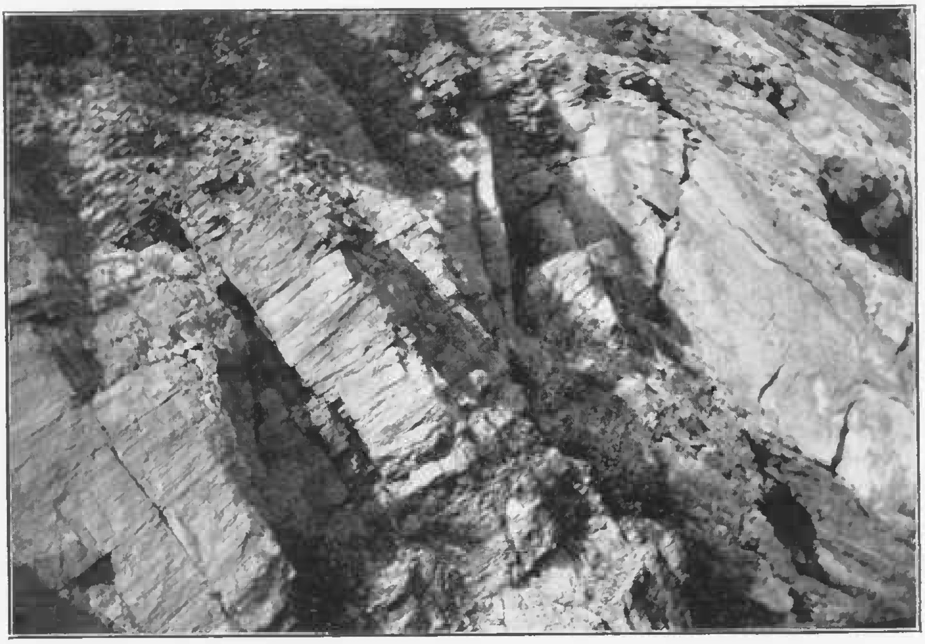

FIG. 1.—VIEW SHOWING ANTICLINE IN KEYSER LIMESTONE NEAR RAWLINGS.

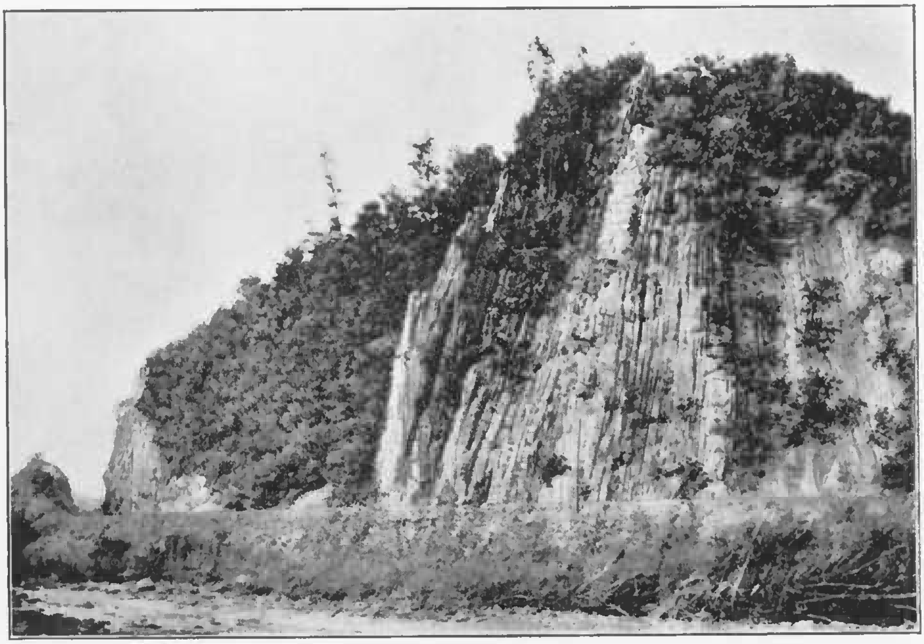

FIG. 2.—VIEW SHOWING THE NEARLY VERTICAL STRATA OF THE HELDERBERG FORMATION AT THE DEVIL'S BACKBONE.

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subglobosa, a species closely related to *R. æquiradiata* of New York. The fauna of the Maryland Becraft is in many respects similar to that of the New Scotland, but a closer approach to the Oriskany aspect is indicated by the presence of *Rhipidomella assimilis, Plethorhyncha præspeciosa, Rensselæria subglobosa, Cyrtina rostrata,* and *Meristella lata.*

BECRAFT-NEW SCOTLAND BOUNDARY.—The upper limit of the New Scotland is shown by the transition from the New Scotland white chert with a little interbedded limestone, to the Becraft limestone carrying a smaller amount of black chert.

COMPOSITE SECTION OF THE HELDERBERG FORMATION

Becraft Member 85 feet	Cherry Run, West Virginia	Dark blue arenaceous limestone, with lumps of black chert. The fauna is most abundant in the upper half, where *Rensselæria subglobosa* is the characteristic fossil. This member is absent west of Hancock. In other eastern sections the thickness may attain to 125 feet.	About 85 feet.
New Scotland Member 49 feet	Twenty-first Bridge, West Virginia	Soft, bluish argillaceous shales, with some harder layers and occasional manganese-phosphatic nodules. Its faunule includes *Dalmanella planiconvexa, Rhipidomella oblata, Schuchertella woolworthana, Leptæna rhomboidalis, Anoplia helderbergiæ, Ambocœlia umbonata ?, Spirifer macropleurus, Meristella arcuata,* and *Trematospira multistriata.*	20 feet.
	Devil's Backbone, Cumberland, Maryland	Massive gray limestone, with bands of chert, becoming thin bedded above, with partings of shale; characterized by *Spirifer macropleurus.*	29 feet.
Coeymans Member 8.6 feet	Devil's Backbone, Cumberland, Maryland	Massive, regularly bedded, blue-gray limestone. The upper bed of this unit forms the prominent ridge of the "Devil's Backbone," near Cumberland. Containing *Gypidula cœymanensis, Spirifer cyclopterus,* and stems of *Lepocrinites.*	8.6 feet.

Keyser Member 281 feet	Keyser, West Virginia	Thin to medium-bedded gray limestone with fine brown lines, nearly unfossiliferous, *Leperditia altoides*	17.3	281.0
		Compact gray limestone, thin bedded	3.4	263.7
		Gray crystalline limestone	0.8	260.8
		Heavy-bedded gray limestone with many transverse calcite seams *Spirifer vanuxemi prognosticus*	29.2	259.5
		Shaly limestone containing fossiliferous crystalline layers. Weathers more easily than adjoining units *Tentaculites gyracanthus*, *Schuchertella prolifica*, *Meristella prænuntia*	7.2	230.3
		Thin-bedded gray limestone *Tentaculites gyracanthus*	10.6	223.1
		Heavy-bedded, dark blue limestone, bottom foot argillaceous *Rensselæria mutabilis*	25.7	212.5
		Massive bed of dark blue limestone spotted with crinoids and corals preserved in calcite	16.6	186.8
		Heavy-bedded, dark blue limestone, gray and crystalline toward the top	26.0	170.2
		Dark blue limestone heavy-bedded below, becoming thin bedded toward top	9.0	144.2
		A solid heavy bed of blue limestone *Gypidula coeymanensis* var. *prognostica* (aa)	2.0	135.2
		Heavy-bedded, dark blue limestone *Camarocrinus stellatus*	5.6	133.2
		Thin, irregularly bedded, dark blue limestone	6.6	127.6
		Thin, irregularly bedded, dark blue limestone	13.6	121.6
		Heavy-bedded, blue limestone. The cystid zone	18.0	108.0
		Heavy-bedded, dark blue limestone	24.0	90.0
		Heavy-bedded, dark blue limestone	27.0	66.0
		Very massive, hard, dark nodular limestone	20.3	39.0
		Dark, thin-bedded very nodular limestone	3.1	18.7
		Nodular limestone, with some chert	15.6	15.6

ORISKANY FORMATION [1]

INTRODUCTORY

The name Oriskany sandstone was applied by Hall [2] to the friable white sandstone at Oriskany Falls, N. Y., and was generally adopted by geologists. In 1899, Clarke and Schuchert included all the various exact and inexact local developments of Oriskany equivalents under the serial term

[1] Contributed by R. B. Rowe, Charles Schuchert, and Charles K. Swartz.

[2] 3d Ann. Rept. N. Y. Geol. Survey, 1839, pp. 308, 309.

Oriskanian. This embraces the Camden, Port Ewen, Esopus, Oriskany, and Decewville formations.

The Oriskany formation of Maryland consists of lower black cherty shale, overlain by calcareous sandstone or arenaceous limestone. The sandstone, because of its resistance to weathering, unites with the New Scotland cherty limestone to form a series of high ridges or mountains wherever it is exposed.

The thickness of the Oriskany is variable. At 21st Bridge it is 350 feet, and at Tonoloway 417 feet thick, while but 14 miles northeast of the latter place it is only 50 feet thick. These facts suggest an unconformity by erosion of its upper surface.

SUBDIVISIONS

The Oriskany formation is subdivided into two members which differ both lithologically and faunally. They are, in ascending order, the Shriver Chert and the Ridgely sandstone members.

Shriver Chert Member

CHARACTER AND THICKNESS.—The name Shriver Chert is proposed for this member from Shriver Ridge at Cumberland, Maryland, upon which it is extensively exposed. It was called the Lower Oriskany by Schuchert.[1] It consists of a dark siliceous shale containing large quantities of black impure chert in the form of nodules or layers of nodules. Upon weathering both shale and chert become buff or yellowish in color and break into sandy fragments, the chert in some cases becoming spongy. The rock has the property of cementing upon exposure and is much used as a surfacing material for roads for which purpose it is admirably adapted. Where it outcrops the surface of the ground becomes covered with a thick mantle of gravel-like fragments, the resulting soil being well adapted to the cultivation of orchards and berries. This member occupies extensive areas upon the slopes of the mountains upon which the Oriskany outcrops in Allegany County.

[1] Proc. U. S. Nat. Mus., vol. xxvi, 1903, p. 422.

The thickness of the Shriver Chert member is variable. In the more westerly localities it is about 100 feet thick. It thins eastward and is absent in Washington County.

Fauna.—The fauna of this member is meager. A list of the species found in it is given in the table of distribution.

Ridgely Sandstone Member

CHARACTER AND THICKNESS.—The sandstone member of the Oriskany formation was termed the Monterey sandstone by Darton [1] in 1892. It was later called the Upper Oriskany by Schuchert.[2] It is named from Ridgely, West Virginia, at the north end of the Knobly Mountain, opposite Cumberland, at which place it is admirably exposed.

This member is composed of a calcareous sandstone which passes in places into an arenaceous limestone because of the great development of calcareous cement. It also contains conglomeratic beds, one of which, situated near the top of the member in the vicinity of Cumberland, contains pebbles resembling grains of wheat. When unaltered by exposure the rock is bluish-gray, calcareous, very tough, and admirably adapted for use as railroad ballast. Upon weathering the calcareous cement is dissolved out by the surface waters and the rock disintegrates, forming sand and large boulders of sandstone, which cover the mountain slopes and are often carried far into the valleys. If the rock was originally very calcareous it becomes friable upon weathering and yields a quartz sand which is quarried extensively as a glass sand, particularly in the vicinity of Berkeley Springs, West Virginia, where it is very free from iron. Less pure beds are used as building sand. The character of the rock undergoes a change eastward, becoming more calcareous until in the North Mountain area it is a limestone sufficiently pure to be used as a source of lime. It then contains numerous beds of chert and closely resembles the underlying Becraft limestone. The thickness of the Ridgely member varies from 250 feet in the western exposures to 50 feet or less at the North Mountain.

[1] Amer. Geol., vol. x, 1892, p. 15; Staunton Folio, U. S. Geol. Survey, 1894.
[2] Proc. U. S. Nat. Mus., vol. xxvi, 1903, p. 422.

FAUNA.—This member has yielded most of the prolific fauna described from the Oriskany formation of Maryland. The uppermost beds at Ridgely, West Virginia, have furnished the local collectors of Cumberland with many fine fossils. Mr. Andrews, however, obtained the specimens described by Hall mainly from two quarries, now abandoned, in the city of Cumberland. One of these is in Green Street, below the Episcopal Church, and the other is in the rear of the German Lutheran Church. Both quarries are in the upper 75 feet of the Oriskany. In the Green Street quarry the Marcellus shales plainly mark the top of the formation. At these localities, however, particularly at the one back of the German Lutheran Church on Shriver's Hill, the excavation has been carried far below the surface into layers that are not shown in West Virginia. This serves to explain why certain forms like *Spirifer cumberlandiæ, S. tribulis,* etc., are now seldom found about Cumberland.

At this locality a peculiar condition of leaching of the Oriskany has made it possible to obtain fossils completely weathered out of the inclosing rock, as siliceous pseudomorphs. This method of preservation is restricted to Cumberland and the reason for it will be shown presently. So many of these delicate fossils have been sent out by local collectors that it has become a general belief that they can be procured anywhere in the Oriskany of Maryland. Regarding this state of preservation Hall[1] wrote:

"While in the State of New York the accessible portions of the rock furnish us for the most part with casts of its fossils, or, if beyond the reach of weathering, with a compact mass of calcareous sandstone in which the fossil remains are closely imbedded, we find, in Maryland and some parts of Virginia, that in the friable sandstone the shells are entirely silicified and quite free from adhering stone, so that the exterior markings and internal structure are perfectly preserved; the interior being quite hollow, or filled only with loose sand. In these localities, not only do we find the cavities of large gasteropods with no more adhering matter than those of the Tertiary sands, but more unfrequently the delicate internal apparatus of the Brachiopod is almost entirely preserved."

[1] Pal. New York, vol. iii, 1859, pp. 401, 402.

Rowe was the first to explain the cause for this restricted leaching out of the Oriskany fossils and their occurrence in "sand pockets." He states: "Most of the fine collecting grounds for Oriskany fossils in this region are within five or ten minutes walk from the hotels in Cumberland. The disintegration of the sandstone has been carried on there much more completely than at any other place, and has been due, no doubt, to the cutting of the Potomac River and Wills Creek across Knobly Mountain and Shriver Ridge. The constant downward percolation of the water from the Potomac River and Wills Creek, when both flowed over this part of Cumberland, has carried away the calcareous material of the Oriskany arenaceous limestone and the fossils and has partially replaced the latter with silica. As leaching continued, all the calcareous material was finally removed and more or less large partially empty pockets or caves were formed. These are filled with loose sand and in them the fossils are at times found in considerable quantity."

The Ridgely fauna becomes abundant only in the upper 150 feet of the member.

SHRIVER-RIDGELY BOUNDARY.—The line of division between these members is not sharp. The amount of chert diminishes in the upper part of the Shriver member and thin beds of sandstone appear, forming beds of passage to the overlying sandstone.

LIMITS OF THE ORISKANY

ORISKANY-HELDERBERG BOUNDARY.—The lower limit of the Oriskany is clearly indicated in the Cumberland area by the lithological difference between the Shriver Chert and the New Scotland member of the Helderberg. The Shriver Chert is black when freshly exposed. Upon weathering it yields small buff, or orange colored, sandy fragments which are thickly strewn over the surface of the outcrop. The New Scotland chert on the contrary is white and upon weathering yields large, irregular ragged masses. The shale at the top of the New Scotland is usually not exposed but its position is frequently indicated by a slight depression of the surface between the chert beds. Because of their resistance to erosion the New Scotland and Oriskany cherts usually occupy the crests of hills or mountains of considerable altitude.

The contact of the Oriskany and Helderberg is more obscure in the eastern part of the Hancock area where the Shriver member is absent and both formations are largely limestone. This is especially true where the Coeymans contains beds of sandstone as it does in the North Mountain area. The line of division is best distinguished under these circumstances by the fact that the Becraft limestone is comparatively free from sand grains, while the Oriskany limestone yields sandy or even conglomeratic fragments upon weathering.

ROMNEY-ORISKANY BOUNDARY.—The Lower Devonian was formerly thought to be terminated by a marked hiatus. Unconformity by erosion was reported by Darton[1] between the Oriskany and Romney of Virginia. This view has been held by most subsequent observers. The belief was based, in part, upon the supposed absence of the Onondaga fauna in Maryland and adjacent areas. It has recently been shown by Kindle,[2] however, that the Onondaga fauna is present in the basal beds of the Romney. While the magnitude of any hiatus at the close of the Oriskany must therefore be small, the occurrence of at least a short erosional uncomformity at that horizon is indicated by the following facts: the great abruptness of the transition from the Oriskany to the Romney, the apparent erosion of the upper surface of the Oriskany at many places, its varying thickness, and the local development of a basal conglomerate in the Romney, the latter being well shown at Warren Point, Fulton County, Pennsylvania, just north of the Maryland-Pennsylvania line.

COMPOSITE SECTION OF THE ORISKANY FORMATION

Ridgely Sandstone Member 258 feet	Twenty-first Bridge, West Virginia	Heavy-bedded arenaceous limestone, gradually changing downward into a black chert or siliceous shale. In the lowest beds are found *Spirifer cumberlandiæ*, *S. concinnoideus*, and *Eatonia sinuata*. Fossils, however, are rare until 100 feet above the base of this division, where the characteristic Hipparionyx fauna attains greater individual and specific representation, culminating in the upper 100 feet, which is the present source of nearly all the Cumberland Oriskany fossils. 258 feet.

[1] Amer. Geol., vol. x, 1892, p. 16.
[2] Bull. U. S. Geol. Survey No. 508, 1912.

Shriver Chert Member 100 feet	Twenty-first Bridge, West Virginia	
		Bedded and nodular black chert and siliceous shale, with a sparse fauna distinct from the Hipparionyx fauna above and from the Helderberg below. In the eastern sections of Washington County, there is no black chert, the time interval here being occupied by the typical more sandy Oriskany. Near the base are found *Anoplotheca flabellites*, *Leptostrophia arctimuscula*, and Ostracoda. Just below the middle occur *A. flabellites*, *Spirifer tribulis*, *S. paucicostatus*, dance of ostracods and *Chonetes hudsonicus*. *Diaphorostoma desmatum*. Near the top is an abun- *Pholidops multilamellosa*, *Tentaculites acula*, and *Beachia suessana* var. *immatura*, *Anoplia nucleata*, About 100 feet.

CORRELATION OF THE LOWER DEVONIAN [1]

THE HELDERBERG FORMATION

INTRODUCTORY

Earlier students have held widely divergent views as to the limits and correlation of the Helderberg of Maryland. It will be helpful therefore to present a brief résumé of the conclusions reached by them before discussing the problems to be considered.

The Helderberg formation in Pennsylvania and Maryland is part of a thick series of limestones to which Pratt [2] gave the name Lewistown formation in 1881. This term was used in the reports of the Second Geological Survey of Pennsylvania and also by the authors of several geological folios of the U. S. Geological Survey.[3]

In 1899-1900 Rowe [4] made a critical study of the Lower Devonian of Maryland and clearly recognized the complex character of the Lewistown formation. He separated it into three parts to which he gave the names Niagara, Salina, and Helderberg formations. The Helderberg was made to comprise not only the Helderberg formation as defined in this volume,

[1] Contributed by C. K. Swartz.

[2] Second Geol. Survey of Pa., vol. T, 1881, pp. 127-135.

[3] Darton, N. H. Folios U. S. Geol. Survey Nos. 14, 1891, 32, 1894, 61, 1896, Darton and Taff, Folio U. S. Geol. Survey No. 28, 1896.

[4] Dissertation presented for the degree of Doctor of Philosophy in the Johns Hopkins University, 1900.

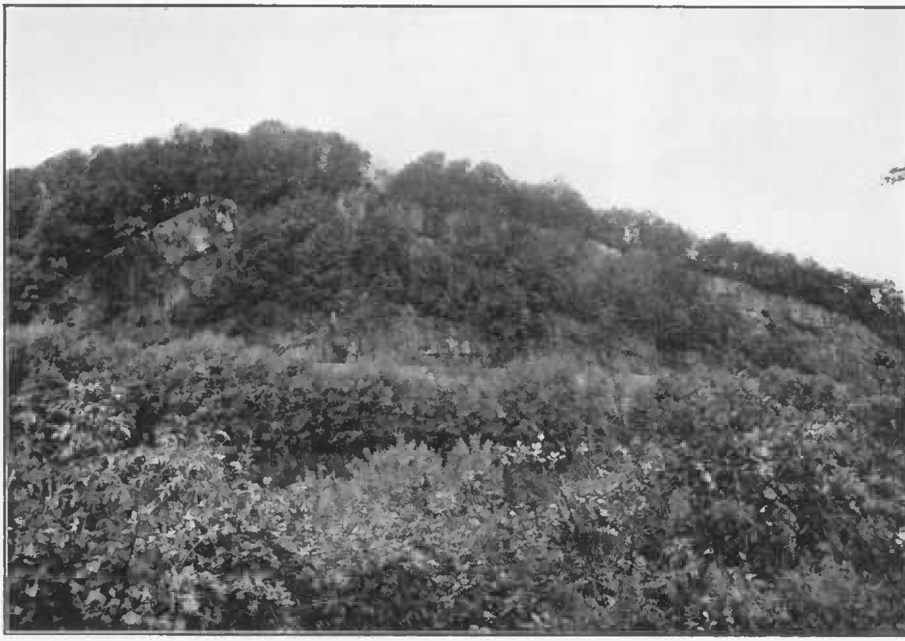

FIG. 1.—VIEW SHOWING THE ANTICLINE OF ORISKANY SANDSTONE ON NORTH BRANCH OF THE POTOMAC NEAR JUNCTION WITH SOUTH BRANCH.

FIG. 2.—DETAILED VIEW OF A PORTION OF FIGURE I.

but also the Tonoloway formation, the latter being considered equivalent to the "Tentaculite" (Manlius) limestone of New York. Rowe divided the Helderberg into the equivalents of the Manlius, Coeymans, New Scotland, and Becraft formations of New York. O'Harra[1] who prepared a report upon the geology of Allegany County about the same time assigned the same limits to it. Schuchert[2] made a critical study of the Lower Devonian of Maryland a little later and published a brief synopsis of his results in 1903. He divided the strata formerly embraced in the Lewistown formation as follows:

Devonian	Helderberg	Becraft, 85-125 feet thick. Absent in western Maryland.
		New Scotland, 66 feet thick.
		Coeymans, 110 feet thick.
Silurian	Manlius, 110 feet thick.	
	Salina, 1135 feet thick.	
	Niagara, 300 feet thick.	

The Helderberg, as defined by Rowe, is thus equivalent to the Helderberg, Manlius, and upper part of the Salina of Schuchert.

In 1908-1909 Maynard[3] studied the beds termed the Manlius formation by Schuchert (comprising most of the *Chonetes jerseyensis zone*). He named them the Corrigan formation and correlated them with the Cobleskill, Rondout, and Manlius formations of New York and the Decker Ferry, Rondout, and Manlius formations of New Jersey, believing that these units are undifferentiated in Maryland.

In 1910 the writer proposed to the Committee on Formational Names of the U. S. Geological Survey a further subdivision of these limestones. In the following summer Ulrich, Stose and the writer visited western Maryland together and agreed to divide the equivalents of the Lewistown limestone into the Helderberg, Tonoloway, and Wills Creek formations and assigned to them the limits recognized in this volume, in which conclusion Schuchert later concurred. The lower member of the Helder-

[1] Md. Geol. Survey, Allegany County, 1900, p. 94.

[2] Proc. U. S. Nat. Mus., vol. xxvi, 1903.

[3] Dissertation presented for the degree of Doctor of Philosophy in the Johns Hopkins University, 1909.

berg was also termed the Keyser member, although the Keyser-Coeymans boundary was defined later. Ulrich subsequently studied the Helderberg of Maryland more fully and discussed its correlation in the Pawpaw-Hancock Folio of the U. S. Geological Survey.[1] He recognized four divisions of the Helderberg formation, the Becraft, New Scotland, Coeymans, and Keyser members. The Keyser member was divided into three faunal zones, each characterized by a definite association of species as follows; a lower zone containing species related to the Decker Ferry fauna of New Jersey, a second zone extending to the top of the Gypidula bed, a third zone embracing the beds above the Gypidula bed. Minor faunal horizons were discriminated in each zone.

The Tonoloway was correlated, in a general way, with the Cobleskill and Manlius of New York, while the lower zone of the Keyser was correlated with the Decker Ferry of New Jersey, which was considered younger instead of older than the Manlius of New York. The Coeymans, New Scotland, and Becraft were correlated with the formations of the same name in New York.

The writer also made an independent investigation of the problem at the same time and his results are embodied in the following discussion.

FAUNAL AND LITHOLOGICAL SUBDIVISIONS

It has been shown in the preceding discussion that four divisions may be recognized in the Helderberg formation, the Keyser, Coeymans, New Scotland and Becraft members, which differ both in their lithology and faunas. These members may be further subdivided into a number of more or less persistent faunal zones and subzones.

Keyser Member

Two rather well-defined lithological units may be recognized in the Keyser member. The lower of these is a nodular limestone varying from 100 to 130 feet in thickness, while the upper division is rarely nodular and contains many shaly beds. This member may also be divided into two faunal zones, although the limits of the lithological divisions do not coincide precisely with those of the faunal zones.

[1] Pawpaw-Hancock Folio, U. S. Geol. Survey, 1912, Field Edition, pp. 55-56.

The lower faunal zone is here termed the *Chonetes jerseyensis zone.* It is about 110 feet thick and is characterized by the presence of *Chonetes jerseyensis* and associated species. The upper zone is termed the *Favosites helderbergiæ* var. *præcedens zone* from the abundance of that coral in it. The fossils found in the latter zone differ to a large extent from those of the *Chonetes jerseyensis zone.*

A conspicuous feature of the Keyser member is the existence in it of at least five thick reefs of corals and stromatoporoids. It was long supposed that but two such reefs were recognizable in Maryland, both of which are exposed at the Devil's Backbone. Further study, however, has shown the presence of similar reefs at other horizons. These reefs are of wide extent. They are usually very resistant to weathering and stand out as massive ledges on the hillsides, the weathered stromatoporoids presenting a singular curly and knotted appearance.

Both the *Chonetes jerseyensis* and *Favosites helderbergiæ* var. *præcedens zones* may be further divided into a number of subzones, each of which is characterized by some diagnostic feature as shown in the following table:

Keyser member.	Favosites helderbergiæ var. præcedens zone.	Leperditia subzone. Corriganville Upper Stromatopora reef. Tentaculites gyracanthus subzone. Corriganville Lower Stromatopora reef. Rensselæria mutabilis subzone. Keyser coral reef.
	Chonetes jerseyensis zone.	Bryozoan subzone. Gypidula coeymanensis var. prognostica subzone. Spirifer modestus-cystid subzone. Rawlings Stromatopora reef. Cladopora rectilineata subzone. Rhynchospira subzone. Warrior Mountain coral reef.

The subzones are characterized as follows:

CHONETES JERSEYENSIS ZONE.—*The Warrior Mountain coral reef Subzone* occurs at the base of the Helderberg on Warrior Mountain. It is well exposed on the mountain side north of the triangulation station, at which place it contains a profusion of *Favosites pyriformis, F. favosus integritabulatus,* and *Syringostroma centrotum.*

Rhynchospira Subzone.—The beds overlying the Warrior Mountain coral reef, or in the absence of the latter, the lower beds of the Keyser, contain a profusion of *Chonetes jerseyensis* and associated Decker Ferry species. This fauna is especially well developed at Tonoloway where it contains the following species: *Favosites pyriformis, Atrypa reticularis, Camarotœchia litchfieldensis, Chonetes jerseyensis, Meristella* sp., *Rhynchospira globosa, Rhynchospira formosa, Schuchertella deckerensis, Spirifer modestus, Spirifer octocostatus, Stropheodonta bipartita, Uncinulus convexora, Cyphotrypa corrugata, Fenestella cumberlandica,* and *Klœdenella clarkei.*

Cladopora rectilineata Subzone.—*Cladopora rectilineata* occurs profusely at many localities beneath the horizon of the second coral reef. It may be identical with the *Cladopora rectilineata zone* of the Decker Ferry formation of New Jersey. Associated in it are: *Favosites pyriformis, Cyathophyllum inequale, Atrypa reticularis, Camarotœchia litchfieldensis, Camarotœchia lamellata, Dalmanella concinna, Rhynchospira globosa ?, Schuchertella deckerensis, Uncinulus convexorus.*

Rawlings Stromatopora reef Subzone.—A second reef, or series of reefs, occurs 50 to 75 feet above the base of the Helderberg at many localities, as at Hancock, Tonoloway, southwest of Rawlings, Maryland, and Hyndman, Pennsylvania. It is not possible to affirm that these reefs, found at such widely separated points, occupy one horizon, although their stratigraphic position is approximately the same and they bear similar faunules. Common species are *Syringostroma barretti, Favosites pyriformis, Aulopora schohariæ,* and *A. schucherti.*

Spirifer modestus-cystid Subzone.—The succeeding subzone contains a faunule of great interest. Species of Spirifer are common in it, including *Spirifer modestus, S. eriensis, S. vanuxemi* var. *prognosticus,* and *S.*

octocostatus, while *Chonetes jerseyensis* is found in its upper strata at many localities. At Keyser, *Camarocrinus stellatus* is found in profusion in a thin-bedded shaly limestone just below the Gypidula subzone. A great number of cystids have been obtained in the lower part of this subzone, constituting one of the most remarkable features of the entire fauna. These include *Jækelocystis hartleyi, J. papillatus, J. avellana, Lepocrinites mantius, Pseudocrinites gordoni, Sphærocystites globularis, S. multifasciatus,* and *Tetracystis chrysalis.*

The Gypidula coeymanensis var. *prognostica Subzone.*—This zone is the most persistent faunal subdivision in the Keyser member. It is found in nearly all the sections exposing its horizon, and is hence of great value for purposes of correlation. It is filled with a great profusion of a small variety of *Gypidula, G. coeymanensis* var. *prognostica,* which occurs but rarely at other horizons.

Bryozoan Subzone.—The succeeding beds are usually shaly, thin-bedded, and carry a profusion of bryozoa of many species. The Decker Ferry fauna including *Chonetes jerseyensis,* and *Schuchertella deckerensis* recurs in it. This was called by Ulrich the *Petalotrypa subzone* from a characteristic bryozoan since identified as *Diplostenopora siluriana* by Bassler.

FAVOSITES HELDERBERGIÆ VAR. PRÆCEDENS ZONE.—The strata above the bryozoan subzone contain a fauna which differs in many respects from that beneath and manifests distinct relations to the Coeymans. Few species of brachiopods occur in it and most of these are not found in the lower beds. This zone may be divided into the following subzones:

Keyser Coral Reef Subzone.—A massive coral reef is found at Keyser, West Virginia, and at Potomac Station, Maryland, above the bryozoan subzone which abounds in *Cyathophyllum schucherti, Favosites helderbergiæ* var. *præcedens* and contains also *Halysites catenulatus.* Ulrich also reports *Cyathophyltum inequale* from this horizon.

Rensselæria mutabilis Subzone.—*Rensselæria mutabilis* is found in profusion at Keyser, Corriganville, and Tonoloway at apparently the same horizon above the Keyser coral subzone.

Corriganville Lower Stromatopora Reef.—Two massive Stromatopora reefs occur in the upper part of the Keyser at the Devil's Backbone and at many other localities both east and west of Cumberland. They seem to be the most persistent reefs in the Keyser member and were long considered the only ones. Both reefs abound in *Stromatopora constellata* and *Favosites helderbergiæ* var. *præcedens.* They are here termed the Corriganville Lower and Upper coral reefs respectively, because of the fine exposure at the Devil's Backbone at Corriganville.

Tentaculites gyracanthus Subzone.—A shaly limestone occurs between the Stromatopora reefs that abounds in *Tentaculites gyracanthus.* At Keyser and Dawson this subzone contains also a great profusion of *Schuchertella prolifica* and *Meristella prænuntia.*

Corriganville Upper Stromatopora Reef.—The last-named subzone is overlain at the Devil's Backbone and various other places by a reef similar to the one below it and containing the same species.

Leperditia Subzone.—The upper beds of the Keyser member are characterized at the Devil's Backbone and at many other localities by a profusion of a late form of *Leperditia alta* named *L. altoides.* The beds of this subzone are usually somewhat shaly and are interbedded with thicker, dark brown strata. The following species also occur in it: *Schuchertella prolifica, Meristella prænuntia, Tentaculites gyracanthus, Orthoceras rigidum.*

Coeymans Member

The Coeymans member is too thin (never more than 13 feet) to render an analysis of its faunules valuable.

New Scotland Member

The New Scotland is divisible, lithologically, into two very distinct parts, the lower being a very cherty limestone and the upper a fissile shale.

The lowest beds of limestone contain less chert than the other strata. *Chonostrophia helderbergiæ* is abundant near the base of this member at the Devil's Backbone and at Dawson, at which horizon *Spirifer perlamellosus* also usually makes its first abundant appearance. *Meristella arcuata* becomes profuse in certain sections a short distance above the base.

Spirifer macropleurus is abundant only in the very cherty beds and is rare below them, while species of Trematospira are common in the upper limestone strata.

The New Scotland fissile shale is characterized by an abundance of *Dalmanella planiconvexa.*

Becraft Member.

The Becraft member is restricted to so small an area in Maryland that a detailed analysis of its faunules has not appeared valuable.

CORRELATION WITH FORMATIONS OF OTHER AREAS

Since the age of the Helderberg of Maryland involves the problem of the age of the subjacent beds the correlation of the latter will be considered first in treating the subject under discussion.

The Helderberg is underlain by the Tonoloway formation which consists of thin-bedded, platy limestone and interbedded calcareous shale. Upon weathering the limestone yields thin, hard fragments which cover the surface of the soil. Fossils are rare save in a few highly fossiliferous beds. The fauna of the Tonoloway has not been studied critically up to the present time. Among the most important species in it are the following, according to the identifications of Ulrich:[1]

Partial list of fossils from the lower portion of the Tonoloway limestone.

Stromatopora sp. undet.
Favosites globuliformis.
Fistullporella, thinly lamellose species.
Cyphotrypa, new lamellate species.
Orthopora n. sp. (cf. O. regularis).
Schuchertella hydraulica var.
Meristella bella?
Whitfieldella nucleolata.
Rhynchospira globosa.
Rhynchonella litchfieldensis.
Rhynchonella hydraulica?
Rhynchonella? lamellata.
Hormotoma sp. undet. (resembles H. gracilis).
Tentaculites gyracanthus.
Calymene camerata.
Leperditla alta.
Leperditia altoides ?.
Beyrichia n. sp. (resembles Entomis flabellifer and E. oblonga).
Klœdenia n. sp.
Bollia (? Halliella) n. sp. (reticulated surface, loop obsolete).
Klœdenella clarkei.
Klœdenella halli.
Klœdenella (? Tetradella) cf. hieroglyphica (Krause).

[1] Pawpaw-Hancock Folio, U. S. Geol. Survey, 1912, p. 7.

Fossils from the upper 50 feet of the Tonoloway limestone.

Stropheodonta bipartita.
Spirifer corallinensis.
Spirifer eriensis.
Tentaculites gyracanthus.
Klœdenia cf. nearpassi.
Klœdenia sussexensis var.
Halliella ? cf. seminulum.
Primitia humilis ?
Klœdenella clarkei.
Klœdenella (? Tetradella) hieroglyphica.
Octonaria n. sp.
Bythocypris cf. concinna.

One of the most conspicuous members of the fauna is *Tentaculites gyracanthus* which occur so profusely in the Manlius of New York as to have led the early geologists of that State to call the Manlius the Tentaculite limestone. The Tonoloway limestone also resembles the Tentaculite limestone lithologically, being hard thin-bedded and somewhat argillaceous. These facts led Rowe[1] to correlate it with the Manlius and to include it in the Helderberg of Maryland as was done by Hall in the case of the Manlius of New York. Schuchert,[2] on the contrary, correlated it with the Salina of New York, in part. Ulrich has recently expressed the opinion that it is equivalent in a broad way to the Cobleskill and typical Manlius, "although the fauna indicates that the Tonoloway sedimentation in Maryland in part preceded that of the Manlius and Cobleskill of New York."[3] He also states that most of the diagnostic species of the Tonoloway occur in the Schoharie Valley between the base of the Cobleskill and the top of the Manlius. The fauna of the Tonoloway differs, however, in many respects from that of the Manlius and particularly from the Cobleskill fauna, as shown by the absence or great rarity of many of the most characteristic species of those formations. This fact renders the correlation of the Tonoloway with them very uncertain. Indeed, it may be questioned whether present knowledge permits its correlation with any of the formations of New York with precision. It is also possible that the Tonoloway is not represented by any unit in New York. Definite correlation with the New York section is therefore not attempted in this place pending a fuller investigation of the problem. It is, however, clearly of

[1] *Op. cit.*
[2] Proc. U. S. Nat. Mus., vol. xxvi, 1903, p. 415.
[3] Pawpaw-Hancock Folio, U. S. Geol. Survey, 1912, p. 7.

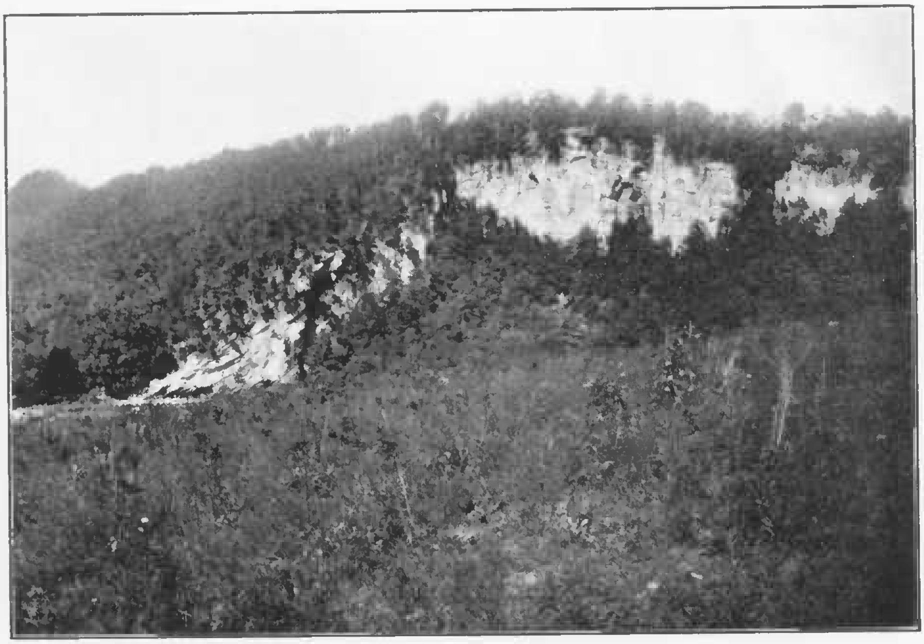

FIG. 1.—VIEW SHOWING ANTICLINE OF ORISKANY SANDSTONE EAST OF 21ST BRIDGE.

FIG. 2.—VIEW SHOWING ORISKANY SANDSTONE OVERLAIN BY THE ROMNEY FORMATION AT MONSTER ROCK.

late Cayugan age as shown by the general composition of its fauna. Recent studies of the writer tend to show that the Tonoloway is probably the same as the Bossardville of Pennsylvania and New Jersey.

Keyser Member

The presence of the Keyser member of the Helderberg in parts of West Virginia adjacent to Maryland is shown in the description of the Maryland sections. The relation of the Keyser member to strata of the same age in Pennsylvania, New Jersey, and New York will now be considered.

CORRELATION WITH PENNSYLVANIA.—The Keyser limestone has been traced continuously from Maryland into southern Pennsylvania and has been found to possess the same lithology and faunas in both areas.

It is present also in central Pennsylvania where the same features are clearly recognizable, establishing the essential identity of the beds in both regions. Its relations will be seen best by the examination of a few typical sections in the area. The sections described were examined very briefly by the writer, but the relations are sufficiently clear to permit conclusions as to their general similarity.

Claypole[1] described the following section at New Bloomfield, Pennsylvania:

	Vertical thickness feet	Total vertical thickness feet
Yellow flint beds (Oriskany chert member).		
CLARKS MILL SHALE.		
Limestone beds with black chert	8	242.5
Bed with *Stromatopora*	1	234.5
Bed with *Tentaculites* and brachiopods	20	233.5
Coral bed	0.5	213.5
Tentaculites	3	213
Tentaculites and some brachiopods	3	210
Not described	2	207
Corals	1	205
Rhynchonella beds	2	204
Concealed	4	202
Uneven gray shales with limestone beds	1	198
Concealed	8	197
Concealed, *Chætetes* and *Tentaculites*	1	189
Hard dark limestone full of small *Chætetes* and brachiopods	3	188

[1] Rept. 2d Geol. Survey Pa., vol. F2, 1885, p. 182.

	Vertical thickness feet	Total vertical thickness feet
Concealed	6	185
Limestone	1	179
Sbale	1	178
Concealed *Leptæna* bed	8	177
Rough shale	3	169
Concealed	4	166
Thin, smooth shale	0.5	162
Concealed	8	161.5
Coral bed	6	153.5
Rubbly limestone	15	147.5
Smooth limestone and shale	2	132.5
Concealed	3	130.5
Soft shale—*Syringopora* ? and *Sphærocystites*	1	127.5
Rhynchonella bed filled with *Rhynchonella formosa*	5	126.5
Crinoidal	0.5	121.5
Firm blue limestone, *Rhynchonella formosa*	3	121
Thin-bedded, wavy, *Murchisonia minuta* abundant	3	118
Shaly limestone forming nodules. *Beyrichia* and *Rhynchonella globosa*, *Murchisonia* at top	12	115
Coarse limestone, *Beyrichia* abundant	4	103
Thin-bedded yellow limestone	3	99
Thin-bedded blue limestone	5	96
Thin-bedded limestone. *Leperditia* abundant	1	91
Concealed	40	90
Thin-bedded limestone, dark, *Leperditia*	50	50

WATERLIME BEDS. Thinner at top.

An examination of the section by the writer showed that the Clarks Mill beds embrace the Keyser and Tonoloway formations. The Tonoloway comprises the lower 103 feet and is overlain by the Keyser. It is probable that the Keyser is present in its entirety, the top of the Clarks Mill shale being approximately the Coeymans-Keyser boundary.

The upper strata of the Keyser are thin-bedded to massive but not nodular limestone, while the lowest beds are nodular and somewhat shaly, precisely as found in Maryland. The faunal succession is also quite similar to that observed in the latter State, a rapid examination showing the presence of the following zones of the Maryland section, enumerated in descending order:

Tentaculites gyracanthus and *Meristella* sp. abundant in the upper part of the section.

Coral zone (Keyser coral zone ?).

Cystid zone—*Sphærocystites* sp.

Stenochisma formosa zone.

Rhynchospira globosa zone.

The *Gypidula cœymanensis* var. *prognostica zone* was not observed. It is believed that a more thorough examination would establish still more closely the essential similarity of the faunas of both areas.

The underlying Tonoloway consists of hard, platy, dark blue limestone breaking with a clean, flat cleavage and contrasting strikingly with the nodular basal beds of the Keyser. A more massive bed 4 feet thick is present at the top of the Tonoloway. The transition from the Keyser to the Tonoloway is abrupt. The fauna of the latter formation consists chiefly of ostracods. All these features are characteristic of the same strata in Maryland.

The underlying (Waterlime) of Claypole appears essentially the same as the Wills Creek formation of Maryland. These facts permit little doubt that the Clarks Mill shale embraces the Keyser and Tonoloway of Maryland. The Coeymans is not exposed and is perhaps absent.

An excellent section of the Helderberg is seen in the cuts of the Northern Central Railroad on the Susquehanna River at Selinsgrove Junction, about 40 miles northeast of the preceding locality. The Helderberg is exposed in two anticlines at this place both of which are described by White.[1]

The section is exposed in the anticline north of Selinsgrove Junction. It begins at a cave-like excavation north of the 135th mile post of the Northern Central Railroad and extends southward to the end of the exposure.[2]

[1] Rept. 2d Geol. Survey Pa., vol. G7, 1883, pp. 343-348.

[2] The writer is greatly indebted to Mr. H. K. Schock, formerly of Susquehanna University, Selinsgrove, Pennsylvania, who measured this section and collected fossils from it.

	Vertical thickness ft.	in.	Total vertical thickness ft.	in.
Concealed. Chiefly shale.				
Spring.				
Massive, gray, crinoidal limestone	9	1	232	7
Interbedded shale and limestone	4	4	223	6
Massive, fossiliferous limestone containing chert	3	9	219	2
Thin-bedded banded limestone	5	10	215	5
Shaly limestone	7	10	209	7
Medium-bedded gray limestone	8	9	193	0
Thin-bedded shaly limestone	13	0	184	2
Shale	1	0	171	2
Massive dark limestone, thinner beds near top	21	10	170	2
Calcareous shale with thin beds of impure limestone	2	0	148	4
Massive dark blue limestone	7	4	146	4
Shale and shaly limestone interbedded with bands of purer limestone	26	10	131	0
Massive gray-blue banded limestone	11	7	112	2
Nodular limestone, shaly at bottom	11	5	100	7
Massive nodular limestone	11	11	89	2
Thin-bedded, nodular limestone	3	9	77	3
Gray nodular limestone, some thin beds	13	6	73	6
Stromatopora reef, upper 2 feet consisting of smaller species	12	0	60	0
135 mile post.				
Thin-bedded, nodular limestone	5	11	48	0
Gray, impure limestone, somewhat crinoidal	0	10	42	1
Nodular limestone, somewhat shaly	24	6	41	3
Massive dark blue limestone, upper 18 inches thinner bedded	16	0	16	9
Thin-bedded, argillaceous limestone, lowest stratum exposed, probably base of Keyser limestone	0	9	0	9
Concealed. Fissile, platy limestone is exposed north of this point, containing numerous ostracods.				

The most important feature of the section is the marked lithological and faunal change at the base of the Keyser. The underlying beds are fissile, platy limestones with an ostracod fauna, contrasting greatly with the lower nodular beds of the Keyser. The *Chonetes jerseyensis* fauna is present in the lower beds. *Rhynchospira globosa* is abundant near the base of the section and is succeeded by a Stromatopora reef. *Cladopora rectilineata* and *Halysites catenulatus* are also abundant in the lower strata of the same age at Grovania while *Tentaculites gyracanthus* occurs in abundance at a higher horizon. The upper beds are but sparingly fossiliferous, shaly, and some strata are laminated. The transition to the overlying very fossiliferous member of the Helderberg is seen at a spring near the south end of cut and is probably abrupt, although this fact has not been sufficiently investigated. The Selinsgrove Junction section may be considered typical of the many exposures of the Keyser limestone of this region. The features described are similar to those presented by the Keyser of Maryland, permitting little doubt of the essential identity of these members in both areas.

An excellent exposure of the Helderberg is seen in the quarries at Grovania 19 miles northeast of Selinsgrove Junction. The lower nodular beds of the Keyser resemble those at the latter locality and contain a similar massive Stromatopora reef. A short distance below this reef is a bed abounding in *Cladopora rectilineata* and *Halysites catenulatus*. This zone occupies a position similar to that of the *Cladopora rectilineata zone* in the lower Keyser of Maryland with which it may be identical. A notable feature of the section is a sandstone seen at the top of the quarry which occurs 46 stratigraphic feet above the Stromatopora reef. This stratum has been interpreted[1] as indicating an unconformity by erosion at the top of the Keyser, but the exposure of the overlying strata is too imperfect at the present time to fully establish this fact.

Examination of the preceding sections renders the following conclusions probable:[2] The Bossardville limestone of central Pennsylvania is identical with the Tonoloway limestone of Maryland, resembling it in lithology, stratigraphic position and in containing an ostracod fauna. The sparse brachiopod fauna of the Tonoloway has not been observed in central Pennsylvania, suggesting that the Maryland area was more closely connected with the open sea.

The Keyser member of the Helderberg is present in Pennsylvania and closely resembles the corresponding Maryland beds in lithology and fauna. The lower strata are nodular while the upper are in part laminated

[1] Grabau, N. Y. State Mus., Bull. 92, 1906, p. 173.

[2] The conclusions here advanced are only tentative. Further investigation is needed before they can be established.

argillaceous limestones, as in Maryland. The general sequence of faunal zones is also similar, the *Chonetes jerseyensis* fauna being present in the lower strata, and *Tentaculites gyracanthus* in the upper beds.

The upper limit of the Keyser is probably limited by an unconformity which separates it from the overlying Coeymans or New Scotland. The basal part of the Oriskany is a cherty shale suggesting the Shriver Chert member at the base of the Oriskany of Maryland.

The Helderberg and Bossardville limestones are well exposed in eastern Pennsylvania where they agree in fauna and lithology with the corresponding beds of New Jersey with which they are continuous. The discussion of the latter area will therefore apply to them.

CORRELATION WITH NEW JERSEY.—The Lower Devonian and Upper Silurian limestones of New Jersey were divided by Weller[1] into the following formations:

Devonian	Becraft New Scotland Coeymans
Silurian	Manlius Rondout Decker Ferry Bossardville

The Bossardville of New Jersey so closely resembles the formation of the same name in central Pennsylvania that there is little doubt of their essential identity. The latter can possibly be traced southward into Maryland where it is termed the Tonoloway.

Weller subdivided the Decker Ferry into three faunal zones each characterized by a definite association of species which he named as follows in descending order:

Rhynchonella lamellata zone.
Ptilodictya frondosa zone
Chonetes jerseyensis zone.

The most diagnostic species of the lower zone is *Chonetes jerseyensis* associated with *Schuchertella deckerensis, Stenochisma deckerensis,* and *Camarotœchia litchfieldensis.* All of these and many others common in that zone are abundant also in the *Chonetes jerseyensis zone* of the Keyser of Maryland.

[1] Pal. N. J., vol. iii, 1903.

Weller's second zone, characterized by the bryozoan *Ptilodictya frondosa,* is very thin and has not been recognized in Maryland.

His upper zone contains a rich coralline fauna of which the more important species are *Cladopora rectilineata, Favosites pyriformis, Cyathophyllum inequale, Halysites catenulatus,* and stromatoporoids. The *Cladopora rectilineata zone* of the Keyser of Maryland occupies a similar position and contains *Cladopora rectilineata* in profusion associated with *Favosites pyriformis* and *Cyathophyllum inequale. Halysites catenulatus* occurs at a somewhat higher horizon. A zone in a like position in the lower Keyser of central Pennsylvania abounds in *Cladopora rectilineata* and *Halysites catenulatus.*

An examination of the entire fauna of the *Chonetes jerseyensis zone* of the Keyser of Maryland still further emphasizes its close faunal relation to the Decker Ferry of New Jersey. Of 40 species, other than ostracods, described by Weller from the Decker Ferry 60 per cent occur also in the *Chonetes jerseyensis zone* of Maryland, including its most diagnostic forms. Eighteen, or 38 per cent, of the previously described species found in the Keyser of Maryland occur also in the Decker Ferry of New Jersey. This difference is due in part to the fact that the Keyser of Maryland contains a much larger fauna than the corresponding beds in New Jersey. The table of distribution exhibits this relation more fully.

The Decker Ferry also resembles the lower Keyser lithologically, some beds being nodular while all are highly fossiliferous, contrasting strikingly with the underlying fissile, platy, almost unfossiliferous limestone of the Bossardville of New Jersey and Tonoloway of Maryland.

The close resemblance of the *Chonetes jerseyensis zone* of the Keyser to the Decker Ferry of New Jersey in fauna, lithology, and stratigraphic sequence, together with the similarity of the corresponding strata in Pennsylvania is believed to indicate the essential identity of both horizons. It is to be noted, however, that while the lower limit of the Decker Ferry and *Chonetes jerseyensis zone* of the Keyser limestone seem to be the same their upper limits may differ. This is suggested by the fact that the *Cladopora rectilineata zone* lies at the top of the Decker Ferry of New Jersey and much below the upper limit of the *Chonetes jerseyensis* fauna of Maryland. If it occupies like horizons in both areas then the *Chonetes jerseyensis* fauna persisted longer in Maryland than in New Jersey, a feature which may be due to the continuance of open-sea conditions for a longer period in Maryland. Upon this supposition the upper part of the *Chonetes jerseyensis zone* of Maryland may be synchronous with a part of the Manlius of New Jersey. These conclusions, however, are not assured and the true relations cannot be adequately determined until the intervening area in Pennsylvania has been studied more critically.

Following the deposition of the Decker Ferry and lower Keyser the sea became more restricted as shown by the more argillaceous composition of the overlying beds, the presence of numerous ostracods, and the greater rarity of brachiopods in them. These features, however, are more marked in New Jersey than in Maryland.

The Rondout of New Jersey is an argillaceous limestone, one stratum of which is a cement rock. Its fauna is peculiar to such sediments, consisting almost exclusively of a few species of the genus Leperditia, all of which are found in the Keyser of Maryland, although they are not restricted to one horizon. The most abundant species is *Leperditia gigantea* which occurs at the Devil's Backbone 235-236 feet above the base of the Keyser.

The Rondout formation seems to have been a local deposit which had its largest development in New York and thinned toward New Jersey. It has not been recognized in Maryland.

The Manlius of New Jersey, overlying the Rondout, is a nodular limestone characterized by a Stromatopora reef and the abundance of *Tentaculites gyracanthus, Spirifer vanuxemi, Stropheodonta varistriata,* and a species of Leperditia identified as *L. alta.* The *Favosites helderbergiæ* var. *præcedens zone* of the Keyser of Maryland contains similar, though more abundant, Stromatopora reefs at most localities. *Tentaculites gyracanthus* occurs in profusion between the Corriganville Stromatopora beds, while *Spirifer vanuxemi* is represented by a variety that differs somewhat from the typical form. The latter species is also found in the underlying *Chonetes jerseyensis zone* where it more closely approaches the typical form. A variety of *Leperditia alta,* known as *L. altoides,* is common in certain of the upper beds of the Keyser member. Three of the four diagnostic species of the Manlius, are therefore represented in this zone, two of which occur as varietal forms.

The fauna of Maryland differs from that of the Manlius of New Jersey in containing species of a more normal marine habitat including many corals. The most striking difference, however, is the presence of a number of species of distinct Helderberg affinities in which respect it resembles the transition beds at the top of the Manlius of Schoharie, and elsewhere in New York. The significance of this fact will be considered later.

The preceding facts indicate that the *Favosites helderbergiæ* var. *præcedens zone* of the Keyser is, in a general way, of the age of the Manlius-Rondout interval of New Jersey and that both occupy a similar stratigraphic position, being limited above by the Coeymans and below by the *Chonetes jerseyensis zone.* The difference between them may be in part geographic, arising from differences in the conditions under which they were deposited. It is, however, not improbable that they may occupy a slightly different stratigraphic position. As has been shown, the lower beds of the Manlius of New Jersey may be older than the upper strata of the *Chonetes jerseyensis zone* and hence older than the base of the *Favosites helderbergiæ* var. *præcedens zone,* while it is possible that the upper beds of the latter zone are younger than the upper beds of the Manlius of New Jersey, since both appear to be bounded above by an unconformity.

Weller showed that the Coeymans, New Scotland, and Becraft of New Jersey are equivalent to the formations bearing the same names in New York. The corresponding formations of Maryland are also correlated with them as is shown elsewhere in this volume.

If these conclusions are true the Keyser limestone of Maryland lies between approximately the same limits as the combined Manlius, Rondout, and Decker Ferry of New Jersey to which formations it appears to be equivalent. Their relations are indicated in the following diagram:

Maryland	Pennsylvania	New Jersey
Coeymans	Coeymans	Coeymans
Keyser	Keyser	Manlius Rondout Decker Ferry
Tonoloway	Bossardville	Bossardville

CORRELATION WITH NEW YORK.—Different problems are presented in considering the correlation of the Helderberg of Maryland with the formations east and west of the Helderberg Mountains of New York. These areas are therefore considered separately.

Correlation with Formations East of the Helderberg Mountains.—The Lower Devonian and Upper Silurian strata pass, without modification, from northern New Jersey into southeastern New York. In approaching Rondout, New York, however, the lower formations undergo a change accompanied by an increasing development of cement beds leading to the discrimination of new formations. Clarke and Hartnagel recognize the following sequence in the vicinity of Rondout.[1]

Devonian	Coeymans
	Unconformity
	Manlius
	Rondout
Silurian	Cobleskill
	Rosendale
	Wilbur
	Binnewater
Ordovician	Unconformity
	Normanskill

The Coeymans, Manlius, and Rondout are clearly the same as the corresponding formations of northern New Jersey so that their correlation needs no further consideration here. Divergent views have, however, been held covering the relation of the Decker Ferry to the formations of New York.

Weller[2] correlated the Decker Ferry of New Jersey with the Cobleskill of New York, basing his conclusion upon the evident similarity of their faunas. Hartnagel[3] who studied the subject somewhat later, restricted the name Decker Ferry to the two lower zones of Weller's formation and correlated them with the Rosendale and Wilbur of New York. He named the coralline zone of Weller's Decker Ferry the Cobleskill, correlating it with the formation of that name in New York and considered the 15 feet

[1] N. Y. State Mus., Handbook No. 19, 1912, Table 2.
[2] Pal. N. J., vol. iii, 1903.
[3] Rept. N. Y. State Paleontologist for 1903, N. Y. State Mus., 57th Ann. Rept., 1905, vol. i, pt. i, pp. 348-349.

of strata immediately beneath it transitional between the Decker Ferry and the Cobleskill. Both Weller and Hartnagel referred the Manlius, Rondout, and Cobleskill of southeastern New York and northern New Jersey to the Silurian System.

These interpretations are exhibited in the following table:

<table>
<tr><td></td><td colspan="2">Weller, 1902</td><td colspan="2">Hartnagel, 1903</td></tr>
<tr><td rowspan="5">Silurian</td><td colspan="2">Manlius</td><td colspan="2">Manlius</td></tr>
<tr><td colspan="2">Rondout</td><td colspan="2">Rondout</td></tr>
<tr><td rowspan="2">Decker Ferry = Cobleskill</td><td>Rhynchonella lamellata zone, 25 feet</td><td colspan="2">Cobleskill, 10 feet
Transitional zone, 15 feet</td></tr>
<tr><td>Ptilodycta frondosa zone
Chonetes jerseyensis zone</td><td>Decker Ferry</td><td>Rosendale
Wilbur</td></tr>
<tr><td colspan="2">Bossardville limestone</td><td colspan="2">Bossardville limestone</td></tr>
</table>

The correlation of the Keyser of Maryland, with the Decker Ferry, Rondout, and Manlius of northern New Jersey, has been considered already. If Hartnagel's correlation of the latter formations be accepted, the Keyser of Maryland represents the interval from the Wilbur to the Manlius of southeastern New York, inclusive.

Correlation with Formations West of the Helderberg Mountains.—Hartnagel who has recently made a critical study of the Upper Silurian of New York considers the Manlius, Rondout, and Cobleskill of southeastern New York equivalent to the formations bearing the same names in the central part of the State.[1] Ulrich has recently presented a view that differs widely from that of Hartnagel and Clarke and others.[2]

[1] N. Y. State Mus., Bull. No. 69, 1903.

[2] Pawpaw-Hancock Folio, U. S. Geol. Surv., 1912, Field Edition, pp. 62-65. The writer is greatly indebted to Dr. Ulrich for revision and correction of the accompanying statements

According to Ulrich's view the beds usually referred to the Manlius formation at Manlius, in central New York, comprise different units which may be discriminated as follows, in descending order:

"Manlius" of authors.	Upper beds—Transition beds.
	Cement beds—Rondout.
	Fossiliferous bed—Decker Ferry ?.
	Typical Manlius—Manlius fauna.

The beds referred to the Manlius formation at Rondout, by other students, are believed by Ulrich to be comparable to the upper beds of the Manlius section, while the Rondout formation is believed to be identical with the cement beds which lie above the typical Manlius in the Manlius section. In other words, the Rondout is held to be younger, and not older, than the typical Manlius. At Manlius this section shows a fossiliferous bed between the cement beds and the typical Manlius which is provisionally correlated with the Decker Ferry. The typical Manlius is believed to have pinched out before reaching Rondout where it is represented by a hiatus below the Decker Ferry. Ulrich's view may be represented as follows:

	Section at Manlius Central New York	Section at Rondout Southeastern New York
	Onondaga or Oriskany.	
Lower Devonian	Hiatus.	Coeymans.
	Transition beds (Keyser).	"Manlius" of authors.
	Rondout.	Rondout.
	Decker Ferry ?	Decker Ferry.
Silurian	Typical Manlius.	Hiatus.
	Cobleskill.	Hiatus.

Ulrich bases his view upon a close correlation of the lithological and faunal zones of the sections at Manlius and Rondout by which he believes he has established the presence of the Rondout above the typical Manlius in the Manlius section. Since the Rondout is underlain by the Decker Ferry with apparent conformity in southeastern New York the latter formation is held to be younger than the typical Manlius and hence distinct from the Cobleskill.

This conclusion is apparently further supported by the presence of species related to those of the Cobleskill and Manlius of New York below the base of the *Chonetes jerseyensis zone* in Maryland, including *Tentaculites gyracanthus* in abundance, *Camarotœchia ? lamellata, Camarotœchia litchfieldensis, Stropheodonta bipartita, Leperditia alta,* etc. Ulrich explains the evident similarity of the Decker Ferry and Cobleskill faunas by the suggestion that the Cobleskill fauna recurs in the younger Decker Ferry although the formations are distinct.

He hence proposes to draw the Silurian-Devonian boundary at the top of the typical Manlius and refers the Decker Ferry, the Rondout, the upper beds at Manlius, and the Keyser limestone to the Devonian.

A serious difficulty in the acceptance of this view, in the opinion of the writer, is the fact that the *Chonetes jerseyensis* fauna has never been observed above the typical Manlius of New York, while it is known to be present in the Cobleskill.[1] The data upon which these views are based have not been published and it is manifestly premature to discuss them at this time. The author has not adequately studied the problem here presented and is unable to offer any opinion as to the validity of these conclusions.

If Hartnagel's correlation of the New York sections is correct, the evidence indicates that the Keyser member of the Helderberg formation is equivalent to the formations between the base of the Wilbur and the top of the Manlius of New York. If Ulrich's interpretation be accepted, the Keyser is equivalent to the Decker Ferry, Rondout, and uppermost beds of the Manlius as found in New Jersey, all of which lie above the horizon of

[1] Dr. Ulrich has kindly furnished the following comment upon the above statement: "To this objection I would answer that the Keyser zones containing *C. jerseyensis* are not represented in either the Manlius, the Schoharie or the Rondout sections with the possible exception of the Decker Ferry zone itself, which is doubtfully identified between the cement beds (Rondout) and the typical Manlius at Manlius only. At all three localities the beds between the Rondout and the base of the Coeymans, or the Oriskany or Onondaga where the Coeymans is absent (as at Manlius), are correlated by me with the upper fourth or less of the Keyser in Maryland. *C. jerseyensis* was not found in the doubtfully identified Decker Ferry zone at Manlius but the half hour's search I gave these beds is insufficient to establish the absence of the fossil at Manlius above the typical Manlius."

the typical Manlius of New York. The reader is referred to the diagram on p. 31 in which the correlation of the Keyser with various formations is summarized.

HELDERBERG ELEMENTS IN THE FAUNA.—Reference has already been made to the presence of a number of species of Helderberg affinities in the Keyser limestone. Their range is indicated in the table of distribution.

Certain species of the Helderberg, including *Pholidops ovata* and *Rhynchospira globosa*, appear in the Tonoloway beneath the Keyser. A larger number make their advent in the lower beds of the Keyser including *Pholidops ovata, Rhynchospira globosa* var., *Rhynchospira formosa, Stenoschisma formosa,* and *Uncinulus nucleolatus.*

At a somewhat higher horizon a variety of *Anoplotheca concava* appears. The upper part of the *Chonetes jerseyensis zone* contains a profusion of *Gypidula cœymanensis* var. *prognostica,* a forerunner of the diagnostic species of the Coeymans. The base of the *Favosites helderbergiæ præcedens zone* is marked by the advent of *Rensselæria mutabilis* while at a higher horizon *Uncinulus nucleolatus* is associated with *Schuchertella prolifica,* which is very closely related to *S. woolworthana* of the Coeymans. Grabau[1] has noted a similar mingling of Helderberg and Silurian species in the uppermost beds of the Manlius at Schoharie and elsewhere in New York, and has described them as transition beds between the Silurian and Devonian.

These Helderberg species entered the Maryland sea in Keyser time, mingling with the Silurian species which continued to constitute the larger part of the faunas. The Keyser limestone is, therefore, clearly transitional between the Silurian and Devonian. Accepting the principle that the age of the formation is that of its youngest fauna, the Keyser is here referred to the Helderberg although the majority of the species in it are distinctly Silurian. The Helderberg fauna thus appears to have invaded Maryland before its advent in New York in Coeymans time, suggesting that its route of immigration may have been by way of Maryland.

[1] N. Y. State Mus., Bull. No. 92, 1906, p. 114.

The relation of the species of the Keyser member to those of other horizons is summarized in the subjoined table.

	Keyser member		Chonetes jerseyensis zone		Favosites heldbergiæ var. præcedens zone	
	No.	Pct.	No.	Pct.	No.	Pct.
Species occurring in other areas	73	45	61	49	19	53
Species restricted to Maryland	91	55	63	51	17	47
Total	164	..	124	..	36	..
Species occurring in Tonoloway	14	8	12	..	3	..
Species occurring in both zones	10	6	10	..	10	..
Range of species occurring in other areas (omitting *Atrypa reticularis* and *Leptæna rhomboidalis*):						
Decker Ferry of New Jersey	28	38	24	40	5	26
Rondout of New Jersey	3	4	3	5	1	5
Manlius of New Jersey	5	7	4	7	2	10
Wilbur of New York	7	9	4	7	2	10
Cobleskill of New York	11	15	10	17	3	16
Rondout of eastern New York	8	11	7	12	2	10
Rondout of central New York	6	8	4	7	3	16
Manlius of eastern New York	4	5	3	5	2	10
Manlius of central New York	5	7	4	7	2	10
Coeymans, New Scotland and Becraft	31	43	19	30	12	63

The preceding table shows that the fauna of the *Chonetes jerseyensis zone* is more closely related to the Decker Ferry fauna of New Jersey than to any other, a relationship rendered more pronounced by the character of the species found in it, including *Chonetes jerseyensis, Schuchertella deckerensis, Stenochisma deckerensis, Cladopora rectilineata* and various other important members of that fauna.

The fauna of this zone also shows a marked relation to that of the upper members of the Helderberg, 30 per cent of the species not restricted to the Keyser member being found in them. It also bears a less striking, though close resemblance to the fauna of the Cobleskill, 17 per cent of the species not restricted to the Keyser occurring in it.

The fauna of the *Favosites helderbergiæ præcedens zone* is still more closely related to that of the overlying members of the Helderberg, 63 per cent of its species being found in them. That it is older, however, than the Coeymans to which Schuchert referred it is shown by the occurrence in it of so large a number of species known elsewhere only in older strata, and by the abrupt lithological and faunal break and probable unconformity which separates the Keyser member from the overlying Cocymans of Maryland. Three species of this zone, *Spirifer vanuxemi* var. *prognosticus, Tentaculites gyracanthus,* and *Leperditia altoides* suggest a relationship to the Manlius.

The fauna of the Keyser member, considered as a whole, shows pronounced relations to the Helderberg to which it is referred.

Coeymans Member

The guide fossil of the Coeymans is *Gypidula coeymanensis,* which occurs everywhere in this member in Maryland as in New York. The following table clearly shows its Coeymans age:

	Number	Per cent
Species occurring elsewhere	19	87
Species restricted to Maryland	3	13
Total	22	..
Occurring in the Coeymans of New York and New Jersey	18	82

It also resembles the Coeymans of New York in its lithology being a massive crystalline limestone carrying many crinoid and Lepadocystis stems.

New Scotland Member

The New Scotland member is characterized by the presence of *Spirifer macropleurus* which is found at all the outcrops of the cherty limestone. Among the other abundant species are *Spirifer perlamellosus, Schuchertella woolworthana, Strophonella leavenworthana, Dalmanella perelegans, Meristella arcuata* and species of the genera Trematospira and Eatonia. The similarity of the fauna of this member to that of the New Scotland of New York is clearly shown in the following table:

	Number	Per cent
Species occurring elsewhere	73	91
Species restricted to Maryland	7	9
Total	80	..
Species occurring in the New Scotland of New York and New Jersey	68	85

Becraft Member

The Becraft of Maryland is characterized by the presence of *Spirifer concinnus* and other species diagnostic of the Becraft of New York as shown by the list of species. The relations of the member are shown in the subjoined table which emphasizes the close resemblance of the fauna to that of the New Scotland, a condition observed also in New York and New Jersey.

	No.
Species previously described	22
New species	1
Total	23
Previously described species occurring in the New Scotland of New York and New Jersey	14
Previously described species occurring in the Becraft of New York and New Jersey	6
Previously described species occurring in the Oriskany of New York and New Jersey	8

The beds closely resemble the Becraft of New York not only faunally, but also in their lithology and their stratigraphic position.

ORISKANY FORMATION

As has been shown in the preceding chapter, the Oriskany formation is divisible into two members the Shriver Chert below and the Ridgely sandstone above.

Shriver Chert Member

About Kingston and Rondout, New York, Davis[1] found a series of shaly limestones, said to lie above the Becraft, with a thickness of 250 feet. This he called the Upper Shaly Limestone, because it contained many of the fossils of the underlying shaly limestone (the New Scotland). Later Clarke and Schuchert[2] named these strata the Kingston beds. The same name had been used in 1873 by the Canadian geologists, Bailey and Matthew, hence Clarke,[3] renamed the New York formation Port Ewen,

[1] Amer. Jour. Sci., vol. xxvi, 1883, p. 389.
[2] Science, Dec. 7, 1899.
[3] N. Y. State Mus., Bull. No. 49, 1903, p. 666.

after a station on the West Shore Railway not far from Kingston. Subsequently Grabau[1] discovered that the greater part of the original Kingston consisted of the Helderberg series repeated by overthrust faulting, and terminated by an "impure schistose limestone" more than 100 feet thick, having a Lower Oriskany fauna like that of Becraft Mountain, New York. The fauna of the Lower Oriskany was described by Clarke.[2]

The following table shows the relations of the fauna of the Shriver Chert member to the Helderberg and Oriskany of New York and Maryland:

	No.
Species previously described	12
New species	17
Total	29

The range of the previously described species in other formations is as follows:

	No.
New Scotland of New York	4
Becraft of New York	7
Lower Oriskany of New York	11
Upper Oriskany of New York	5
Ridgely sandstone member of Oriskany of Maryland	10

The Lower Oriskany age of these beds is shown by the above table.

The Shriver Chert resembles the Camden Chert of Tennessee lithologically. The faunal resemblance is but slight.[3]

Ridgely Sandstone Member

The Ridgely sandstone member contains a fauna rich in species and individuals. The following table shows their range:

	No.
Species restricted to Maryland	54
Species occurring elsewhere	66
Total	120

[1] N. Y. State Mus., Bull. No. 49, 1903, p. 1063. See also Van Ingen and Clarke *ibidem*, pp. 1193-1197; Shimer, N. Y. State Mus. No. 80, 1905, p. 184.

[2] N. Y. State Mus., Mem. No. 3, 1900.

[3] See Schuchert, Amer. Jour. Sci., vol. vii, 1889, p. 184.

The species not restricted to Maryland have the following range in the formations of New York:

	No.
Coeymans	2
New Scotland	19
Becraft	6
Lower Oriskany	27
Upper Oriskany	31

This member closely resembles the typical Oriskany of New York in its lithology and its fauna. The faunal relations are shown not only by the large number of species common to both, but also by the occurrence of *Spirifer arenosus,* the guide fossil of the Oriskany, in profusion associated with many other species diagnostic of that formation, including *Spirifer murchisoni,* and various members of the genera Rensselæria and Eatonia. The presence of many species of the Lower Oriskany of New York is also to be noted. The restriction of so large a number of species to Maryland is due to the fact that a longer time is represented here than in New York.

GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF SPECIES.[1]

The geological and geographical distribution of the species obtained from the Maryland Lower Devonian has already been partly indicated in the discussion of the various zones. A more complete presentation of the occurrence of these forms is shown in the following tables as well as in the chapters on correlation and on the systematic paleontology:

[1] Contributed by C. K. Swartz.

	SPECIES	MARYLAND										NEW JERSEY							NEW YORK													
			Helderberg							Oriskany									East				Central			Helderberg			Oriskany			
			Keyser																													
		Tonoloway	Chonetes jerseyensis zone	Favosites helderbergiæ var.	Range not determined	Coeymans	New Scotland	Becraft	Range not determined	Shriver	Ridgely	Decker Ferry	Rondout	Manlius	Coeymans	New Scotland	Becraft	Oriskany	Wilbur	Cobleskill	Rondout	Manlius	Cobleskill	Rondout	Manlius	Coeymans	New Scotland	Becraft	Lower	Upper	Below	Above
	PORIFERA.																															
1	Hindia sphæroidalis Duncan			*			*									*										*	*				*	
	COELENTERATA.																															
2	Streptelasma strictum Hall						*									*	*										*	*				
3	Streptelasma cumberlandica Swartz								†																							
4	Zaphrentis rœmeri M. Edwards and Haime								*		*															*						
5	Zaphrentis keyserensis Swartz			†																												
6	Cyathophyllum clarki Swartz				†																											
7	Cyathophyllum radiculum Rominger ?								*																						*	
8	Cyathophyllum oherni Swartz								†																							
9	Cyathophyllum inequale (Hall)		*									*								*			*									
10	Cyathophyllum schucherti Swartz			†																												
11	Cyathophyllum marylandicum Swartz			†																												
12	Heliophyllum cf. corniculum Lesueur								*																		*					*
13	Columnaria ? helderbergiæ Swartz		†																													
14	Cystiphyllum fasciculatum Swartz								†																							
15	Cystiphyllum sp.				†																											
16	Favosites helderbergiæ Hall					*	*								*											*	*					
17	Favosites helderbergiæ var. præcedens Schuchert			*															*	*	*		*	*							‡	
18	Favosites pyriformis Hall		*									*																				
19	Favosites conicus Hall						*	*			*																*					*
20	Favosites basalticus Goldfuss								*																						*	
21	Favosites favosus var. integritabulatus Swartz		†																												‡	
22	Favosites ? schriveri (Herzer)										†																					
23	Striatopora bella Swartz										†																					
24	Striatopora sp.		†																													
25	Cladopora rectilineata Simpson		*									*								*												
26	Cladopora cf. rectilineata Simpson		*									‡								‡												
27	Cladopora multiseriata Weller			*											*																	
28	Pleurodictyum lenticulare (Hall)						*																				*					
29	Aulopora schohariæ Hall				*			*																			*					
30	Aulopora schucherti Swartz		†				†																									
31	Ceratopora ? marylandica Swartz			†																												
32	Halysites catenulatus Linné			*								*							*	*			*	*							*	
33	Stromatopora constellata Hall			*																*			*			*					*	
34	Syringostroma barretti Girty		*																							*						
35	Syringostroma centrotum Girty		*																							*						
36	Idiostroma sp.				*																											
	ECHINODERMATA.																															
37	Camarocrinus stellatus Hall		*																						*							
38	Anomalocystis disparillis Hall ?										†																					
39	Lepocrinites gebhardi Conrad					*																				*						
40	Lepocrinites manlius Schuchert		†																													
41	Tetracystis chrysalis Schuchert		†																													
42	Jaekelocystis hartleyi Schuchert		†																													
43	Jaekelocystis papillatus Schuchert		†																													
44	Jaekelocystis avellana Schuchert		†																													
45	Pseudocrinites gordoni Schuchert		†																													
46	Pseudocrinites abnormalis Schuchert		†																													
47	Pseudocrinites stellatus Schuchert		†																													

† = restricted to Maryland. ‡ Affine = related species.

	SPECIES	Maryland										New Jersey							New York													
			Helderberg							Oriskany									East				Central			Helderberg			Oriskany			
			Keyser																													
		Tonoloway	Chonetes jerseyensis zone	Favosites helderbergiæ var.	Range not determined	Coeymans	New Scotland	Becraft	Range not determined	Shriver	Ridgely	Decker Ferry	Rondout	Manlius	Coeymans	New Scotland	Becraft	Oriskany	Wilbur	Cobleskill	Rondout	Manlius	Cobleskill	Rondout	Manlius	Coeymans	New Scotland	Becraft	Lower	Upper	Below	Above
	ECHINODERMATA.—Continued.																															
48	Pseudocrinites clarki Schuchert		†																													
49	Pseudocrinites subquadratus Schuchert		†																													
50	Pseudocrinites elongatus Schuchert		†																													
51	Pseudocrinites perdewi Schuchert		†																													
52	Trimerocystis peculiaris Schuchert		†																													
53	Sphærocystites multifasciatus Hall		†																													
54	Sphærocystites globularis Schuchert		†																													
55	Sphærocystites ovalis Schuchert		†																													
56	Thysanocrinus eugenius Ohern										†																					
57	Technocrinus sculptus Hall										†																					
58	Technocrinus striatus (Hall)										†																					
59	Technocrinus andrewsi (Hall)										†																					
60	Technocrinus spinulosus (Hall)										†																					
61	Technocrinus ? lepidus Ohern										†																					
62	Calceocrinus marylandicus Ohern										†																					
43	Homocrinus proboscidalis Hall										†																					
64	Homocrinus hartleyi Ohern										†																					
65	Edriocrinus sacculus Hall										*							*											*			
66	Edriocrinus pocilliformis Hall						*	*																				*					
	VERMES.																															
67	Cornulites cingulatus Hall				*										*													*		*			
	MOLLUSCOIDEA—BRYOZOA.																															
68	Rhopalonaria attenuata Ulrich & Bassler		*																												*	
69	Ascodictyon siluriense Vine		*																												*	
70	Ceramopora ? incondita Ulrich & Bassler		†																													
71	Fistulipora maculosa (Hall)						*																					*					
72	Fistulipora cumulata Ulrich & Bassler		†	†																												
73	Fistuliporella quinquedentata Ulrich & Bassler		†																													
74	Fistuliporella minima Ulrich & Bassler		†																													
75	Fistuliporella marylandica Ulrich & Bassler		†																													
76	Fistuliporella maynardi Ulrich & Bassler		†																													
77	Chilotrypa micropora Ulrich & Bassler		†																													
78	Chilotrypa constricta (Hall)						*																					*					
79	Cyphotrypa corrugata (Weller)		*									*																				
80	Batostomella interporosa Ulrich & Bassler		†	†																												
81	Callotrypa striata (Hall & Simpson)						*																					*					
82	Callotrypa macropora (Hall)						*																					*					
83	Eridotrypa parvulipora Ulrich & Bassler		†	†																												
84	Eridotrypa corticosa (Hall)						*																					*					
85	Lioclema subramosum Ulrich & Bassler		†	†		†																										
86	Lioclema pulchellum Ulrich & Bassler				†																											
87	Stenopora (??) incrustans Ulrich & Bassler		†																													
88	Diplostenopora siluriana (Weller)		*									*																				
89	Monotrypa sphærica (Hall)						*								*													*					
90	Monotrypa tabulata (Hall)						*																					*					
91	Stromatotrypa globularis Ulrich & Bassler		*																									*					
92	Fenestella cumberlandica Ulrich & Bassler		†																													
93	Fenestella philia Hall						*																					*					
94	Fenestella (Cycloporina) altidorsata U. & B.		†																													
95	Fenestella ? idalia Hall						*																					*					

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No.	SPECIES	Maryland										New Jersey							New York														
			Helderberg							Oriskany									East				Central			Helderberg			Oriskany			
			Keyser																													
		Tonoloway	Chonetes jerseyensis zone	Favosites helderbergiæ var.	Range not determined	Coeymans	New Scotland	Becraft	Range not determined	Shriver	Ridgely	Decker Ferry	Rondout	Manlius	Coeymans	New Scotland	Becraft	Oriskany	Wilbur	Cobleskill	Rondout	Manlius	Cobleskill	Rondout	Manlius	Coeymans	New Scotland	Becraft	Lower	Upper	Below	Above
	MOLLUSCOIDEA—BRYOZOA.—Continued.																															
96	Polypora dictyota Ulrich & Bassler		†																													
97	Polypora compacta (Hall)						*																				*					
98	Semicoscinium planum Ulrich & Bassler		†																													
99	Semicoscinium coronis (Hall)						*																				*					
100	Thamniscus regularis Ulrich & Bassler		†																													
101	Orthopora rhombifera (Hall) ?		*	*			*																				*					
102	Orthopora regularis (Hall)						*																				*					
103	Orthopora ovatipora (Hall)						*																				*					
104	Ptilodictya tenella Ulrich & Bassler		†																													
105	Stictopora (??) papillosa Hall						*																				*					
	MOLLUSCOIDEA—BRACHIOPODA																															
106	Orbiculoidea roederi Schuchert										†																					
107	Orbiculoidea ampla (Hall)										*							*												*		*
108	Orbiculoidea schucherti Swartz			†																												
109	Orbiculoidea sp.			†																												
110	Schizocrania sp.						†																									
111	Pholidops multilamellosa Schucbert									†																						
112	Pholidops tumida Schuchert		*	*								*				*		*									*					
113	Pholidops ovata Hall		*	*								*				*											*					
114	Lingulapholis terminalis (Hall)										*																		*	*		
115	Orthostrophia strophomenoides (Hall)						*									*											*					
116	Dalmanella planiconvexa (Hall)						*	*			*																*	*				
117	Dalmanella clarki Maynard		†																													
118	Dalmanella concinna (Hall)		†	?																												
119	Dalmanella perelegans (Hall)					*	*									*		*								*	*	*	*			
120	Dalmanella eminens (Hall)						*									*											*					
121	Rhipidomella emarginata (Hall)		†																													
122	Rhipidomella oblata (Hall)					*	*									*	*	*								*	*	*	*			
123	Rhipidomella assimilis (Hall)							*																			*	*				
124	Rhipidomella musculosa (Hall)										*																			*		
125	Rhipidomella musculosa var. arctisinuata Schuchert										†																					
126	Rhipidomella marylandica Schuchert										†																					
127	Schizophoria multistriata (Hall)						*										*										*	*				
128	Schizophoria oriskania Schuchert										†																					
129	Leptæna rhomboidalis (Wilckens)		*			*	*	*				*			*	*	*	*	*	*			*			*	*	*	*	*	*	*
130	Leptæna rhomboidalis var. ventricosa (Hall)										*							*												*		
131	Leptænisca concava (Hall)					*	*																			*	*					
132	Stropheodonta coeymanensis Swartz					†																										
133	Stropheodonta arata (Hall)					*	*																			*	*					
134	Stropheodonta varistriata (Conrad)		?											*	*							*			*	*						
135	Stropheodonta demissa (Conrad)										*																			*		*
136	Stropheodonta (Leptostrophia) beckii (Hall)						*				?					*	*										*	*				
137	Stropheodonta (Leptostrophia) planulata (Hall)					*	*	*							*											*		*				
138	Stropheodonta (Leptostrophia) bipartita (Hall)	*	*									*							‡	‡	‡		‡									
139	Stropheodonta (Leptostrophia) arctimuscula Schuchert									†																						
140	Stropheodonta (Leptostrophia) magnifica (Hall)										*							*											*	*		
141	Stropheodonta (Leptostrophia) magniventra (Hall)										*																			*		
142	Strophonella geniculata (Hall)		†																													

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SPECIES	Maryland										New Jersey							New York													
		Helderberg							Oriskany									East				Central			Helderberg			Oriskany			
		Keyser																													
	Tonoloway	Chonetes jerseyensis zone	Favosites helderbergiæ var.	Range not determined	Coeymans	New Scotland	Becraft	Range not determined	Shriver	Ridgely	Decker Ferry	Rondout	Manlius	Coeymans	New Scotland	Becraft	Oriskany	Wilbur	Cobleskill	Rondout	Manlius	Cobleskill	Rondout	Manlius	Coeymans	New Scotland	Becraft	Lower	Upper	Below	Above
MOLLUSCOIDEA—BRACHIOPODA.—Cont'd.																															
143 Strophonella leavenworthana (Hall)					*	*									*											*	*				
144 Strophonella punctulifera (Conrad)					*	*								*	*	*									*	*	*				
145 Strophonella keyserensis Swartz			†																												
146 Strophonella headleyana (Hall)						*				?																*					
147 Strophonella undaplicata Swartz						†																									
148 Schuchertella prolifica Schuchert			†																												
149 Schuchertella woolworthana (Hall)					*	*	*							*	*											*	*				
150 Schuchertella becraftensis (Clarke)									*	*																		*			
151 Schuchertella deckerensis (Weller)		*									*																				
152 Schuchertella deformis (Hall)		†																													
153 Schuchertella sinuata Hall & Clarke		†																													
154 Schuchertella marylandica Maynard		†																													
155 Hipparionyx proximus Vanuxem										*							*											*	*		*
156 Chonetes subacutiradiatus Schuchert						*																				*					
157 Chonetes rowei Schuchert										†																					
158 Chonetes hudsonicus Clarke									*	*							*											*			
159 Chonetes jerseyensis Weller		*									*								*			*									
160 Chonetes jerseyensis var. spinosus Maynard		†																													
161 Anoplia helderbergiæ Schuchert						†																									
162 Anoplia nucleata (Hall)									*	*							*									*		*	*		*
163 Chonostrophia complanata (Hall)										*							*											*	*		
164 Chonostrophia helderbergiæ Hall & Clarke						*																			*						
165 Gypidula coeymanensis Schuchert					*									*											*	*					
166 Gypidula coeymanensis var. prognostica Schuchert		*																							‡						
167 Gypidula coeymanensis var. corriganensis Maynard		†																													
168 Gypidula subglobosa Maynard		†																													
169 Rhynchotreta cumberlandica (Rowe)										†																					
170 Stenochisma formosa Hall		*													*	*	*									*	*				
171 Stenochisma deckerensis (Weller)		*									*																				
172 Camarotœchia (?) altiplicata (Hall)						*																				*					
173 Camarotœchia oriskania (Rowe)										†																					
174 Camarotœchia (?) lamellata (Hall)	*	*									*							*	*	*		*	*								
175 Camarotœchia litchfieldensis Schuchert	*	*									*							*	*	*											
176 Camarotœchia gigantea Maynard		†																													
177 Camarotœchia campbellana (Hall)						*																				*	*				
178 Camarotœchia præspeciosa Schuchert							†																								
179 Camarotœchia speciosa (Hall)										†																					
180 Camarotœchia speciosa var. ramsayi (Hall)										†																					
181 Camarotœchia barrandii (Hall)										*							*											*	*		
182 Camarotœchia barrandii var. fitchana (Hall)										*																		?	*		
183 Camarotœchia pleiopleura (Conrad)										*																			*		
184 Uncinulus vellicatus (Hall)						*	*								*	*										*					
185 Uncinulus abruptus (Hall)						*	*																			*					
186 Uncinulus globulus Schuchert						*																				*					
187 Uncinulus nucleolatus (Hall)		*	*		?	?								*												*					
188 Uncinulus nucleolatus var. angulatus Maynard		†																													
189 Uncinulus gordoni Maynard		†																													
190 Uncinulus keyserensis Schuchert			†																												
191 Uncinulus convexorus Maynard		†																													
192 Wilsonia globosa Weller		*									*																				
193 Wilsonia (cf.) globosa Weller		*																													
194 Eatonia singularis (Vanuxem)						*	*								*											*					

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No.	SPECIES	MARYLAND										NEW JERSEY							NEW YORK													
		Helderberg								Oriskany									East				Central			Helderberg			Oriskany			
			Keyser																													
		Tonoloway	Chonetes jerseyensis zone	Favosites helderbergiæ var.	Range not determined	Coeymans	New Scotland	Becraft	Range not determined	Shriver	Ridgely	Decker Ferry	Rondout	Manlius	Coeymans	New Scotland	Becraft	Oriskany	Wilbur	Cobleskill	Rondout	Manlius	Cobleskill	Rondout	Manlius	Coeymans	New Scotland	Becraft	Lower	Upper	Below	Above
	MOLLUSCOIDEA—BRACHIOPODA.—Cont'd.																															
195	Eatonia peculiaris (Conrad)						*	*			*							*									*		*	*		
196	Eatonia whitfieldi Hall										†																					
197	Eatonia medialis (Vanuxem)						*	*		*	*					*											*		*			
198	Eatonia sinuata Hall										†																					
199	Eatonia hartleyi Schuchert										†																					
200	Rhynchonella (?) bialveata Hall						*																				*					
201	Rensselæria mutabilis (Hall)			*			*																			*	*					
202	Rensselæria mutabilis var.			†																												
203	Rensselæria subglobosa Weller							*										*											*			
204	Rensselæria subglobosa var. avus Schuchert							†																								
205	Rensselæria subglobosa var. crassa Schuchert							†																								
206	Rensselæria circularis Schuchert										†																					
207	Rensselæria marylandica Hall										†																					
208	Rensselæria marylandica var. symmetrica Schuchert										†																					
209	Rensselæria keyserensis Swartz			†																												
210	Rensselæria (Beachia) proavita Schuchert			†																												
211	Rensselæria (Beachia) cumberlandiæ (Hall)										†																					
212	Rensselæria (Beachia) suessana (Hall)										*					*														*		
213	Rensselæria (Beachia) suessana var. immatura Schuchert									†																						
214	Rensselæria (Beachia) ovalis (Hall)										†																					
215	Oriskania lucerna Schuchert										†																					
216	Tropidoleptus carinatus (Conrad)										*																					*
217	Atrypa reticularis (Linné)		*			*	*				*	*			*				*	*			*			*	*	*			*	*
218	Atrypa ? biconvexa Maynard		†																													
219	Atrypina imbricata (Hall)						*									*											*					
220	Spirifer macropleurus (Conrad)						*								*	*											*					
221	Spirifer perlamellosus Hall						*									*										*	*					
222	Spirifer cumberlandiæ Hall										†																					
223	Spirifer modestus Hall		†																													
224	Spirifer modestus var. plicatus Maynard		†																													
225	Spirifer octocostatus Hall		*												*																	
226	Spirifer paucicostatus Schuchert									†																						
227	Spirifer vanuxemi Hall		*									‡		*							*			*	*							
228	Spirifer vanuxemi var. prognosticus Schuchert		*	*								‡																				
229	Spirifer eriensis Grabau	*	*																	*	*	*	*									
230	Spirifer cyclopterus Hall					*	*								*	*	*										*	*				
231	Spirifer tribulis Hall									†	†																					
232	Spirifer angularis Schuchert										†																					
233	Spirifer intermedius Hall										†																					
234	Spirifer murchisoni Castelnau										*							*											*	*		
235	Spirifer murchisoni var. marylandicus Schuchert										†																					
236	Spirifer hartleyi Schuchert										†																					
237	Spirifer perdewi Schuchert										†																					
238	Spirifer tribuarius Schuchert									†																						
239	Spirifer arenosus (Conrad)									*	*							*												*		*
240	Spirifer concinnus Hall							*							*												*	*				
241	Spirifer concinnoideus Schuchert										†																					
242	Spirifer gordoni Schuchert										†																					
243	Reticularia bicostata (Vanuxem)		*									*																				
244	Ambocœlia umbonata (Conrad) ?						*																								*	

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			Helderberg							Oriskany									East				Central			Helderberg			Oriskany			
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		Tonoloway	Chonetes jerseyensis zone	Favosites helderbergiæ var.	Range not determined	Coeymans	New Scotland	Becraft	Range not determined	Shriver	Ridgely	Decker Ferry	Rondout	Manlius	Coeymans	New Scotland	Becraft	Oriskany	Wilbur	Cobleskill	Rondout	Manlius	Cobleskill	Rondout	Manlius	Coeymans	New Scotland	Becraft	Lower	Upper	Below	Above
	MOLLUSCOIDEA—BRACHIOPODA.—Cont'd.																															
245	Metaplasia pyxidata (Hall)										*							*											*	*		
246	Cyrtina rostrata (Hall)							*			*							*												*		
247	Rhynchospira rectirostris (Hall)										†																					
248	Rhynchospira globosa (Hall)	*	*				*																			*	*					
249	Rhynchospira formosa Hall	*										*			*												*					
250	Trematospira simplex Hall ?						†																									
251	Trematospira multistriata (Hall)						*									*											*		*			
252	Trematospira deweyi (Hall)						*																				*					
253	Trematospira equistriata Hall & Clarke						†																									
254	Nucleospira ventricosa (Hall)		*			*	*								*	*											*					
255	Nucleospira elegans Hall		*				*	*			*																*					
256	Nucleospira swartzi Maynard		†																													
257	Anoplotheca concava (Hall)						*	*								*											*		*			
258	Anoplotheca concava var. tonolowayensis Swartz		*				‡	‡								‡											‡		‡			
259	Anoplotheca equistriata Schuchert										†																					
260	Anoplotheca dichotoma (Hall)										*							*											*			
261	Anoplotheca (Leptocœlia) fimbriata (Hall)										†																					
262	Anoplotheca (Leptocœlia) flabellites (Conrad)						*	*		*	*							*											*	*		*
263	Whitfieldella prosseri Grabau								*																						*	
264	Whitfieldella nucleolata Hall	*	*									*								*	*		*	*								
265	Whitfieldella minuta Maynard		†																													
266	Meristella prænuntia Schuchert			†																												
267	Meristella arcuata (Hall)						*	*																			*					
268	Meristella lata (Hall)							*			*							*											*	*		
269	Meristella lentiformis Clarke									*	*																		*			
270	Meristella rostellata Schuchert										‡																					
271	Meristella symmetrica Schuchert										†																					
272	Merista typa (Hall)		†																													
	MOLLUSCA—PELECYPODA.																															
273	Grammysia sp.				*																						*					
274	Pterinea halli Clarke										*										*		*				*					
275	Leptodesma sp.										†																					
276	Mytilarca marylandica Ohern								†																							
277	Mytilarca cordiformis (Hall)								*																		*					
278	Mytilarca (Plethomytilus) rowei Ohern										†																					
279	Amphicœlia ulrichi Maynard		†																													
280	Palæopinna lata Ohern										†																					
281	Actinopteria communis (Hall)		*			*	*				*				*												*		*			
282	Actinopteria communis (Hall) var.										*																		‡			
283	Actinopteria textilis (Hall)						*											*									*		?			
284	Actinopteria textilis var. arenaria (Hall)										*																			*		
285	Actinopteria virginica Ohern										†																					
286	Actinopteria reticulata Weller		*									*																				
287	Avicula recticosta Hall ?										*																			*		
288	Aviculopecten ? cumberlandensis Ohern								†																							
289	Aviculopecten tenuilamellatus Hall		*																								*					
290	Megambonia lamellosa Hall										*																		*	*		
291	Cypricardinia lamellosa Hall		?																								*					
292	Cypricardinia sublamellosa Hall						*									*																
293	Ilionia sinuata (Hall)								*													*	*									

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	SPECIES	Maryland										New Jersey							New York													
			Helderberg							Oriskany									East				Central			Helderberg			Oriskany			
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		Tonoloway	Chonetes jerseyensis zone	Favosites helderbergiæ var.	Range not determined	Coeymans	New Scotland	Becraft	Range not determined	Shriver	Ridgely	Decker Ferry	Rondout	Manlius	Coeymans	New Scotland	Becraft	Oriskany	Wilbur	Cobleskill	Rondout	Manlius	Cobleskill	Rondout	Manlius	Coeymans	New Scotland	Becraft	Lower	Upper	Below	Above
	MOLLUSCA—GASTROPODA.																															
294	Pleurotomaria labrosa Hall						*																				*	*				
295	Bellerophon cf. auriculatus Hall								*														*									
296	Bellerophon helderbergiæ Swartz		†																													
297	Cyrtolites expansus Hall										*																		*	*		
298	Loxonema fitchi Hall								*												*	*			*		*	*				
299	Loxonema ? sp		*																													
300	Holopea sp.								*																							
301	Holopea ? sp								*																							
302	Orthonychia tortuosum (Hall)										*							*											*	*		
303	Platyceras nodosum Conrad										*																		*	*		
304	Platyceras gebhardi Conrad						*				*																*	*	*			
305	Platyceras gebhardi var. ventricosum Conrad										*																*			*		
306	Platyceras magnificum Hall										†																					
307	Platyceras subfalcatum Ohern										†																					
308	Platyceras patulum Hall										†																					
309	Platyceras reflexum Hall						*				*																			*		
310	Platyceras ? callosum Hall										†																					
311	Platyceras sinuatum Hall ?										*																*					
312	Platyceras trilobatum Hall ?						*																				*					
313	Platyceras tenuiliratum Hall ?						?																				*					
314	Platyceras angulare Rowe										†																					
315	Platyceras multisinuatum Hall						*																				*					
316	Platyceras platystomum Hall ?										*																*					
317	Platyceras spirale Hall						*																				*					
318	Platyceras gracile Ohern										†																					
319	Platyceras subconicum Ohern										†																					
320	Platyceras newberryi Hall										*																*					
321	Strophostylus transversus Hall										†																					
322	Strophostylus matheri Hall										†																					
323	Strophostylus andrewsi Hall										†																					
324	Diaphorostoma ventricosum (Conrad)						*				*							*									*	*	*	*		
325	Diaphorostoma depressum (Hall)						*				?																*					
326	Diaphorostoma desmatum Clarke									*								*											*			
327	Platystoma niagarense Hall		*																												*	
328	Tentaculites ? acus Clarke							*																					*			
329	Tentaculites aculus Hall									*								*									*		*	*		
330	Tentaculites elongatus Hall					*	*			*					*	*		*									*	*	*	*		
331	Tentaculites gyracanthus (Eaton)	*	*	*										*								*			*							
	MOLLUSCA—CEPHALOPODA.																															
332	Orthoceras longicameratum Hall								*																	*						
333	Orthoceras schucherti Maynard		†																													
334	Orthoceras rigidum Hall			?																						*						
335	Cyrtoceras ? dubium Swartz					†																										
	ARTHROPODA—TRILOBITA																															
336	Proetus pachydermatus Barrett		*									*																				
337	Proetus cf. protuberans Hall						*								*											*						
338	Cordania cyclurus (Hall & Clarke)						?																				*					
339	Cyathaspis australis Ohern								†																							
340	Calymene camerata Conrad	*	*									*							*	*			*									

† = restricted to Maryland.

SPECIES	Maryland: Tonoloway	Maryland: Helderberg, Keyser: Chonetes jerseyensis zone	Maryland: Helderberg, Keyser: Favosites helderbergiæ var.	Maryland: Helderberg, Keyser: Range not determined	Maryland: Helderberg: Coeymans	Maryland: Helderberg: New Scotland	Maryland: Helderberg: Becraft	Maryland: Helderberg: Range not determined	Maryland: Oriskany: Shriver	Maryland: Oriskany: Ridgely	New Jersey: Decker Ferry	New Jersey: Rondout	New Jersey: Manlius	New Jersey: Coeymans	New Jersey: New Scotland	New Jersey: Becraft	New Jersey: Oriskany	New York: Wilbur	New York: East: Cobleskill	New York: East: Rondout	New York: East: Manlius	New York: Central: Cobleskill	New York: Central: Rondout	New York: Central: Manlius	New York: Helderberg: Coeymans	New York: Helderberg: New Scotland	New York: Helderberg: Becraft	New York: Oriskany: Lower	New York: Oriskany: Upper	New York: Below	New York: Above
ARTHROPODA—TRILOBITA.—Continued.																															
341 Homalonotus swartzi Ohern										†																					
342 Homalonotus vanuxemi Hall										*							*									*	*		*		
343 Phacops logani Hall						*									*	*										*					
344 Phacops sp.										†																					
345 Dalmanites aspinosus Weller		*									*																				
346 Dalmanites keyserensis Swartz		†																													
347 Dalmanites micrurus (Greene)						?				*															*	*					
348 Dalmanites multiannulatus Ohern										†																					
349 Dalmanites latus Ohern										†																					
350 Dalmanites (Synphoria) stemmatus Clarke										*																		*			
351 Dalmanites (Corycephalus) dentatus Barrett ?										*							*									*	*				
352 Dalmanites (Chasmops) anchiops (Greene)										*																					*
353 Dalmanites (Hausmannia) pleuroptyx (Greene)					*	*								*	*	*									*	*	*				
354 Dalmanites berkleyensis Swartz										†																					
ARTHROPODA—OSTRACODA.																															
355 Leperditia altoides Weller	?	*	*								*		‡							‡	‡		‡	‡							
356 Leperditia elongata Weller		*										*																			
357 Leperditia gigantea Weller		*	*									*																			
358 Aparchites gordoni Ulrich & Bassler				†																											
359 Primitia postturgida Ulrich & Bassler									†																						
360 Primitia ? cumberlandica Ulrich & Bassler				†																											
361 Primitia ? concentrica Ulrich & Bassler									†																						
362 Primitiella variolata Ulrich & Bassler									†																						
363 Ulrichia æqualis Ulrich & Bassler									†																						
364 Strepula irregularis Jones & Holl				*																										*	
365 Halliella ? seminula var. longa Ulrich & Bassler	‡			*																										‡	
366 Halliella triplicata Ulrich & Bassler				†																											
367 Æchmina cuspidata Jones & Holl						*																				*					
368 Mesomphalus hartleyi Ulrich & Bassler			†																												
369 Mesomphalus submarginata Ulrich & Bassler				†																											
370 Klœdenia nearpassi (Weller)	‡	*	*								*																				
371 Klœdenia kümmeli Weller		*										*	*																		
372 Klœdenia sussexensis (Weller)	‡	*									*																				
373 Klœdenia barretti (Weller)		*									*																				
374 Klœdenia centricornis Ulrich & Bassler				*																					*						
375 Klœdenia fimbriata Ulrich & Bassler				?																					*						
376 Ctenobolbina ? denticula Ulrich & Bassler				†																											
377 Ctenobolbina ? dubia Ulrich & Bassler				†																											
378 Bollia americana Ulrich & Bassler									†																						
379 Bollia curta Ulrich & Bassler									†																						
380 Bollia irregularis Ulrich & Bassler						†																									
381 Bollia jugalis Ulrich & Bassler									†																						
382 Bollia ungula Jones									*																						*
383 Klœdenella clarkei (Jones)	*	*	*																						*					*	
384 Klœdenella clarkei var. paupera U. & B.				†																											
385 Klœdenella turgida Ulrich & Bassler		†																													
386 Klœdenella turgida var. ventrosa U. & B.				†																											
387 Klœdenella pennsylvanica (Jones)		*																													
388 Thlipsura multipunctata Ulrich & Bassler									†																						
389 Octonaria ? angulata Ulrich & Bassler		†																													
390 Octonaria inæqualis Ulrich & Bassler		†		†																											

† = restricted to Maryland. ‡ Affine = related species.

	SPECIES	Maryland										New Jersey							New York															
			Helderberg							Oriskany									East				Central			Helderberg			Oriskany					
			Keyser																															
		Tonoloway	Chonetes jerseyensis zone	Favosites helderbergiæ var.	Range not determined	Coeymans	New Scotland	Becraft	Range not determined	Shriver	Ridgely	Decker Ferry	Rondout	Manlius	Coeymans	New Scotland	Becraft	Oriskany	Wilbur	Cobleskill	Rondout	Manlius	Cobleskill	Rondout	Manlius	Coeymans	New Scotland	Becraft	Lower	Upper	Below	Above
	ARTHRODODA—OSTROCODA.—Continued.																															
391	Octonaria simplex (Krause)				*																										*	
392	Craterellina oblonga Ulrich & Bassler									†																						
393	Craterellina robusta Ulrich & Bassler									†																						
394	Bythocypris punctulata var. arctatum U. & B.				†																											
395	Pontocypris arcuata Ulrich & Bassler		†																													
396	Pontocypris mawii var. breviata (Jones)				*																										*	
397	Pachydomella longula Ulrich & Bassler				†																											

† = restricted to Maryland.

LOCAL SECTIONS OF THE LOWER DEVONIAN[1]

SECTIONS OF HELDERBERG FORMATION

The sections are given according to their geographic occurrence beginning with the southwestern part of the Cumberland area and proceeding east to the Hancock area.

SECTIONS OF KEYSER MEMBER

The more important exposures of the Keyser member in Maryland and some few in the adjacent States of West Virginia and Pennsylvania are described in detail. The sections not only include the Keyser member, but extend into the Coeymans above and the Tonoloway below for a short distance, where these divisions are exposed, in order to show the relation of the Keyser to the overlying and underlying strata.

Certain definite fossil horizons or some stratum with well-defined lithological characteristics are used as datum planes from which any point in the section can be located by those who may in the future be interested in seeing and studying these sections.

Cumberland Area

I. Section at Keyser, West Virginia

The Helderberg formation is admirably exposed in the extensive quarries of the Standard Lime and Stone Company situated about ¾ mile southeast of Keyser, West Virginia, along the Baltimore and Ohio Railroad. Two quarries are worked here. The eastern quarry is in the Tonoloway while the western embraces beds extending from the top of the Tonoloway to the base of the Oriskany. Both the upper and lower limits of the Helderberg formation are well shown. This is one of the finest exposures in the region and it is from it that the Keyser member receives its name.

The lower beds of the Keyser are somewhat shaly, very nodular and of dark blue color. These are succeeded by massive dark blue limestones

[1] Contributed by C. K. Swartz, T. Poole Maynard, Chas. Schuchert, and R. B. Rowe. The local sections of the Keyser member of the Helderberg Formation are by Swartz and Maynard.

containing very few fossils. Great numbers of cystids have been found in the strata between 90 and 133 feet above the base of the Keyser. This is a local development of the rich cystid fauna which makes this locality of great interest. The *Gypidula coeymanensis* var. *prognostica zone* is at about the same altitude at which it is found in the other sections in the Cumberland region. The Gypidula become so large and so closely approach *Gypidula coeymanensis* of the Coeymans member that they are very difficult to distinguish. A conspicuous feature of the upper part of the Keyser member is the thick zone of coral which lies 186 feet above the base. This zone is overlain by more shaly beds containing *Tentaculites gyracanthus, Schuchertella prolifica,* and *Meristella prænuntia* in profusion. The upper strata are banded, much less fossiliferous, and resemble the Tonoloway in their lithological features. It is difficult to collect fossils in the Coeymans and New Scotland members although they are well exposed.[1]

HELDERBERG FORMATION	Vertical thickness feet	Total vertical thickness
Coeymans Member		
Massive crinoidal limestone very fossiliferous.		
Keyser Member		
Thin to medium-bedded gray limestone, nearly unfossiliferous throughout, with fine brown lines. *Leperditia altoides* 27.7....	17.3	281.0
Compact gray limestone, thin-bedded. At top of unit occur *Leperditia altoides* (a), *Meristella prænuntia, Nucleospira* sp., *Uncinulus* sp. At base occurs *Lioclema subramosum*.............	3.4	263.7
Gray crystalline limestone..............................	0.8	260.3
Heavy-bedded gray limestone with many transverse calcite seams. *Meristella prænuntia* var. small, *Spirifer vanuxemi* var. *prognosticus, Lioclema subramosum* 256.7′, *Schuchertella prolifica* 234.5	29.2	259.5
Shaly limestone containing fossiliferous crystalline layers. Weathers more easily than the adjoining units. *Schuchertella prolifica* and *Tentaculites gyracanthus* occur in abundance at 223.1, 223.5, 225.1, 226.1, *Meristella prænuntia,* abundant 223, 225.1, *Uncinulus keyscrensis* 223.1, 225.1, *Uncinulus nucleolatus* ? 225.1, *Lioclema subramosum* 223.5, 225.1...............	7.2	230.3

[1] The numbers after names of fossils indicate the altitude in feet at which they occur above the base of the formation.

	Vertical thickness feet	Total vertical thickness
Thin-bedded gray limestone *Tentaculites gyracanthus* in abundance 213.5, 216.7, 217, 218.1, 219.5, *Uncinulus keyserensis* 213.5, 214 (a), 216.7, 217, 217.8, 218.1, *Meristella prænuntia* 212.7, 214 (a), 214.7 (a), 216.7 (a), 217, *Schuchertella prolifica* 213.5, 217	10.6	223.1
Heavy-bedded, dark blue limestone, bottom foot argillaceous. *Uncinulus keyserensis* occurs throughout, more abundantly, however, at 189.8, 195.2. *Meristella prænuntia* throughout the unit; *Uncinulus nucleolatus* 211.2; *Rensselæria mutabilis* 195.2; *Bryozoa* 193.6	25.7	212.5
Massive bed of dark blue limestone spotted with crinoids and corals preserved in calcite. *Favosites helderbergiæ* var. *præcedens* (a), *Cyathophyllum marylandicum* (a), *Tentaculites gyracanthus*, *Beachia proavita*, *Meristella prænuntia*. *Uncinulus keyserensis* 186.4. *Uncinulus nucleolatus* 171.2, 182.2, 184.2; *Meristella prænuntia* 182.2	16.6	186.8
Heavy-bedded, dark blue limestone, gray and crystalline toward the top. Crinoid fragments, *Merista typa* and *Uncinulus keyserensis* 169.2	26.0	170.2
Dark blue limestone heavy-bedded below, becoming thin-bedded toward top. *Atrypa reticularis*, *Chonetes jerseyensis*, *Rhynchospira formosa* 140	9.0	144.2
A solid heavy bed of blue limestone. *Gypidula coeymanensis* var. *prognostica* throughout	2.0	135.2
Heavy-bedded, dark blue limestone containing *Camarocrinus stellatus* (a), *Tentaculites gyracanthus*, *Trimerocystis peculiaris*, and *Calymene camerata*	5.6	133.2
Thin, irregularly bedded, dark blue limestone. At the top of this unit occurs *Spirifer modestus*	6.0	127.6
Thin, irregularly bedded, dark blue limestone. Seven feet below top of this unit were found *Stenochisma formosa* ?, *Schuchertella deckerensis*, *Uncinulus convexorus*, *Platyostoma* sp.	13.6	121.6
Heavy-bedded blue limestone. *Atrypa reticularis*, *Schuchertella deckerensis*, crinoids. Between 100 to 133 feet vertically a profusion of cystids is found including *Sphærocystitis multifasciatus* (aa), *S. globularis* (a), *Pseudocrinites gordoni* (a), *Jækelocystis hartleyi* (a), *Pseudocrinites stellatus*, *P. clarki*, *P. perdewi*, *Jækelocystis papillatus*, *J. avellana*, *Lepocrinites manlius*, *Tetracystis chrysalis*. At bottom occur *Atrypa reticularis*, *Schuchertella deckerensis*, *Uncinulus convexorus*, *Platyostoma* sp.	18.0	108.0
Heavy-bedded dark blue limestone. *Camarotœchia* sp., *Spirifer* sp., *Atrypa reticularis* (a), *Tentaculites gyracanthus*, *Fenestella cumberlandica* 80. *Lioclema subramosum*, *Batostomella*		

	Vertical thickness feet	Total vertical thickness
interporosa, Fistuliporella cumulata, Atrypa reticularis, Rhynchospira formosa, Schuchertella sp. 73.8, *Uncinulus* sp. 73, *Camarotœchia litchfieldensis* 66	24.0	90.0
Heavy-bedded, dark blue limestone. Very nodular toward bottom. *Camarotœchia litchfieldensis, Uncinulus convexorus, Whitfieldella minuta* 65, *Atrypa reticularis, Camarotœchia concinna, Murchisonia* ? sp., *Stenochisma formosa* ? 58.4, *Atrypa reticularis, Chonetes jerseyensis, Rhipidomella* sp., *Rhynchospira formosa, Spirifer eriensis* 58, *Camarotœchia litchfieldensis* 50 and 47, *Cyphotrypa corrugata, Camarotœchia litchfieldensis, Chonetes jerseyensis, Rhynchospira formosa, Schuchertella* sp., *Uncinulus convexorus* 39	27.0	66.0
Very massive, hard, dark, nodular limestone. The top of this unit forms the second large bedding plane above the base of the Keyser. *Atrypa reticularis, Chonetes jerseyensis, Stenochisma formosa, Spirifer octocostatus, Stropheodonta bipartita*, crinoid rings. *Camarotœchia litchfieldensis, Whitfieldella minuta* 23	20.3	39.0
Black, thin-bedded, very nodular limestone. *Camarotœchia litchfieldensis* 18	3.1	18.7
Nodular limestone with some chert. *Stropheodonta bipartita, Whitfieldella minuta*, ostracods 9.4. *Stropheodonta bipartita*, ostracods 1	15.6	15.6
Thickness of Keyser member	281.0	....

TONOLOWAY FORMATION

Fissile, calcareous shales	8.0	
Concealed.		

The following species have been identified from the Keyser member at this locality, but their exact stratigraphic position is not known:

Hindia sphæroidalis, Tentaculite zone.
Zaphrentis keyserensis.
Cladopora rectilineata.
Aulopora schucherti.
Ceratopora marylandica, Tentaculite zone.
Ceramopora micropora.
Atrypa biconvexa.
Dalmanella concinna.
Nucleospira swartzi, Lower beds.
Camarotœchia lamellata, Lower beds.
Rhynchospira globosa, Lower beds.
Rhipidomella emarginata, Lower beds.
Schuchertella marylandica, Lower beds.
Spirifer modestus var. plicatus.
Whitfieldella nucleolata.

II. Section at Dawson

At the southwest end of Fort Hill, about ½ mile northeast of Dawson Station on the Baltimore and Ohio Railroad there is an excellent exposure of the Oriskany sandstone, the New Scotland, and the Coeymans, and a part of the Keyser. A part of the Tonoloway is also exposed. The middle and lower parts of the Keyser are concealed by weathering of the shaly beds.

The Oriskany forms the southwest extremity of Fort Hill. The New Scotland is seen below this, containing *Spirifer macropleurus* (aa), beneath which is a zone carrying *Meristella arcuata* and also several Stromatopora beds of the upper part of the Keyser. The abundant bryozoan fauna characteristic of the middle Keyser of the Cumberland area occurs about 8 feet below the lowest Stromatopora bed, beneath which *Tentaculites gyracanthus* (aa), *Schuchertella prolifica* (c), and crinoids (aa) occur. The junior author also reports the presence of *Chonetes jerseyensis* in association with these species, but it has not been found by later observers. The remainder of the Keyser is concealed. This section affords one of the finest exposures of the limestone beds of the New Scotland in the Cumberland area.

The section begins at the bottom of the exposure in the quarry and was measured in vertical thickness.[1]

HELDERBERG FORMATION	Vertical thickness feet	Total vertical thickness
Coeymans Member		
Gray crystalline limestone containing numerous crinoid stems, *Gypidula coeymanensis*, *Atrypa reticularis*, etc. A conglomerate at base contains rounded fragments of limestone.		
Keyser Member		
Thin-bedded gray limestone, distinctly banded with fine brown lines. Ripple-marked surface about a foot above the base of unit. Stromatopora bed at 5.7 feet above base of unit........	8.8	50.7
Heavy-bedded gray limestone, distinctly banded as in above unit. At top of unit is Stromatopora bed 1.2 feet thick. *Leperditia altoides* abundant 9.8; crinoid rings, *Lioclema subramosum*, *Schuchertella* sp., *Uncinulus* sp. 0.6......................	12.3	41.9
Thin-bedded, gray limestone, banded like preceding units, unfossiliferous	3.0	29.6
Thin-bedded gray limestone not banded or if so very indistinctly. *Meristella* sp. 3.7..................................	6.6	26.6

[1] The lower 13 feet of this section were studied by T. Poole Maynard, the remainder by C. K. Swartz assisted in field measurements by J. B. Reeside, Jr.

	Vertical thickness feet	Total vertical thickness
Medium-bedded gray limestone, lower part showing distinct banding. Stromatoporoids in layer one foot thick 2.2 to 3.2 feet above base; *Orthopora rhombifera*, *Fistuliporella cumulata*, ostracods 4.9	8.8	20.0
Two beds of gray limestone separated by a shale parting. Ostracoda, *Schuchertella prolifica*, *Uncinulus keyserensis* 0.8	1.8	11.2
Thin-bedded, shaly gray limestone, *Lioclema subramosum* 3.9, 2.3, 1.6; *Schuchertella prolifica* 3.9, 2.3 (a), 1.6, 0.4; *Tentaculites gyracanthus* 2.8, 2.3, 1.6 0.4; *Uncinulus keyserensis* 3.9, 2.8, 2.3; *Meristella prænuntia* 3.9, 2.8; *Eridotrypa parvulipora*, *Orthopora rhombifera*, *Mesomphalus hartleyi* 2.8; *Klœdenella clarkei* 1.6, *Klœdenia nearpassi* 3.9; *Chonetes jerseyensis* at top and base[1]	4.8	9.4
Single bed of light gray limestone which weathers into thin beds, unfossiliferous	3.0	4.6
Thin-bedded, shaly limestone weathering to a light gray or brown color, *Tentaculites gyracanthus* and *Meristella prænuntia* throughout; *Lioclema subramosum* 1.5, *Uncinulus keyserensis* 0.9; *Orbiculoidea schucherti* 0.9, 0.5	1.6	1.6
Concealed below this.		
Thickness of Keyser member exposed	50.7	

III. Section at Cookerly[2]

There is an excellent exposure of the lower part of the Keyser limestone and of the upper portion of the Tonoloway formation about two and a half miles southwest of Rawlings, at the first curve on the Baltimore and Ohio Railroad southwest of Cookerly. This section is of special interest because the lower part of the Keyser contains a heavy bed of stromatoporoids which has not been observed elsewhere in this position in the Cumberland area, although it is known to occur in a similar horizon at Hyndman, Pennsylvania. The fauna found above and below the Stromatopora beds shows that it is to be referred to the Keyser. The Keyser occupies the center of a syncline. The underlying Tonoloway limestones are thin-bedded and contain few fossils.

[1] *Chonetes jerseyensis* was reported in abundance by Dr. T. Poole Maynard, but subsequent search failed to reveal its presence.

[2] This section was measured by C. K. Swartz. The fauna was studied by T. Poole Maynard.

The Stromatopora bed occurs near the middle of the section and just beneath it *Cladopora rectilineata* is found in great profusion. Fossils are very numerous in the upper part of the section, including *Chonetes jerseyensis, Dalmanella concinna, Stropheodonta bipartita,* and *Camarotœchia litchfieldensis,* all of which are characteristic of the lower part of the Keyser member.

HELDERBERG FORMATION

Keyser Member	Vertical thickness feet	Total vertical thickness
Concealed.		
Thin-bedded shaly limestone	10.0	118.4
Massive nodular limestone	4.0	108.4
Axis of syncline on bed of track.		
Thin-bedded shaly limestone with some thicker beds containing *Batostomella interporosa, Fenestella cumberlandica, Fistuliporella marylandica, Orthopora rhombifera, Rhynchospira formosa, Stropheodonta bipartita, Chonetes jerseyensis* (aa), *Schuchertella deckerensis, Camarotœchia litchfieldensis, Favosites* sp., *Dalmanella concinna, Stropheodonta* sp., *Uncinulus convexorus*	10.0	104.4
Massive crinoidal limestone	1.6	94.4
Calcareous shale with some bands of limestone containing *Batostomella interporosa, Eridotrypa parvulipora, Lioclema subramosum, Schuchertella* sp., *Rhynchonella litchfieldensis, Nucleospira swartzi*	6.0	92.8
Massive nodular limestone	6.5	86.8
Shaly nodular limestone containing *Atrypa reticularis*	11.4	80.3
Massive crystalline dark limestone	8.0	68.9
Stromatopora bed. *Syringostroma barretti, Aulopora schucherti*	5.0	60.9
Massive nodular limestone abounding in *Cladopora rectilineata* in upper 2.7 feet. In this unit occur *Favosites pyriformis, Cladopora rectilineata,* Bryozoa, *Stropheodonta bipartita* (c) *Uncinulus convexorus*	16.0	55.9
Dark crystalline limestone	2.3	39.9
Massive nodular limestone, containing *Batostomella interporosa, Stropheodonta* sp., *Dalmanella concinna, Nucleospira swartzi*	25.0	37.6
Dark banded arenaceous limestone	1.6	12.6
Thin-bedded nodular limestone slightly cherty	3.5	11.0
Thin-bedded nodular limestone. Much chert in upper 2 feet. *Fenestella cumberlandica, Schuchertella* sp., crinoids	7.5	7.5
Thickness of Keyser member exposed	118.4	

TONOLOWAY FORMATION

Fissile, platy, argillaceous, blue limestone.

IV. Section ¾ Mile Southwest of Rawlings

The Potomac River flows through a narrow gorge ¾ mile south of Rawlings Station where an uninterrupted section of the New Scotland and Coeymans limestone and upper part of the Keyser is afforded in the cuts of the Baltimore and Ohio Railroad.

The section[1] begins south of the watchman's house.

HELDERBERG FORMATION

New Scotland Member	Vertical thickness feet	Total vertical thickness
Concealed. New Scotland shale.		
Gray limestone, upper beds containing much chert. *Spirifer macropleurus* fauna	30.0	158.7
Coeymans Member		
Massive, blue crystalline limestone, very fossiliferous, containing *Gypidula coeymanensis*, *Atrypa reticularis*, crinoid stems. Contains some irregular fragments at base. Thickness approximate. The New Scotland and Coeymans limestone together are 39 thick	9.0	128.7
Keyser Member		
Massive dark granular limestone. Brown sandy lines 2 feet above base of unit, containing stromatoporoids in upper 2 feet. *Leperditia* sp. abundant	7.4	121.7
Shale	0.8	114.3
Massive dark granular limestone	4.1	113.5
Shaly limestone	2.8	109.4
Massive dark granular limestone, upper 18 inches somewhat shaly	3.7	106.6
Medium-bedded limestone, upper 9 inches shaly, containing stromatoporoids. Ostracods abundant 9 inches below top	2.4	102.9
Shaly limestone	5.7	100.5
Shaly limestone, upper 2 feet more massive. Band of chert at bottom and 3.8 feet above bottom of unit	13.4	94.8
Very cherty limestone	1.8	81.4
Shale	0.9	79.6
Limestone	0.9	78.7
Shale	0.5	77.8

[1] Measured by C. K. Swartz.

	Vertical thickness feet	Total vertical thickness
Shaly limestone	3.4	77.3
Stromatopora reef. Upper part shaly	3.3	73.9
Shaly limestone	0.8	70.6
Massive granular limestone	4.5	69.8
Argillaceous limestone, thin and medium-bedded. Some stromatoporoids	13.6	65.3
Massive reef consisting wholly of stromatoporoids	6.5	51.7
Shaly limestone partially concealed abounding in *Spirifer vanuxemi* var. *prognosticus*. *Tentaculites gyracanthus*, crinoids, delicate, branching Bryozoa	20.2	45.2
Dark blue nodular limestone abounding in *Favosites helderbergiæ præcedens*	3.0	25.0
Largely concealed along track. At bottom of unit a coral reef abounding in *Favosites helderbergiæ præcedens* and containing *Halysites catenulatus*	22.0	22.0
Concealed.		
Thickness of Helderberg exposed	158.7	

V. Section at Pinto

One of the best exposures of Middle and Upper Silurian rocks in the State occurs at Pinto, Maryland. The section extends from the base of the Clinton to the middle of the Keyser. The Tonoloway is typically exposed and the contact between it and the Keyser can be well observed. The lowest beds of the Keyser are exposed on the north side of the Baltimore and Ohio Railroad just east of Potomac Station. The remainder of the Keyser is partly concealed, but by going up the hill much of it can be seen. The top of the "Salina" was placed by Rowe and Schuchert[1] at the uppermost exposure of limestone in the railroad cut. While the limestones exposed in the cliff east of the station are not very fossiliferous, *Camarotœchia litchfieldensis* and *Stropheodonta bipartita,* two New York Cobleskill forms, are found here together with *Spirifer modestus,* a characteristic Keyser species. A heavy crinoid bed is present while *Cladopora rectilineata* occurs in the greatest abundance below it. The *Gypidula cœymanensis* var. *prognostica zone* occurs to the west. The upper portion of the section is cut out by a fault, but the New Scotland beds can be seen upon the hillside to the northeast.

[1] Rowe manuscript. Library Johns Hopkins University. Schuchert. Proc. U. S. Nat. Mus., vol. xxvi, 1903, p. 423.

The section begins at the base of the Romney shale, 100 feet south of the fork in the road, one road leading north to Cresaptown and the other northwest to Keyser. The Keyser limestone lies immediately beneath the Romney shale.

HELDERBERG FORMATION

Keyser Member

	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Dark blue limestone. The upper portion filled with *Favosites helderbergiæ* var. *præcedens* and crinoids...	590.0	41.0	173.9
Ravine running east and west....................			
Concealed	470.0	6.9	132.9
The section now follows along the strike of the rock. The following fossils were found, mostly loose: *Favosites helderbergiæ* var. *præcedens* (aa), crinoids (aa), *bryozoa* (aa), *Cladopora rectilineata, Atrypa reticularis* (aa), *Gypidula coeymanensis* var. *prognostica* (c), *Leptæna rhomboidalis* (r), *Nucleospira swartzi* (c), *Camarotœchia litchfieldensis* (c), *Calymene* sp...	430.0	....	....
Largely concealed. Heavy-bedded dark blue limestone is exposed at the top and the bottom of this unit. *Calymene camerata* was found loose at the top. Ten feet below the top were found loose crinoids (a), *Atrypa reticularis* (a), *Stenochisma deckerensis* (c), *Stropheodonta* (cf.) *bipartita, Schuchertella deckerensis* (c)	30.0	19.2	126.0
The beds were measured in vertical thickness only from here to the bottom of the section.			
Solid blue-gray limestone containing some crinoids.	....	4.0	106.8
Arenaceous thin-bedded gray limestone containing at top a crinoid bed about 3 feet thick. Crinoids also occur throughout the whole unit though not as abundantly as in this bed. At the bottom occur *Thamniscus regularis* (a), *Orthopora rhombifera* (a), *Favosites pyriformis, Cladopora rectilineata* (aa), *Atrypa reticularis* (aa), *Dalmanella concinna* (c), *Meristella* sp., *Camarotœchia litchfieldensis* (c), *Camarotœchia lamellata* (r), *Rhynchospira* (cf.) *globosa, Schuchertella deckerensis* (r), *Uncinulus convexorus* (c)..........	....	12.4	102.8
Heavy-bedded gray limestone containing crinoids. Thin-bedded towards the top. At the bottom occur *Dalmanella concinna* (c), *Camarotœchia lamellata* (r)	....	4.5	90.4
Mostly concealed	....	7.0	85.9
Massive dark blue limestone. At the bottom occur corals, *Camarotœchia litchfieldensis* (c), *Stropheodonta* sp., *Tentaculites gyracanthus* (r).............	....	10.0	78.9

	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Concealed	....	5.0	68.9
The remainder of the section is seen in the cut of the Baltimore and Ohio Railroad east of the station.			
Massive blue limestone. Crinoids, Bryozoa	....	6.0	63.9
Concealed	....	3.9	57.9
Massive blue-gray limestone containing small *Meristella* sp.	....	4.6	54.0
Heavy-bedded dark blue limestone weathering to a light gray. *Atrypa reticularis, Camarotœchia litchfieldensis*, Bryozoa 47.5 above base of Keyser, *Camarotœchia litchfieldensis*, corals 36.2 above base	....	26.6	49.4
Thin-bedded dark blue limestone weathering to a gray, heavier bedded towards the middle and becoming thin-bedded again towards the bottom	....	10.6	22.8
Shaly argillaceous limestone near the top, becoming heavier bedded blue limestone towards the bottom. At the top are found *Stropheodonta bipartita* (c), and at the bottom are found *Spirifer modestus* (c), *Camarotœchia litchfieldensis* (c)	....	12.2	12.2
Thickness of Keyser member exposed	....	173.9	
TONOLOWAY FORMATION			
Thin-bedded gray limestone	....	10.0	30.0
Mostly concealed. Shaly gray limestone	....	20.0	20.0
Spring.			

The following fossils have also been found in the Keyser in this section, their precise horizon being unknown: *Cyathophyllum clarki, Halysites catenulatus, Cyathophyllum schucherti, Gypidula subglobosa, Stenochisma formosa, Rhynchospira formosa*. The *Gypidula coeymanensis prognostica zone* is probably located about the top of the upper concealed unit. The coral bed at the top of the exposure is believed to be the Keyser coral bed. The profuse development of the *Cladopora rectilineata subzone* is a conspicuous feature of the section.

VI. Section at Miller's Spring, West Virginia

The Keyser limestone is exposed in a small quarry situated about one mile south of Ridgely Station on the Western Maryland Railroad, on the west side of Knobly Mountain. This quarry is south of the tunnel and just to the east of the big spring, known as Miller's Spring. The limestone was once quarried for the burning of lime. A heavy Stromatopora bed 15 feet thick is exposed on the east face of the quarry. Only a few feet of what is thought to be the middle Keyser is exposed here. The upper part of the section is in the *Rensselæria mutabilis subzone.*

The section begins at the top of the exposure in the quarry and only the vertical thickness was measured.

HELDERBERG FORMATION

Keyser Member

	Vertical thickness feet	Total vertical thickness
Massive hard, cherty gray limestone. Throughout this bed the following fossils were found: *Favosites helderbergiæ præcedens* (aa), *Cladopora rectilineata* (r), Stromatoporoids (aa), crinoids (aa), *Rensselæria mutabilis* (aa), *Stenochisma formosa* (aa), Bryozoa (aa)	15.0	31.9
Massive blue limestone. At the bottom occur *Favosites helderbergiæ* var. *præcedens* (a), crinoids (a), *Batostomella interporosa, Eridotrypa parvulipora, Fistuliporella marylandica, Orthopora rhombifera*	11.3	16.9
Gray limestone made up almost entirely of crinoids and Bryozoa. *Atrypa reticularis* (c)	1.6	5.6
Light blue limestone. At bottom occur *Atrypa reticularis* (r)	4.0	4.0
Concealed		
Thickness of Keyser member exposed	31.9	

VII. Section in Cash Valley

The Keyser is exposed about 3½ miles southwest of Corriganville on the same ridge upon which the Helderberg formation is seen at the Devil's Backbone. A branch of Braddock Run has cut across the ridge at this point and the quarrying of limestone for the burning of lime has exposed part of the Keyser.

The sequence of strata seems to be identical with that at the Devil's Backbone. The thick, heavy crinoid bed of the lower Keyser is exposed near the bottom of the section. The *Gypidula cœymanensis* var. *prognostica zone* occurs perhaps a little higher up in the section than at Devil's Backbone and only about 2 feet of this zone is exposed. Beneath the Gypidula zone *Dalmanella clarki* is very abundant and has not been found in any other section. It is associated with *Spirifer vanuxemi, S. modestus,* and *Chonetes jerseyensis*. *Halysites catenulatus* is found in the lower third of the Keyser member as at Devil's Backbone and accords with its occurrence in the same zone in Pennsylvania and New York. The upper crinoid bed is not exposed though many crinoid stems were found in the talus in the upper portion of the section. Near the middle of the Keyser member the limestone beds are very shaly and contain the same bryozoan faunules as at Devil's Backbone. Above the bryozoan fauna come the heavy, massive dark blue limestones of the middle beds of the Keyser member.

The section of the Keyser member at this point is not so good as that at the Devil's Backbone. However, the principal fossil zones are exposed and while much of the section is covered by talus, yet the latter furnishes a large number of well-preserved fossils, so that this is one of the best collecting grounds for fossils of the Keyser member in Maryland.

The section begins at the bottom of the lowest Stromatopora bed of the Keyser in the limestone quarry at Cash Valley. In addition to *Stromatopora constellata* this bed contains crinoids (aa), *Cyathophyllum schucherti, Favosites helderbergiæ* var. *præcedens.*

HELDERBERG FORMATION

Keyser Member	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Thin-bedded gray limestone, heavy-bedded at top. At the bottom occur *Stropheodonta varistriata* (r), *Calymene* sp.	137.1	6.8	130.4
Blue-gray heavy-bedded limestone becoming dark blue near the bottom, beneath which the limestone is cherty	130.3	18.0	123.6
Thin-bedded cherty limestone	112.3	2.0	105.6
Heavy-bedded grayish-blue limestone. At the bottom occur *Atrypa reticularis* (r)	110.3	3.0	103.6
Thin-bedded gray-blue limestone. At bottom occur *Dalmanella* sp., crinoids (c), *Orthopora rhombifera, Stromatotrypa globularis* (c), *Stenochisma* sp. (r). This is the first occurrence of bryozoa in the section	107.3	3.8	100.6
Thin-bedded limestone becoming more argillaceous towards the bottom. Near the top occur crinoids, *Batostomella interporosa, Diplostenopora siluriana, Fistuliporella marylandica, F. micropora, Orthopora rhombifera. Ptilodictya tenella, Leptæna rhomboidalis* (r), *Camarotœchia litchfieldensis.* This is the first prolific bryozoan layer	103.5	4.5	96.8

	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Thin-bedded gray limestone, cherty and shaly towards the bottom. At the bottom occur crinoids, *Batostomella interporosa, Diplostenopora siluriana, Fistuliporella marylandica, Orthopora rhombifera, Tentaculites gyracanthus* and *Stropheodonta* sp.......	99.0	2.2	92.3
Shaly, gray, extremely argillaceous limestone. At the top of this unit occurs a bed extremely prolific in bryozoa, *Batostomella interporosa, Diplostenopora siluriana, Fenestella cumberlandica, Fistuliporella marylandica, Ptilodictya tenella*, crinoids (aa), *Rhynchospira* (r), *Stenochisma* sp., *Stropheodonta* sp., *Klœdenella turgida, Octonaria inequalis, O. angulata, Pontocypris arcuata*	96.8	3.0	90.1
Concealed.			
On the slope of the hillside facing the road were found throughout this unit crinoid stems, *Batostomella interporosa, Stromatotrypa globularis, Diplostenopora siluriana, Fistuliporella maynardi, F. marylandica, Orthopora rhombifera, Ptilodictya tenella, Rhopolonaria attenuata, Stenochisma* sp., *Atrypa reticularis* (c), *Spirifer vanuxemi* (r), *Octonaria inequalis, O. angulata, Klœdenella turgida, Primitia ? cumberlandica*, corals	93.8	14.0	87.1
Thin-bedded arenaceous limestone standing out like a backbone containing crinoids. Loose on the hillside were found *Diplostenopora siluriana, Fenestella (Cycloporina) altidorsata, Fistuliporella marylandica, Orthopora rhombifera, Ptilodictya tenella, Polypora dictyota, Spirifer octocostatus, Stenochisma* sp., *Stropheodonta* sp., *Schuchertella* cf. *deckerensis, Lepidocrinus gebhardi* (r), crinoids (aa)................	79.8	4.0	73.1
Concealed.			
In this unit on the hillside were found *Batostomella interporosa, Eridotrypa parvulipora, Fenestella (Cycloporina) altidorsata, Fistuliporella marylandica, Orthopora rhombifera, Polypora dictyota, Rhopolonaria attenuata, Thamniscus regularis, Stenochisma formosa* (r), *Gypidula coeymanensis* var. *prognostica*, crinoids	75.8	9.0	69.1
Blue argillaceous thin-bedded limestones. This is the *Gypidula coeymanensis prognostica zone*. At the bottom was found *Chonetes jerseyensis* (r)..........	66.8	2.1	60.1
Dull blue-gray arenaceous limestone, thin-bedded at the top. *Gypidula coeymanensis* var. *prognostica* and *Rhipidomella emarginata* (r) at the bottom.........	64.4	4.5	58.0
Heavy-bedded gray limestone weathering somewhat hackly on the surface, arenaceous. At the bottom occur *Chonetes jerseyensis* (c), and *Stropheodonta* sp.	59.5	3.1	53.5

	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Heavy-bedded limestone weathering like the above unit. *Stenochisma* sp., *Atrypa reticularis*	56.0	6.1	50.4
Concealed. On the hillside in this unit were found *Chilotrypa micropora, Fenestella* (*Cycloporina*) *altidorsata, Orthopora rhombifera, Polypora dictyota, Atrypa reticularis, Dalmanella clarki* (aa), *Camarotœchia litchfieldensis, Stenochisma deckerensis, Spirifer modestus, S. eriensis* (rr), *Loxonema* sp., *Tentaculites gyracanthus, Leperditia* sp., *Aulopora* sp., crinoids	49.4	7.8	44.3
Purplish-blue argillaceous, heavy-bedded limestone.	40.8	1.5	36.5
Concealed	39.0	13.8	35.0
Grayish-blue massive limestone with crinoids, bryozoa, *Stropheodonta* sp	24.0	1.4	21.2
Concealed	22.3	9.2	19.8
Crinoid bed, crinoids extending through the whole bed	12.3	6.9	10.6
Concealed	4.7	2.0	3.7
Heavy blue-gray limestone	2.0	1.7	1.7
The remainder of this section is concealed.			
Thickness of Keyser member exposed	....	130.4	

The following fossils have also been found in this section, their precise horizon being unknown:

Cyphotrypa corrugata.
Camarotœchia gigantea.
Dalmanella concinna, Lower beds.
Merista typa, Lower beds.
Aulopora schucherti.
Halysites catenulatus.
Nucleospira swartzi.
Schuchertella deformis.
Stropheodonta geniculata, Lower beds.
Uncinulus convexorus, Lower beds.
Wilsonia globosa.
Actinopteria communis.
Bellerophon helderbergiæ.
Platyostoma sp.

VIII. Section at Devil's Backbone

The Devil's Backbone is locally so-called because one of the heavy beds at the top of the Coeymans stands out at this place as a marked topographic feature resembling somewhat a backbone in appearance. This ridge is the first prominent one on the west side of the Wills Mountain anticline and is formed of Helderberg and Oriskany strata.

The Helderberg is well exposed by the cutting of Wills Creek, which flows approximately parallel to the west side of the ridge from above the Maryland-Pennsylvania line until it is joined by Jennings Run at Corriganville where it makes a sharp turn to the southeast and cuts across the ridge. The cutting of the Huntington Division of the Pennsylvania Railroad has aided greatly in exposing this section. The Keyser at this point consists of fairly pure limestone and there is little talus. The strata stand in practically a vertical position, making the measurement of the section comparatively easy. The lower strata of the Keyser are heavy-bedded carrying but few fossils, chiefly small Camarotœchia and ostracods. The succeeding 35 feet are sparsely fossiliferous. Above this, bryozoa and *Chonetes jerseyensis* are found, immediately overlying which is the lower crinoid bed, 5 feet in thickness. One hundred and thirty to 137 feet above the base of the Keyser occurs the *Gypidula coeymanensis* var. *prognostica zone,* 7 feet in thickness, abounding in that form. Immediately beneath the Gypidula zone the following forms are found which are the same as those occurring in a similar position in the heavy-bedded blue limestone at the Market Street Bridge section in the city of Cumberland: *Merista typa, Dalmanella concinna, Chonetes jerseyensis, Spirifer modestus, S. vanuxemi, Strophonella geniculata, Halysites catenulatus. Schuchertella deformis* and *S. deckerensis* are found above the Gypidula zone, other species occurring less frequently. The prolific bryozoan fauna which is characteristic of the middle Keyser of the Cumberland area is found 140-156 feet above the base of the section, above which the limestone becomes heavy-bedded carrying *Atrypa reticularis* and *Leptæna rhomboidalis.* The upper part of the Keyser contains two heavy beds of stromatoporoids and terminates above in thin-bedded, banded, limestone which is sparingly fossiliferous and constitutes the *Leperditia alta zone.* The contact of the Keyser and Coeymans is admirably shown.[1]

HELDERBERG FORMATION

Coeymans Member	Vertical thickness feet	Total vertical thickness
Massive crinoidal limestone forming main ridge of Devil's Backbone. At its base are limestone pebbles	6.0	....
Keyser Member		
Thin-bedded to shaly limestone	2.7	289.6
Stromatopora bed	0.7	286.9

[1] The figures after the names of fossils indicate the altitude in feet at which they occur above the base of the formation.

	Vertical thickness feet	Total vertical thickness
Drab limestone banded with fine brown lines. Hackle-toothed bedding planes. *Orthoceras* cf. *rigidium*, *Tentaculites gyracanthus*, and *Schuchertella prolifica* (a) 284.5	7.4	286.2
Yellow shale	2.0	278.8
Massive, drab, banded limestone weathering into a prominent ridge	7.0	276.8
Drab, banded limestone; fairly massive; upper surface ripple-marked	5.0	269.8
Platy, banded, medium-bedded limestone	4.5	264.8
Platy, banded limestone weathering lower than the adjacent units	2.5	260.3
Heavy-bedded, drab banded limestone, weathering platy. *Tentaculites gyracanthus* and Ostracoda 254.8, 256	3.0	257.8
Stromatopora bed. *Stromatopora constellata*	2.5	254.8
Drab banded limestone	0.8	252.3
Massive cobbly bed, full of Stromatoporoids including *Stromatopora constellata*. Stands out as a prominent ledge. Under surface very irregular and with large nodules. *Favosites helderbergiæ* var. *præcedens*	2.3	251.5
Drab, banded limestone	3.0	249.2
Stromatopora reef, *Leperditia altoides* (a) at top	1.2	246.2
Irregular, very argillaceous limestone	0.8	245.0
Massive light-gray limestone. Stromatopora reef 234-236. *Leperditia gigantea* abundant 233.5, 234.5. *Stromatopora constellata*, *Cyathophyllum schucherti* 240	16.5	244.2
Thin-bedded and cobbly gray limestone with numerous stromatoporoids	5.5	227.7
Two massive Stromatopora beds. *Stromatopora constellata*, *Favosites helderbergiæ* var. *præcedens* and *Cyathophyllum schucherti* 217-218	6.1	222.2
Thin to medium-bedded gray limestone. *Stromatopora* 209.4.	9.2	216.1
Cobbly gray limestone	1.2	206.9
Thin-bedded, gray limestone, very cherty in the upper part and becoming less so towards the base	8.3	205.7
Massive gray limestone	5.2	197.4
Massive argillaceous gray limestone; upper 2 feet rather cherty	9.8	192.2
Gray limestone interbedded with white chert, the latter making up much of the thickness of the unit	5.5	182.4
Massive, cobbly argillaceous gray limestone. A single narrow chert layer near the top. At the base occurs *Diplostenopora siluriana*	5.5	176.9
Shale weathered to clay	0.9	171.4

	Vertical thickness feet	Total vertical thickness
Thin-bedded gray limestone in seven beds separated by shaly layers	4.0	170.5
Thin-bedded, somewhat nodular gray limestone; shale parting at top	6.0	166.5
Massive blue limestone. *Schuchertella deckerensis* occurs at base	3.7	160.5
Nodular, thin-bedded limestone	0.5	156.8
Single bed of gray limestone	0.8	156.3
Thin-bedded, somewhat nodular, argillaceous gray limestone. Layers of dark chert in upper half of unit. *Dalmanella concinna* is abundant throughout. *Striatopora* sp. 148, *Schuchertella deckerensis* 140, 148, 149, 153.5, *Atrypa reticularis* 148, 153, *Chonetes jerseyensis* 142.8, 147, 153, *Stenochisma deckerensis* 140, 140.8, 148, 153, *Pholidops ovata* 140, *Camarotœchia litchfieldensis* 139.5, 142, *Leptœna rhomboidalis* 140.8, *Spirifer octocostatus* 139.5, *Platyceras* sp. 147, 153, *Calymene camerata* 154, *Klœdenella turgida* 143, 153.5, *Batostomella interporosa* 143, 153.5, *Stromatotrypa globularis* 153.5, *Fistuliporella marylandica* 140, 143, 153.5, *Orthopora rhombifera* 140, 143, 153.5 *Fenestella* (*Cycloporina*) *altidorsata* 140, 143, *Thamniscus regularis* 143, *Polypora dictyota* 140, 143, *Fistuliporella maynardi* 143, *Eridotrypa parvulipora* 140, *Rhophalonaria attenuata* 140, crinoid rings	16.0	155.5
Massive, nodular gray limestone. *Atrypa reticularis* and *Gypidula coeymanensis* var. *prognostica* are abundant throughout. *Dalmanella concinna* 137.4, 139, *Orthoceras* sp., *Calymene camerata*, *Stenochisma deckerensis*, *Fenestella* (*Cycloporina*) *altidorsata* 137.4, *Schuchertella deckerensis*, 137, crinoid rings	2.5	139.5
Massive dark blue limestone. *Gypidula coeymanensis* var. *prognostica* abundant throughout. At bottom of this unit occur *Chonetes jerseyensis*, *Dalmanella concinna*, *Merista typa*, *Camarotœchia litchfieldensis* (a), *Spirifer octocostatus*, *S. vanuxemi* var. *Strophonella geniculata*, *Schuchertella deformis*, and bryozoa	7.0	137.0
Massive blue, somewhat nodular limestone	18.2	130.0
Thin-bedded, bluish-gray, somewhat argillaceous limestone. Contains *Dalmanella concinna* (a), *Spirifer modestus* (a), *Stenochisma formosa*	28.0	112.0
Schuchert reports *Camarocrinus stellatus* from this unit.		
Massive nodular limestone with crinoid fragments. At the base occur Lepadocrinus stems, *Cladopora rectilineata*, *Atrypa reticularis*, *Schuchertella deckerensis*, *Camarotœchia* sp., *Stropheodonta* sp., *Fenestella cumberlandica*, *Cyphotrypa rotundata*, *Batostomella interporosa*, *Orthopora rhombifera*	5.0	84.0

	Vertical thickness feet	Total vertical thickness
Thin-bedded limestone, nodular, containing *Aulopora* sp., *Atrypa reticularis*, *Chonetes jerseyensis*, *Schuchertella* sp., *Polypora dictyota*, *Fenestella cumberlandica*, *F. altidorsata*, *Orthopora rhombifera* and crinoid fragments..................	2.0	79.0
Massive, heavy-bedded, dark blue nodular limestone. At base occur *Camarotœchia* sp. and *Leperditia* sp., 13 feet below top occur *Stenochisma formosa* (aa)...........................	33.0	77.0
Thin-bedded grayish-blue limestone with some chert layers. *Camarotœchia litchfieldensis* 19.7, 23.7, 39.7, 41.7, *Stropheodonta bipartita* 2.7 (a), 4.7 (a), 5.7, 7.7, *Pholidops ovata* 4.7 (a), *Whitfieldella minuta* 2.7, 19.7, 23.7, *Leperditia altoides* 23 (a), 25, *Spirifer vanuxemi*	44.0	44.0
Thickness of Keyser member..................................	289.6	

TONOLOWAY FORMATION

Concealed. Some fragments of platy thin-bedded limestone in soil.

The following species were found at this place, their exact horizon being unknown: *Cyathophyllum clarki, Cladopora rectilineata, Aulopora schucherti, Halysites catenulatus.*

IX. Section at Corriganville

On the south side of Wills Creek, on the strike of the Helderberg strata of the Devil's Backbone, is an exposure of limestone in the abandoned quarry known as Corrigan's quarry. On the west side of the quarry *Spirifer macropleurus* and *S. perlamellosus* of the New Scotland and other forms occur in abundance. East of the preceding a Stromatopora bed of the Keyser is exposed with a thickness of 5 to 7 feet. Ten to 15 feet below this is another Stromatopora bed on the extreme east side of the quarry. Some Lower Keyser fossils, including *Atrypa reticularis* and *Calymene camerata,* were found loose on the hillside southeast of the quarry.

There is also an admirable section in the cut of the Pittsburg extension of the Western Maryland Railroad through this hill in which all of the strata are exposed from the base of the Oriskany to the middle of the

Keyser. The following section of the Keyser has been measured in the cut:[1]

HELDERBERG FORMATION

Keyser Member	Vertical thickness feet	Total vertical thickness
Drab, shaly limestone with a bed 1 foot thick in middle of unit	2.8	139.2
Dark blue massive limestone with many calcite seams. Hackle teeth at bottom	2.0	137.4
Dark, compact limestone, containing *Meristella prænuntia* and *Schuchertella prolifica*[2] (a)	1.5	135.4
Three heavy beds of compact, dark blue limestone, indistinctly banded with fine brown lines. *Leperditia altoides* abundant	4.3	133.9
Six beds of drab limestone, distinctly banded with fine brown lines. Shale parting at top of unit	7.4	129.6
Single bed of dark limestone, distinctly banded; fracture conchoidal	4.2	122.2
Dark gray limestone with many transverse calcite seams; not banded; shale parting above and below	1.9	118.0
Dark gray limestone; banding indistinct; fracture conchoidal	2.9	116.1
Drab limestone, distinctly banded with fine brown lines; 3-inch shale parting at base	1.6	113.2
Thin-bedded drab limestone; distinctly banded	3.1	111.6
Nodular gray limestone, with Stromatopora	1.4	108.5
Shale with large nodules	0.8	107.1
Yellow, argillaceous limestone	1.0	106.3
Reef of Stromatopora	1.5	105.3
Irregular shale with large nodules	0.8	103.8
Drab, banded limestone in moderately thick beds	4.2	103.0
Yellowish, argillaceous limestone, not distinctly banded. *Leptæna rhomboidalis*	2.0	98.8
Massive gray limestone. Stromatopora in upper 3 feet. Lower part covered by travertine	7.0	96.8
Unit almost concealed by residual clay and travertine. Lower 3 feet nodular, cherty limestone	10.5	89.8
Massive gray limestone, full of chert, resembling Stromatopora	3.5	79.3
Massive, dark nodular limestone; shale parting at top of unit. *Uncinulus* sp. about 2 feet above base	6.6	75.8

[1] Measured by C. K. Swartz, assisted in the field work by J. B. Reeside, Jr., and W. A. Price, Jr.

[2] The vertical altitudes of the fossils listed in this section are only approximately known, the section, as described above, differing somewhat from the measurements made by the collector.

	Vertical thickness feet	Total vertical thickness
Clay seam with a thin crystalline layer of limestone at middle	1.6	69.2
Massive gray limestone, weathering to thin beds at top of cut. About 6 feet above base occurs *Meristella prænuntia*	8.7	67.6
Massive, somewhat crystalline limestone, dark gray in color. Shale parting near middle. Near top of the unit occurs *Rensselæria mutabilis*	5.3	58.9
Massive bed of gray, argillaceous, somewhat crystalline limestone. Chert layer 2 feet above base. Lower part weathering nodular near top of cut	12.3	53.6
Clay seam	1.5	41.3
Massive, somewhat nodular, blue argillaceous limestone.....	4.8	39.8
Clay seam	0.8	35.0
Argillaceous, drab, somewhat nodular, massive bed of limestone	3.5	34.2
Thin-bedded argillaceous limestone with some cherty layers..	4.7	30.7
Heavy, blue, nodular limestone..........	1.0	26.0
Shale parting	0.5	25.0
Massive bed of gray limestone with numerous transverse calcite seams	3.6	24.5
Thin-bedded, argillaceous, nodular limestone. Layers of dark chert throughout one heavy bed 15 feet above base of unit......	16.3	20.9
Massive gray limestone..........	2.6	4.6
Massive gray limestone in a single bed filled with *Gypidula coeymanensis* var. *prognostica*..........	2.0	2.0
Concealed.		
Thickness of Keyser exposed..........	139.2	

X. Sections at Hyndman, Pennsylvania

Two good exposures of the Keyser member are seen in the vicinity of Hyndman, a few miles north of the Maryland-Pennsylvania line, on the western flank of the Wills Mountain anticline. These are designated Section A and Section B. Section A is exposed in a quarry about 800 feet west of the Baltimore and Ohio Railroad station at Hyndman. It was studied earlier by Schuchert and called by him the Lower quarry zone. At the top of the section the *Gypidula coeymanensis* var. *prognostica zone* is exposed. About 30 feet below the Gypidula zone there is a 5-foot bed of stromatoporoids. Few other fossils have been found in the Lower quarry zone. The section begins at the *Gypidula coeymanensis* var. *prognostica zone* in the extreme west end of the quarry.

Section A

HELDERBERG FORMATION

Keyser Member	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
West wall of quarry	111.8	....	....
Gypidula zone. Heavy-bedded, gray-blue limestone, *Gypidula coeymanensis* var. *prognostica* throughout. At the top were found, in thin-bedded shaly limestone, *Batostomella interporosa, Fenestella (Cycloporina) altidorsata, Fistuliporella cumulata, Orthopora rhombifera, Thamniscus regularis, Leptæna rhomboidalis* (r), *Gypidula coeymanensis* var. *prognostica* (aa), crinoids (a). At the bottom occur *Dalmanella* sp., *Stenochisma* sp.	111.8	8.0	111.8
Gray-blue arenaceous limestone. Crinoids (aa)	103.8	1.4	103.8
Gray-blue limestone, heavy-bedded with some thin beds. The lower 5 feet have a greenish cast	102.4	10.0	102.4
Solid massive dark blue limestone. A Stromatopora bed occurs at the bottom of this unit. Few fossils seen	92.4	22.4	92.4
East wall of quarry	70.0	....	70.0
Thin-bedded argillaceous limestone with interbedded bands of arenaceous limestone. Concealed in part	70.0	50.0	70.0
Heavy-bedded dark blue limestone. Concealed in part	20.0	20.0	20.0
Concealed.			
Total thickness of Keyser member described	....	111.8	....

Section B

Hyndman Section B is exposed on the south side of the road about 1150 feet southwest of Hyndman Section A. There are two quarries here. The quarry farthest west and nearest the road has been called the Upper quarry zone by Professor Schuchert. It is in a Stromatopora bed of the upper part of the Keyser and at present is abandoned. It contains *Stromatopora constellata.* Going east of the Upper quarry there is a concealed unit east of which is situated the Lower quarry, at which work is being done at present. It is in the purer limestones lying between the Gypidula zone and a Stromatopora bed, the Gypidula zone being the hanging wall and the Stromatopora bed the foot wall of the quarry. This quarry is in the same beds as those worked in Section A.

The section begins at the top of the *Gypidula coeymanensis* var. *prognostica zone* on the west wall of the quarry.

HELDERBERG FORMATION

Keyser Member	Vertical thickness feet	Total vertical thickness
Gypidula coeymanensis var. *prognostica* is found throughout this unit and at the bottom occur *Spirifer octocostatus* (r), *Atrypa reticularis* (c), *Dalmanella* cf. *concinna* (r), *Meristella* sp., *Camarotœchia litchfieldensis* (c), *Stenochisma deckerensis* (c), *Gypidula coeymanensis* var. *prognostica zone*............	4.6	120.6
Dark blue limestone, thin-bedded at the top, becoming massive near the middle and containing near the bottom a Stromatopora bed. Shaly and thin-bedded limestone at the bottom. Fossils rare	42.8	116.0
Concealed between quarries. This interval is formed of shaly limestone	24.9	73.2
Thin-bedded dark blue limestone with some heavy nodular beds weathering to a gray-blue color, containing a great abundance of fossils. At the top *Batostomella interporosa* (a), *Atrypa reticularis* (aa), *Orthoceras* sp., *Aulopora schucherti*, *Aulopora schohariæ*, *Camarotœchia litchfieldensis* (c), *Stenochisma deckerensis* (c) *Stenochisma formosa* (c), *Uncinulus convexorus* (c). At the bottom occur *Camarotœchia litchfieldensis* (c), *Stropheodonta varistriata* (r)	18.5	48.3
Dark blue limestone, thin-bedded toward the top, heavy-bedded at the bottom............	19.9	29.8
Heavy-bedded dark blue limestone, containing at the bottom *Leperditia* sp., *Stenochisma* sp............	9.9	9.9
Thickness of Keyser member described............	120.6	

TONOLOWAY FORMATION

Thin-bedded dark blue limestone breaking with a clean fracture	19.9	....
East wall of quarry.		

The following fossils, whose exact horizon is not known, were collected in the Keyser beds at Hyndman, Pennsylvania, and are now in the U. S. National Museum: *Cyathophyllum schucherti, Favosites helderbergiæ* var. *præcedens, Schuchertella deckerensis, Chonetes jerseyensis, Whitfieldella* cf. *nucleolata.*

XI. Section at Market Street Bridge, Cumberland

This section is located south of Shriver Ridge at the south end of the Market Street Bridge in the city of Cumberland. It extends along the south side of the Huntington Division of the Pennsylvania Railroad, and along the foot of the stone wall, north of the German Catholic Church. This is the section from which collections were made by Hall and Andrews. The fossils were described by Hall as Lower Helderberg forms, in Volume iii of the Palæontology of New York, 1859. Unfortunately, this section has been almost completely concealed by its use at one time as a dumping ground for the rubbish of Cumberland. The section begins at the Stromatopora reef east of the bridge and extends westward.

HELDERBERG FORMATION *Keyser Member*	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Concealed.			
100 feet east of the Market Street Bridge occurs a thick Stromatopora bed	450.0	....	....
Concealed	350.0	....	....
Bridge	350.0	....	....
Concealed.			
At base of interval argillaceous blue-gray limestone, becoming gray upon weathering, 1.5 thick. Contains *Fenestella (Cycloporina) altidorsata*, *Orthopora rhombifera*, *Dalmanella* sp., *Rhynchospira formosa* (c), *Atrypa reticularis* (c). This exposure is to be seen in the road running parallel to the railroad	350.0	....	....
Concealed	180.0	....	....
Remaining exposures of this section are seen along the bluff south of the railroad. Dark blue limestone appearing heavy-bedded and nodular, weathering to gray. *Gypidula coeymanensis* var. *prognostica* near the top. At the bottom occur *Fistuliporella marylandica*, *Orthopora rhombifera*, *Spirifer modestus* (a) *S. octocostatus*, *Chonetes jerseyensis*, *Schuchertella marylandica*, *Stropheodonta geniculata* (r), *Atrypa reticularis* (c), *Merista typa* (r), *Meristella* sp. and crinoids	160.0	6.6	56.7
Concealed	150.0	23.2	50.1
Blue-gray, heavy-bedded limestones	80.0	8.3	26.9
Concealed	55.0	9.6	18.6
Shaly gray limestone. *Atrypa reticularis* (r) and crinoids	26.0	1.0	9.0
Concealed	25.0	7.9	8.0
Shaly gray nodular limestone. *Camarotœchia lamellata* (a)	1.0	1.0	1.0
Concealed.			

The base of the Keyser member is below the base of the section described. At the viaduct on the Baltimore and Ohio Railroad at Cumberland the following fossils have been identified from the lower beds of the Keyser member:

Corals.
Crinoids.
Atrypa reticularis.
Dalmanella concinna.
Merista typa.
Stenochisma formosa.
Camarotœchia lamellata.
Camarotœchia litchfieldensis.
Spirifer modestus.
Spirifer octocostatus.
Spirifer vanuxemi.
Uncinulus convexorus.
Uncinulus nucleolatus var. angulatus
Wilsonia globosa.
Actinoptera communis.
Platyostoma niagarense.
Orthoceras multiannulatum.

XII. Section on National Road West of Flintstone

This section is exposed along the National Road on the east side and near the top of Martin Mountain, 3½ miles west of Flintstone. It begins at the base of the Helderberg about 175 feet west of the sharp turn of the road to the southwest, ¼ mile east of the summit. The lower nodular beds are exposed in a small quarry by the road and the yellow "gravel" formed by the weathering of the Oriskany chert is seen in excavations a short distance above the top of the section.

HELDERBERG FORMATION

Keyser Member	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Massive dark blue limestone. N. 33° E. 87° W......	289.0	8.0	232.0
Concealed	279.0	37.0	224.0
Thin-bedded limestone with thin beds of chert. N. 34° E. 75° W..	233.0	12.0	187.0
Massive nodular dark blue limestone with thin sheets of calcite along bedding planes. The top of the *Gypidula coeymanensis* var. *prognostica zone* is 3 feet vertically below top of unit, extending 2 feet downward. This species being abundant in lower half of the zone. N. 34° E. 75° W..............................	218.0	28.0	175.0
Concealed	183.0	9.0	147.0
Massive nodular dark blue limestone..............	172.0	16.0	138.0
Massive gray nodular limestone weathering thin-bedded and shaly in places. Crinoid stems very abundant. N. 33° E. 87° W.............................	152.0	29.0	122.0
Massive nodular blue limestone weathering thin-bedded in places. At top occur *Batostomella interporella*, *Eridotrypa parvulipora*....................	116.0	93.0	93.0
Thickness of Keyser member exposed.............		232.0	

TONOLOWAY FORMATION

Blue limestone, not nodular......................	....	3.3	....
Concealed. Fissile platy limestone exposed at places.			

About one-half mile northeast of Breakneck Road, on the east side of Breakneck Hill southwest of the preceding station, there is an exposure of Helderberg rocks. The following Lower Keyser fossils were found in the talus: *Chonetes jerseyensis, Rhipidomella emarginata, Spirifer vanuxemi, S. modestus, Stropheodonta bipartita.*

XIII. Section at Flintstone

The best exposure of the Keyser in this region occurs at Flintstone. The Tonoloway and Lower Keyser are exposed at the south side of the creek in the rear of the Methodist Church at the east end of the village. A massive bed of stromatoporoids outcrops on the north side of the creek. Three hundred feet west of this bed occurs the first exposure in the bluff on the south side of the creek carrying *Gypidula coeymanensis* var. *prognostica.* Below this zone the section is largely concealed for a distance which includes about 50 feet of the vertical thickness of the beds. In the next 20 feet the following characteristic Lower Keyser fossils were found, the species being those which usually occur in the basal part of the member only: *Dalmanella concinna, Cladopora rectilineata, Chonetes jerseyensis, Spirifer modestus.* The lower part of the section is heavy-bedded to massive and contains only a scant fauna. The contact of the Helderberg and Tonoloway formations is seen in the bed of the creek at low water.

The section begins at the base of the massive Stromatopora beds of the Keyser, 7 feet in vertical thickness, which is exposed on the north side of Flintstone Creek near a spring at the east end of the village, and extends to the west.

HELDERBERG FORMATION *Keyser Member*	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Concealed.			
Stromatopora bed at top on north side of creek.....	871.0	....	....
Direction N. 58° W.			
Massive, nodular, blue-gray limestone. N. 58° W. *Gypidula coeymanensis* var. *prognostica* (aa)........	....	10.2	172.9
Massive, hard, blue limestone.....................	....	3.0	162.7
Concealed, with occasional outcrops of nodular limestone. N. 40° E. 20° E............................	571.0	45.4	159.7

	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Direction N. 83° W.			
Massive nodular limestone N. 40° E. 20° E. Eight feet below top occur *Cladopora rectilineata, Favosites helderbergiæ* var. *præcedens*, crinoids, bryozoa, *Atrypa reticularis* (r), *Dalmanella concinna* (r), *Meristella* sp., *Stenochisma formosa* (r), *Calymene camerata.* Twenty-three feet below top occur *Atrypa reticularis* (a), *Chonetes jerseyensis, Spirifer modestus* (r). Near bottom is found *Camarotœchia litchfieldensis*........	437.0	37.0	114.3
Direction S. 78° W.			
Massive nodular limestone. N. 40° E. 23° E........	308.0	12.3	77.3
Gray-blue limestone, not nodular..................	257.0	1.0	65.0
Very massive nodular limestone. N. 40° E. 38° E...	....	27.0	64.0
Bluish-gray nodular limestone, thin-bedded at top and partly concealed at bottom......................	....	22.0	37.0
Direction S. 70° W.			
Concealed	50.0	15.0	15.0
Thickness of Keyser member exposed..............		172.9	

TONOLOWAY FORMATION

Thin-bedded argillaceous limestone visible in bed of creek when water is very low.

XIV. Section 1¾ Miles Northeast of Flintstone

About 1¾ miles northeast of Flintstone, Iron Ore Ridge is cut by a small creek in which occasional exposures of the Keyser member are to be seen. The *Gypidula coeymanensis* var. *prognostica zone* is exposed in the bottom of the creek. Thirty feet below this *Camarotœchia litchfieldensis* and *Spirifer octocostatus* were obtained, and at the bottom of the exposure along the south side of the hill *Spirifer vanuxemi, S. modestus, Stropheodonta bipartita,* and *Leperditia* cf. *alta* were collected. The strata dip here at about 28° southeast and only a few exposures occur where the dip can be taken, so it is not certain that the correct stratigraphic thickness is given.

The section begins at the *Gypidula coeymanensis* var. *prognostica zone* exposed in the creek above which the section is largely concealed.

HELDERBERG FORMATION

Keyser Member	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Hard blue massive limestone, the upper and lower parts filled with *Gypidula coeymanensis* var. *prognostica.* About half of this unit is concealed........	260.0	15.4	150.7
Mostly concealed. Near bottom in heavy blue limestone occur *Camarotœchia litchfieldensis, Spirifer octocostatus,* etc.	225.0	30.8	135.3
Heavy dark blue limestone........................	155.0	6.6	104.5
Concealed	....	35.6	97.9
Heavy dark blue limestone containing at the bottom *Cladopora rectilineata* and bryozoa..................	140.0	8.9	62.3
The remainder of the section is exposed in a direction due west from the bottom of the above unit.			
Concealed. At the bottom of this unit there is an exposure of limestone containing *Spirifer vanuxemi prognostica, S. modestus, Stropheodonta bipartita, Camarotœchia litchfieldensis, Leperditia elongata*....	120.0	53.4	53.4
Thickness of Keyser member exposed.............		150.7	

TONOLOWAY FORMATION

Concealed.

A short distance west of top of section were found *Thamniscus regularis, Fenestella (Cycloporina) altidorsata.*

XV. Section 1¼ Miles East of Rush

Three and one-half miles southwest of Flintstone, on the road crossing Warrior Mountain and leading to Rush, is an exposure of the lower beds of the Keyser limestone on the south side of the road, beginning south 68° west of the residence of Mr. George Twigg. Only the following species were found in the lower portion of the section at this place: *Camarotœchia litchfieldensis, Chonetes jerseyensis, Rhynchospira globosa,* and *Spirifer* (cf.) *vanuxemi* var. *prognosticus.* The Tonoloway is also partly exposed and the stratigraphic position and nodular character of the overlying beds show that they are in the Keyser member. The section begins 730 feet horizontally, east of the road which leads to the south on Warrior Mountain, opposite the residence of Mr. George Twigg.

HELDERBERG FORMATION

Keyser Member

Road N. 30° W.	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Nodular limestone, partially concealed, containing *Cladopora rectilineata*	229.0	12.0	75.0
Concealed	193.0	1.6	63.2
Nodular limestone, partially concealed above, containing *Cladopora rectilineata*	188.0	8.0	61.6
Concealed	165.0	8.0	53.6
Road N. 45° W.			
Nodular limestone	142.0	.6	45.6
Concealed	140.0	4.0	45.0
Very nodular limestone	127.0	3.0	41.0
Concealed. Nodular limestone in part	117.0	15.0	38.0
Nodular limestone partially concealed	71.0	2.0	23.0
Disintegrating nodular limestone	64.0	10.0	21.0
Largely concealed. Thin-bedded nodular limestone containing *Camarotœchia litchfieldensis*, *Chonetes jerseyensis*, *Rhynchospira globosa*, *Spirifer* cf. *vanuxemi* var.	34.0	5.0	11.0
Thin-bedded nodular limestone containing at base *Favosites favosus* var. *integritabulatus* (a), *F. pyriformis* (a)	19.0	6.0	6.0
Thickness of Keyser member exposed		75.0	

TONOLOWAY FORMATION

Concealed	3.0	1.0	....
Fissile limestone, largely concealed with heavier beds 25 to 27 feet, 39 feet, and 61 feet below Helderberg-Tonoloway contact.			

Hancock Area

XVI. Section at Tonoloway

The Potomac River cuts through Tonoloway Ridge at Tonoloway Station on the Western Maryland Railroad, opposite Great Cacapon, West Virginia, where the finest section of the Lower Devonian east of Cumberland is exposed. The section is seen in the cut of the Western Maryland Railroad just east of the station.[1]

[1] The lithological description of the section is by Ulrich and Stose, Pawpaw-Hancock Folio, U. S. Geol. Survey, 1912; the faunal, by C. K. Swartz except the lower 60 feet which is by T. P. Maynard and C. K. Swartz. The figures given after names of fossils indicate altitude in feet at which the fossils were found above base of section.

ORISKANY FORMATION

Shriver Chert Member

Yellow shale with chert.

HELDERBERG FORMATION

	Vertical thickness feet	Total vertical thickness
New Scotland Member		
Residual clay after limestone filled with white blocky chert containing numerous fossils	12.0	293.1
Coeymans Member		
Hard, blue-gray, mottled and fine black-speckled limestone full of fossil fragments	8.5	281.1
Keyser Member		
Somewhat lamellar limestone with argillaceous and purer, fossiliferous, subcrystalline bands. *Lioclema subramosum* and *Strophonella* sp., 270.6	66.0	272.6
Coarsely cobbly to irregular lamellar impure limestone with purer fossiliferous bands. *Schuchertella prolifica, Meristella prænuntia* and *Lioclema subramosum* occur throughout; *Pholidops ovata, Tentaculites gyracanthus*, 263.1, 259.1; *Strophonella leavenworthana*, 263.1; *Batostomella interporosa, Uncinulus keyserensis*, 241.3	26.0	266.6
Very shaly, platy limestone full of *Tentaculites gyracanthus, Meristella* sp., *Uncinulus keyserensis* ? and bryozoa, 236.6 vertically	3.0	240.6
Shaly, cobbly limestone, solid when fresh. *Lioclema subramosum* and *Orthopora rhombifera*, 234.4; *Tentaculites gyracanthus, Meristella* sp., *Uncinulus keyserensis*, 231	7.0	237.6
Very shaly, cobbly limestone. *Tentaculites gyracanthus* (a), *Uncinulus keyserensis* (a), *Meristella* sp., cf. *Dalmanella concinna*, and *Eridotrypa parvulipora*, 230	2.5	230.6
Dark gray-blue limestone, coarsely cobbly, *Rensselaeria mutabilis* (a), *R. mutabilis* var., *Whitfieldia* sp., and *Tentaculites gyracanthus*, 227.5; *Uncinulus keyserensis* ?, *Meristella* sp., *Uncinulus nucleolatus*, 225.3	10.0	228.1
Cobbly limestone with surface full of *Tentaculites gyracanthus, Eridotrypa parvulipora*, and *Batostomella interporosa*.	2.0	218.1
Cobbly limestone containing reef of Stromatoporoids, *Leptæna rhomboidalis, Eridotrypa parvulipora*, and *Lioclema subramosum* (a); *Tentaculites gyracanthus, Uncinulus nucleolatus*..	2.0	216.1
Coarse cobbly argillaceous limestone. *Atrypa reticularis* (a), *Leptæna rhomboidalis, Merista typa*	3.0	214.1
Cobbly limestone. *Leptæna rhomboidalis* abundant throughout. *Stropheodonta bipartita*, 210.2; *Dalmanella concinna* (a),		

	Vertical thickness feet	Total vertical thickness
Spirifer vanuxemi with angular ribs, and *Atrypa reticularis*, 206.1; *Atrypa reticularis* (a), *Tentaculites gyracanthus*, 203.5; *Dalmanella concinna* and *Ptilodictya tenella*, 199.9	14.0	211.1
Rather shaly, cobbly limestone. *Leptæna rhomboidalis* (a), 197; *Stropheodonta bipartita*, 196.6; *Dalmanites* n. sp., 255.4, 193.8, and 188.5; *Actinopteria* sp., *Schuchertella deckerensis*, *Uncinulus keyserensis* and *Stromatotrypa globularis*, 193.1; *Atrypa reticularis*, 193.1, 188.5, 187.9, 187.7; *Chonetes jerseyensis*, 193.1 (a), 188.5, 187.7 (a); *Anoplotheca concava* var., 187.9; *Gypidula coeymanensis* var. *prognostica*, 187.7	12.0	197.1
Massive, cobbly limestone. *Atrypa reticularis* and *Cyphotrypa corrugata*	4.0	185.1
Somewhat shaly limestone breaking into irregular laminæ. *Dalmanella concinna*, *Uncinulus keyserensis*, *Fenestella* (*Cycloporina*) *altidorsata* and crinoid fragments, 181.1. *Schuchertella prolifica* and *Fenestella altidorsata*, 179.6; *Tentaculites gyracanthus* at base	6.0	181.1
Single layer of finely cobbly limestone; basal part bored by worm tubes. *Chonetes jerseyensis* (a), *Stropheodonta bipartita*, *Uncinulus keyserensis*, 159.3	24.0	175.1
Somewhat clayey, finely cobbly limestone	2.8	151.1
Slabby crinoidal limestone containing some corals. *Cyphotrypa corrugata*	1.0	148.3
Finely cobbly limestone, massive when fresh, but breaking up on weathering into irregular pieces and cobble. Small reef of Stromatoporoids and *Favosites* near top and a thicker one near base. *Camarotœchia litchfieldensis*, 135.9; *Favosites* sp., and *Spirifer vanuxemi* with angular ribs, 131.2	21.0	147.3
Subcrystalline limestone, banded with thin clay seams. Contains fossil fragments	5.0	126.3
Subcrystalline limestone, irregularly bedded with thin clay seams and containing large crinoid columns. *Atrypa reticularis* throughout; *Spirifer octocostatus* ?, *Fenestella cumberlandica* near base	5.0	121.3
Thick-bedded, subcrystalline limestone. *Atrypa reticularis* and *Uncinulus* sp. at top; *Rhynchospira formosa* and corals at base	7.0	116.3
Finely cobbly limestone with *Favosites* and massive bryozoa. *Camarotœchia litchfieldensis*, *Schuchertella deckerensis*, and *Cyphotrypa corrugata* (a), 107	6.5	109.3
Thin slabby and shaly limestone, argillite in part. *Klœdenella clarkei* abundant; *Schuchertella deckerensis*, *Meristella* sp., *Stropheodonta bipartita*, *Camarotœchia litchfieldensis* (a). Base of this unit is 130 feet west of base of section measured along track	4.0	102.8

	Vertical thickness feet	Total vertical thickness
Massive dark blue limestone. *Favosites pyriformis* ? near base	13.6	98.8
Massive dark blue nodular limestone. Base of this unit 107 feet west of base of section	19.0	85.2
Thin-bedded dark blue limestone. *Camarotœchia litchfieldensis*, 50.7; *Favosites* sp., 45.6, 48.4; *Rhynchospira globosa* var. abundant at base	21.2	66.2
Thin-bedded dark blue limestone, weathering nodular; *Rhynchospira globosa* var. abundant. Top of unit 62 feet west of base of section	8.8	45.0
Thin-bedded dark blue limestone weathering nodular. At base occurs *Chonetes jerseyensis.* Top of unit 50 feet west of base of section	6.6	36.2
Thin-bedded nodular blue limestone carrying crinoid fragments. At base occur *Chonetes jerseyensis* (a), *Spirifer modestus*. *Uncinulus convexorus.* Top of unit 41 feet west of base of section	19.6	29.6
Concealed, with occasional outcrops of thin-bedded nodular limestone	10.0	10.0
Thickness of Keyser member	272.6	....
Total thickness of Helderberg formation	....	293.1

TONOLOWAY FORMATION

Concealed with occasional outcrops of thin-bedded, platy limestone.

The following species are found in the lower beds of this section, their exact horizon not being known: *Klœdenia barretti, Klœdenia kümmeli, Klœdenia nearpassi, Klœdenella pennsylvanica, Leperditia elongata, Leperditia gigantea.*

The section at Round Top Station on the Western Maryland Railroad east of Tonoloway extends from the top of the Clinton to the base of the Helderberg. However, the Keyser member is exposed only in places on the mountain side, which is steep and not easily accessible. The Lower Keyser fossils found in the talus at this place are: *Spirifer vanuxemi, Atrypa reticularis, Reticularia bicostata, Tentaculites gyracanthus,* and *Whitfieldella minuta.*

XVII. Section at Hancock

There are two exposures of limestone on the southwestern edge of the town, along the west flank of Cove Ridge, that are included in one section, since one supplements the other. These exposures are termed the Upper and Lower quarry zones respectively.

The Upper quarry zone is the site of an old limestone quarry on the south side of the National Road, 310 feet west of the middle of the bridge over Tonoloway Creek. At the top of the section in heavy-bedded limestone *Gypidula coeymanensis* var. *prognostica* occurs. At the base of the section in this quarry is a massive 3½-foot bed of stromatoporoids containing corals. The remainder of the section is concealed at this locality, but by following the strike of the rock northeast across Tonoloway Creek, one finds the Stromatopora bed on the hillside northeast of the road leading north from Hancock, about 59 feet north of the fork in the road. The limestone beneath the Stromatopora bed is quarried at this point for the burning of lime. The section beneath the Stromatopora bed is called the Lower quarry zone.

This section was formerly considered Coeymans and the Lower Keyser was thought to consist of the thin-bedded limestones with abundant ostracods found beneath the strata quarried. Careful search was made for fossils below the described section in the thin-bedded limestones of the Tonoloway, but none other than Tonoloway forms were found. The Stromatopora bed occurs in the lower part of the Keyser.

The following section begins at the top of the exposure in the old abandoned quarry on the National Road, 310 feet west of the middle of the bridge over Tonoloway Creek.

HELDERBERG FORMATION

Keyser Member	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Heavy-bedded gray-blue arenaceous limestone containing a form of *Gypidula* (cf.) *coeymanensis* var. *prognostica*. At the bottom of this unit the following fossils were obtained: *Orthoceras* sp., *Spirifer modestus* (aa), *Atrypa reticularis* (c), *Chonetes jerseyensis* (a), *Stenochisma* sp., *Stropheodonta* sp..........	166.2	5.2	104.2
Dark blue thin-bedded nodular limestone weathering gray. At the bottom of this unit were found *Chonetes jerseyensis* (a), *C. jerseyensis* var. *spinosa* (r), *Stenochisma* sp., *Dalmanella* sp., *Rhynchospira* sp..........	158.2	8.6	99.0
Dark grayish-blue, thin-bedded nodular limestone weathering gray. At the bottom occur *Camarotœchia litchfieldensis* (c), *Atrypa* sp., *Favosites* sp., bryozoa..	145.2	4.6	90.4

	Horizontal distance feet	Vertical thickness feet	Total vertical thickness
Dark grayish-blue thin-bedded limestone weathering gray	137.5	15.9	85.8
Arenaceous gray crinoidal limestone. Crinoids (aa), *Atrypa reticularis*	113.5	11.2	69.9
Stromatopora bed with corals	96.5	3.5	58.7
The remaining portion of the section comes from the Lower Quarry zone, beginning at the bottom of the Stromatopora bed exposed in the upper part of the quarry on the road leading north from Hancock.			
Direction N. 20° E.			
Thin-bedded shaly limestone becoming more arenaceous toward the bottom. *Meristella* sp. at the bottom	93.0	7.5	55.2
Heavy-bedded dark blue limestone containing numerous calcite stringers. Quarried	77.0	11.8	47.7
Direction due West			
Thick-bedded dark blue arenaceous limestone	52.0	4.1	35.9
Thin-bedded dark blue arenaceous limestone. *Leperditia* cf. *alta*	46.0	18.0	31.8
Thin-bedded dark blue arenaceous limestone, largely made up of crinoid stems	20.0	6.9	13.8
Thin-bedded gray-blue somewhat nodular limestone. *Meristella* sp., *Dalmanella* sp	10.0	6.9	6.9
Thickness of Keyser member exposed		104.2	
TONOLOWAY FORMATION			
Blue limestone becoming thin-bedded upon weathering	....	6.0	....
Thin calcareous shale.			

The Keyser member is exposed at various places east of Hancock, but the sections have not been studied in detail.

SECTIONS OF COEYMANS, NEW SCOTLAND, AND BECRAFT MEMBERS [1]

The following sections display the characteristics of the Coeymans, New Scotland, and Becraft members more fully and will aid the student who desires further acquaintance with the subject. The sections will be

[1] Contributed by C. Schuchert, C. K. Swartz, and R. B. Rowe.

treated according to their geographic occurrence beginning with the westernmost exposures in the Cumberland area and proceeding thence eastward.

I. Section at Keyser, West Virginia

An excellent exposure of the entire Helderberg is seen in the quarry of the Standard Lime and Stone Company, east of Keyser, West Virginia. The following section[1] is continuous with the beds of the Keyser member described on a preceding page.

	Vertical thickness feet
ORISKANY FORMATION	
Shriver Chert Member	
Siliceous shale containing numerous chert nodules.	
HELDERBERG FORMATION	
New Scotland Member	
Fissile drab shale	14.0
Gray limestone and interbedded white chert. The chert is in layers 6 to 9 inches thick and forms almost the entire unit. 4.6 feet and 3.6 feet above the base of the unit occurs *Spirifer macropleurus*, at 1.6 feet *Meristella arcuata*	21.5
Medium-bedded gray limestone with some chert layers. 4.5 feet above the base of the unit occur *Phacops logani, Dalmanella perelegans, Schuchertella woolworthana, Spirifer macropleurus*	5.1
Shale much weathered	0.2
Black speckled crinoidal limestone, rather coarse grained with one chert layer	1.1
Thickness of New Scotland member	41.9
Coeymans Member	
Thin-bedded gray crinoidal limestone, with one chert band. At middle of unit occurs *Strophonella leavenworthana*	2.5
Shaly limestone, with a chert layer	1.0
Shale weathered to clay	0.5
Massive gray crinoidal bed with one 6-inch bed of chert	3.5
Massive gray crystalline limestone. Between 2 and 2.7 feet above base of unit are a number of bands of sand which weather out as brown ridges. At base of the unit occur *Atrypa reticularis, Gypidula coeymanensis* (a), *Schuchertella woolworthana, Stropheodonta* sp., *Lioclema subramosum*	6.8
Thickness of Coeymans member	14.3

[1] Measured by C. K. Swartz, assisted by J. B. Reeside, Jr.

II. Section at 21st Bridge

An excellent section of the Oriskany formation and of the New Scotland member of the Helderberg is seen in the axis of a small anticline that is cut by the Potomac River opposite 21st Bridge, Maryland, on the West Virginia side, along the tracks of the Baltimore and Ohio Railroad. The New Scotland shale is well exposed. The New Scotland limestone appears thicker than usual leading Schuchert to estimate its thickness at 44 feet[1] at this place. This appearance is, however, misleading as some of the beds are duplicated by a thrust fault seen along the river so that it is probable that the thickness of the beds is the same as at Keyser and Dawson.

	Vertical thickness feet
ORISKANY FORMATION	
Shriver Chert Member	
Siliceous shale containing much black chert in nodules.	
HELDERBERG FORMATION	
New Scotland Member	
Soft, bluish, argillaceous shales, with some harder layers and occasional manganese-phosphatic nodules. *Chonetes helderbergiæ, Meristella arcuata, Trematospira multistriata, Spirifer macropleurus, Schuchertella woolworthana, Stropheodonta becki,* etc.	20.0
Massive gray limestone with bands of chert, becoming thin-bedded above, with partings of shale; characterized by *Spirifer macropleurus* and containing *Hindia sphæroidalis, Edriocrinus pocilliformis, Dalmanella perelegans, Rhipidomella oblata, Eatonia singularis, E. peculiaris, E. medialis, Anoplotheca concava, Trematospira multistriata, Parazyga dewyi, Spirifer perlamellosus, S. macropleurus, S. cyclopterus, Platyceras spirale, Phacops logani,* etc.	
Concealed.	

III. Section at Dawson

An excellent section of the New Scotland and Coeymans limestone is exposed at the south end of Fort Hill, near Dawson, along the tracks of the Baltimore and Ohio Railroad. The Oriskany sandstone forms the "backbone" at the south end of the mountain and is succeeded by a small covered interval. Immediately east of this the limestone beds of the New Scotland are seen and below them the Coeymans and upper part of the

[1] Proc. U. S. Nat. Mus., vol. xxvi, 1903, p. 422.

Keyser member. This exposure affords one of the finest sections of the New Scotland and Coeymans limestones in the State.[1] It is continuous with that of the Keyser member described on a preceding page.

	Vertical thickness feet	Total vertical thickness
ORISKANY FORMATION		
Massive sandstone at south end of Fort Hill.		
Concealed.		
HELDERBERG FORMATION		
New Scotland Member		
Concealed. Interval occupied by shale.		
Gray limestone and interbedded white chert. The chert is in layers six to nine inches thick and forms almost the entire unit. *Schuchertella woolworthana* and *Spirifer perlamellosus* occur throughout, *Rhipidomella oblata*, 16.8; *Spirifer macropleurus*, 16.8, 4.8; *Trematospira multistriata*, 16.3; *Meristella arcuata*, 16.3, 4.8, 2.8 (a), 0.3; *Leptæna rhomboidalis*, 16.3, 4.8; *Streptelasma strictum* (a), *Monotrypa sphærica*, *M. tabulata*, *Dalmanites pleuroptyx*, *Phacops logani*, *Eatonia medialis*, 16.3; *Stropheodonta* sp., 14.8; *Platyceras* sp., *Anoplotheca concava*, *Nucleospira ventricosa*, *Eatonia medialis*, *Trematospira deweyi*, 8.8; *Dalmanella perelegans*, *Trematospira equistriata*, *Strophonella undaplicata*, 4.8	21.0	29.3
Medium-bedded gray limestone with a chert layer near the middle of the unit. *Dalmanites pleuroptyx*, *Schuchertella woolworthana*, *Leptæna rhomboidalis*, *Dalmanella perelegans*, *Meristella arcuata*, *Rhipidomella oblata* occur abundantly throughout the unit. *Aviculopecten communis*, *A. textilis*, cf. *Leptostrophia* sp., *Stropheodonta arata*, 5.1; *Phacops logani*, *Schizophoria multistriata* ? and *Strophonella undaplicata*, 3.6; *Spirifer macropleurus* and crinoids, 1.6; *Fenestella idalia*, *Actinopteria communis* (a), *Strophonella leavenworthana*, *Callotrypa macropora*, 0.8; *Vermipora* sp., *Chonostropia helderbergiæ*, *Fenestella idalia*, *Anaplotheca concava* (a), *Spirifer cyclopterus*, *Eatonia medialis*, *Leptostrophia planulata*, *Strophonella leavenworthana*, *Strophonella punctulifera*, *Spirifer perlamellosus*, *Strophonella undaplicata*, 0.6; *Spirifer cyclopterus*, *Eatonia medialis*, *Strophonella leavenworthana* at the base of the unit	5.8	8.3
Thin-bedded, gray crystalline limestone with several chert layers. *Spirifer perlamellosus*, 2.1, 1.1; *Orthostrophia stropho-*		

[1] Measured by C. K. Swartz, assisted by J. B. Reeside, Jr. The figures following the names of the fossils indicate the altitudes in feet at which they occur above the base of the units.

	Vertical thickness feet	Total vertical thickness
menoides and bryozoa, 1.6; *Fenestella idalia, Dalmanites pleuroptyx* (a), *Leptæna rhomboidalis* (a), *Actinopteria communis* (a), *Chonostrophia helderbergiæ* (aa), *Rhipidomella oblata, Schuchertella woolworthana*, and *Strophonella leavenworthana*, 1.1	2.5	2.5
Thickness of New Scotland member exposed	29.3	
Coeymans Member		
Thin bed of gray crystalline limestone with a chert layer	0.7	13.6
Shale parting	0.1	12.9
Heavy bed of crinoidal limestone with a chert layer near middle and at base. At base of unit occur *Leptænisca concava, Actinopteria communis, Tentaculites elongatus, Gypidula coeymanensis* (a), *Rhipidomella* sp., *Stropheodonta arata, Strophonella leavenworthana, Strophonella punctulifera*, 1.9; *Gypidula coeymanensis, Leptæna rhomboidalis*, 2.4	3.0	12.8
Massive bed of gray crystalline limestone. Between 2.6 and 3 feet below the base of the unit are a number of bands of sand which weather out as brown ridges on the surface. At the base of the unit are rounded limestone fragments, about 2 to 4 inches in thickness. The line of contact with the Keyser is rather sinuous. 6.8 feet above the base is a *Stromatopora* bed. *Dalmanites pleuroptyx, Gypidula coeymanensis, Atrypa reticularis, Schuchertella woolworthana, Leptæna rhomboidalis* and *Stropheodonta arata* occur in abundance throughout; corals, *Spirifer cyclopterus, Rhipidomella oblata, Strophonella leavenworthana, Strophonella punctulifera* occur at top of unit; chætetoid bryozoa *Stropheodonta planulata*, crinoid rings, *Uncinulus* sp., 8.3; *Spirifer cyclopterus*, 3.0 feet; *Stromatoporoid* sp., *Favosites helderbergiæ*, Fenestelloid bryozoa *Uncinulus* sp., 2.6	9.8	9.8
Thickness of Coeymans member	13.6	

Keyser Member

For description see pages 137-138.

IV. Section at Riverside Station[1]

One of the most conspicuous cliffs along the Potomac River is in Knobly Mountain, West Virginia, east of Potomac Station. It is something over

[1] The section was described by R. B. Rowe who does not give precise measurements.

a thousand feet high and the Helderberg and Tonoloway formations are well exposed. The escarpment is most easily reached from Riverside Station on the West Virginia Central Railroad.

TONOLOWAY FORMATION

High up the hill, which is largely covered at this place, although well exposed a little farther south, is a cliff of thin-bedded limestones from 75 to 100 feet high. This escarpment is very conspicuous and about one-half or three-quarters of the distance to the top of the mountain. Along the top of the escarpment the Tonoloway formation is found. Several specimens of *Tentaculites gyracanthus*, *Leperditia alta*, *Beyrichias*, *Pelecypoda*, small *Meristella* and *Rhynchospira* of the Tonoloway formation of this region were obtained.

For some distance back from the top of this cliff the ground is level.

HELDERBERG FORMATION

Near the bottom of the next ascent is a ledge 5 feet thick of the compact massive gray nodular limestone of the Keyser member.

At the top of the rise and crowning the brow of the hill with a cliff from 30 to 40 feet high is the compact gray limestone of the New Scotland member with numerous layers of white chert, dipping quite perceptibly to the southeast.

On the very top of the cliff *Spirifer macropleurus* is common occurring chiefly in the white chert.

ORISKANY FORMATION

The Oriskany is shown some distance to the eastward farther down the slope. This escarpment forms the highest part of the mountain.

The fossils obtained in the New Scotland limestone are: *Spirifer macropleurus* (a), *S. perlamellosus* (r), *Uncinulus vellicatus* (rr), *Leptæna rhomboidalis* (c), and *Rhipidomella oblata* (rr).

V. Section at Cedar Cliff

The cliffs in Knobly Mountain at Cedar Cliff are almost as imposing as those at Riverside. The tracks of the Western Maryland Railroad run along the base of this exposure. The section is as follows according to the measurement of R. B. Rowe.

ORISKANY FORMATION	Vertical thickness feet	Total vertical thickness
Top of Knobly Mountain, concealed	110.0	320.0
HELDERBERG FORMATION		
New Scotland, Coeymans and Keyser Members		
Light gray massive limestone with bands of light colored chert at the top	210.0	210.0

The upper part of the New Scotland member stands out in a bold cliff near the very top of the mountain. The fossils are shown here along its upper surface as at Riverside, including: *Spirifer macropleurus, S. perlamellosus, Meristella arcuata, Nucleospira ventricosa, Schuchertella woolworthana, Stropheodonta becki, Eatonia medialis,* and *Uncinulus abruptus.*

The Helderberg formation is exposed on the west side of Knobly Mountain at Miller's Spring, immediately south of the tunnel of the Western Maryland Railroad. The occurrence of fossils in the Keyser member at this place has already been discussed. The following fossils were obtained by Rowe from loose blocks of New Scotland limestone at this locality: *Atrypa reticularis* (rr), *Spirifer perlamellosus* (c), *Strophonella leavenworthana* (rr), *Leptænisca concava* (rr), *Leptæna rhomboidalis* (aa), *Schuchertella woolworthana, Chonetes subacutiradiatus* (rr), *Dalmanella perelegans* (rr), *Rhipidomella oblata* (r).

VI. Section at Devil's Backbone

This locality affords one of the finest sections of the Helderberg formation in the entire State. An uninterrupted exposure extends from the base of the Keyser member to the top of the New Scotland limestone. The section described[1] is continuous with that of the Keyser member given on a preceding page to which reference should be made for a further account of this locality. It is also continuous with the section of the Oriskany given on a subsequent page.

[1] Measured by C. K. Swartz and assistants. The figures following the names of the fossils indicate the altitude in feet above the base of the units at which they were found.

HELDERBERG FORMATION

New Scotland Member	Vertical thickness feet	Total vertical thickness
Concealed. The concealed interval consists of fissile gray shale.		
Gray crystalline limestone with interbedded white chert. The latter forms almost the entire thickness of the unit and is in courses 6 to 9 inches thick. *Rhipidomella oblata* and *Spirifer perlamellosus*, 4.4, *Schizophoria multistriata*	13.0	34.0
Gray crystalline limestone with several chert layers	2.0	21.0
Medium-bedded gray limestone with but few chert layers. *Dalmanites pleuroptyx, Leptæna rhomboidalis. Dalmanella perelegans, Meristella arcuata* occur abundantly throughout, and less abundant but common are *Spirifer cyclopterus, S. perlamellosus, Rhipidomella oblata, Schuchertella woolworthana, Fenestella idalia*, 2.4, 2.9; *Orthopora rhombifera*, 2.9; *Orthopora regularis*, 2.9; *Monotrypa tabulata*, 2.9; *Stropheodonta arata* occurs at 8.4, 4.9, 3.8; *Spirifer macropleurus*, 7.9, 6.7, 6, 3.7 (?); *Stropheodonta planulata*, 6.7, 3.8; *Orbiculoidea* sp., 6; *Eatonia medialis*, 4.9, 4.3; *Lichenalia* sp., 4.3, 3.8, 2.9, 2.4, 2; *Strophonella leavenworthana*, 4.3, 3.8, 2.9, 2.4, 2, 0.4 feet; *Strophonella punctulifera*, 3.8, 2.9; *Uncinulus* sp., 2.9; *Cyathophylloid* coral and *Uncinulus nucleolatus*, 2.9; *Leptænisca concava*, 2.4; *Actinopteria cummunis* and *Tentaculites elongatus*, 2.8; *Chonostrophia helderbergiæ*, 2; *Atrypa reticularis* and *Dalmanella eminens* at 0.4; crinoids, 3.8. Near base occur *Anoplotheca concava* (aa), *Spirifer cyclopterus, Schuchertella woolworthana* with fine striæ, *Cypricardinia* cf. *sublamellosa. Tentaculites* sp., *Leptæna rhomboidalis*	9.6	19.0
Yellow shale. *Spirifer perlamellosus*	0.8	9.4
Thickness of New Scotland member exposed	25.4	

Coeymans Member		
Medium-bedded gray limestone with a chert layer at top of unit. *Gypidula coeymanensis* (aa), *Dalmanella perelegans, Spirifer cyclopterus, Leptæna rhomboidalis, Strophonella leavenworthana* occur throughout. At the top are found *Strophonella punctulifera, Meristella* sp., *Schuchertella woolworthana* with fine striæ; and *Atrypa reticularis*	2.6	8.6
Single bed of massive gray limestone weathering to a ridge which stands out as the "Backbone." Chert layers 6 inches thick at top and near middle. Limestone pebbles at base. *Gypidula coeymanensis, Leptæna rhomboidalis, Atrypa reticularis* occur abundantly throughout; *Strophonella punctulifera*, 5.9, 2.9; *Dalmanites pleuroptyx, Strophonella leavenworthana,*		

	Vertical thickness feet	Total vertical thickness
Dalmanella perelegans, 5.9; *Rhipidomella* sp., *Schuchertella woolworthana*, 4.9; *Uncinulus* sp., 3.9; *Cyrtoceras* n. sp., *Nucleospira ventricosa, Spirifer cyclopterus, Stropheodonta coeymanensis, Stropheodonta arata*, and *Uncinulus* sp., 1.9 feet. Lepadocrinus stems abundant	6.0	6.0
Thickness of Coeymans member	8.6	

Keyser Member

VII. Sections at Corriganville

Two additional sections are exposed at Corriganville. One of these is on the south side of the creek opposite the Devil's Backbone in an abandoned quarry from which the rock has been taken out for a distance of 100 or 200 feet back from the hill-slope. The lower part of the New Scotland member, the Coeymans, and a part of the Keyser member have been worked. On the western face of the quarry and on many of the slabs which have fallen down are splendid exposures, showing hundreds of specimens of *Spirifer macropleurus*. They are imbedded in the white chert which weathers in such a way that the internal structure of the fossils is finely shown. They cannot be taken from the chert, however, without destroying them since they have all been more or less silicified.

The following fossils were obtained by R. B. Rowe at this place: *Spirifer macropleurus* (aa), *S. perlamellosus* (a), *Trematospira multistriata* (r), *T. deweyi* (rr), *T. equistriata* (r), *Anoplotheca concava* (aa), *Meristella arcuata* (r), *Nucleospira ventricosa* (r), *Leptæna rhomboidalis* (a), *Strophonella punctulifera* (rr), *S. headleyana* (rr), *Schuchertella woolworthana* (r), *Dalmanella planoconvexa* (r), *D. perelegans* (r), *D. emarginata* (r), *Rhipodomella oblata* (r), *Orthostrophia strophomenoides* (rr), *Schizophoria multistriata* (c), *Eatonia medialis* (r), *E. singularis* (r), *Camarotœchia altiplicata* (rr), *Uncinulus vellicatus* (r), *U. globosus* (rr), *Rhynchonella bialveata.*

An excellent and uninterrupted exposure of the rocks of the Lower Oriskany, New Scotland, Coeymans, and the larger part of the Keyser is seen in the deep cut of the Pittsburg branch of the Western Maryland Railroad through the hill south of the quarry. The beds of the Keyser member have already been described. The following section of the Coeymans and New Scotland is exposed at this place: [1]

	Vertical thickness feet	Total vertical thickness
ORISKANY FORMATION		
Shriver Chert Member		
Siliceous shale containing chert nodules.		
HELDERBERG FORMATION		
New Scotland Member		
Fissile drab shale	20.0	54.2
Shale with several chert layers	1.5	34.2
Gray crystalline limestone with interbedded white chert. The chert is in 6-inch layers and makes up nearly the entire thickness of the unit. *Leptæna rhomboidalis* occurs throughout the unit; *Stropheodonta planulata and Schuchertella woolworthana* (a), 11; *Strophonella undaplicata*, 5; *Spirifer macropleurus*, 6.5; *S. perlamellosus* and *S. macropleurus*, 4.5; *Eridotrypa corticosa, Fenestella idalia, Polypora compacta, Orthopora regularis, Stictopora ? papillosa, Orthopora rhombifera*, 3.0; *Spirifer macropleurus*, 1.8	11.5	32.7
Medium-bedded crystalline limestone with several chert layers. *Leptæna rhomboidalis, Dalmanella perelegans* and *Schuchertella woolworthana* occur throughout the unit; *Anoplotheca concava* is abundant at the top and the base; *Stropheodonta planulata, Spirifer cyclopterus, Strophonella leavenworthana*, 2.5; *Schuchertella woolworthana* var. with fine striæ *Proëtus* cf. *protuberans, Stropheodonta planulata, Meristella arcuata, Rhynchospira globosa* at base	3.5	21.2
Medium-bedded, crystalline limestone with but little chert. *Leptæna rhomboidalis* occurs throughout; *Dalmanites pleuroptyx* and *Rhipidomella oblata*, 6; *Schuchertella woolworthana, Spirifer cyclopterus* 4; *Anoplotheca concava* 3 (a)	7.5	17.7
Shale. *Anoplotheca concava* (a) and *Spirifer cyclopterus*	1.0	10.2
Thickness of New Scotland member	45.0	

Coeymans Member

Dark blue crystalline limestone, very massive and very fossiliferous. Lower surface of unit somewhat irregular. At top occur *Schuchertella woolworthana* with fine striæ; *Actinopteria communis* (?), *Spirifer cyclopterus, Gypidula coeymanensis,*

[1] Measured by C. K. Swartz and assistants. The figures following the names of the fossils indicate the altitude in feet at which they occur above the base of the units.

	Vertical thickness feet	Total vertical thickness
Leptæna rhomboidalis, Strophonella leavenworthana, S. punctulifera, 6; *Meristella* sp., *Dalmanella* sp., 4; *Gypidula coeymanensis, Actinopteria communis* (?), *Stropheodonta planulata, Atrypa reticularis, Spirifer cyclopterus, Uncinulus nucleolatus* ? at base	9.2	9.2
Thickness of Coeymans member	9.2	

VIII. Section near Warren Point

Cove, or Tuscarora Mountain, is an anticline whose harder beds pass beneath the surface about a mile south of the Maryland-Pennsylvania boundary. Licking Creek cuts through its southern end almost on the State line, about 8 miles northeast of Hancock. At this place one of the finest sections of Upper Silurian and Lower Devonian rocks of this region is exposed. By following the road west of Warren Point along Licking Creek, the Tonoloway, Helderberg, and Oriskany are finely exposed while the Clinton outcrops on the south bank of the creek a little farther west.

The Lower Devonian undergoes a rapid change between Hancock and Warren Point. At Hancock the divisions still show many of the characteristics observed in the Cumberland area. At Warren Point the Oriskany is greatly reduced in thickness, being only 52 feet thick instead of over 400 feet thick as at Tonoloway, and its lithological and faunal characters are greatly changed. The Becraft, absent west of this place, appears in force, the New Scotland and Keyser become thinner while the Coeymans is a sandstone. All of these features indicate differences in the conditions of sedimentation.

The following section is exposed on the south side of Licking Creek beginning at the iron bridge and extending westward.[1]

ORISKANY FORMATION

Cherty arenaceous limestone. *Spirifer arenosus, S. murchisoni, Meristella lata, Rensselæria marylandica.*

[1] Measured by R. B. Rowe.

HELDERBERG FORMATION

	Vertical thickness feet	Total vertical thickness
Becraft Member		
Light gray limestone free of chert. *Spirifer concinnus* (aa), *S. cyclopterus* (a), *Meristella arcuata* (c), *Anoplotheca concava* (rr), *Rensselæria subglobosa* (aa), *Plethorhyncha campbellana* (aa), *Eatonia medialis, E. singularis* (r), *E. peculiaris* (rr), *Leptæna rhomboidalis* (rr), *Schuchertella woolworthana* (aa), *Strophonella punctulifera* (r), *Rhipidomella oblata* ? (r)	25.0	162.0
Light gray limestone with numerous bands of black chert	20.0	137.0
Almost pure light gray limestone with a few nodules and one or two layers of chert. *Spirifer concinnus* (aa), *Rensselæria subglobosa* (c), *Plethorhyncha campbellana* (r), *Eatonia medialis* (r), *Schuchertella woolworthana* (r)	25.0	117.0
Mostly black chert in irregular nodular layers, some limestone near the top	17.0	92.0
Talus slope. Fossils from the higher zones: *Spirifer concinnus* (aa), *S. perlamellosus* (rr), *Anoplotheca concava* (rr), *Meristella arcuata* (a), *Rensselæria subglobosus* (c), *Eatonia peculiaris* (r), *E. medialis* (r), *Plethorhyncha campbellana* (rr), *Strophonella punctulifera* (rr), *Stropheodonta planulata* (r), *Leptæna rhomboidalis* (c), *Schuchertella woolworthana* (c), *Rhipidomella oblata* (r), *Tentaculites elongatus* (rr)	40.0	75.0
Thickness of Becraft member	127.0	
New Scotland Member		
Light gray limestone with very numerous layers of light colored almost white chert at the bottom. Blacker near the top. *Spirifer macropleurus* (a), *Meristella arcuata* (c), *Strophonella punctulifera* (r), *Leptæna rhomboidalis* (a)	25.0	35.0
Thickness of New Scotland member	25.0	
Coeymans Member		
Light gray almost quartzitic sandstone, crinoid stems	10.0	10.0
Thickness of Coeymans member	10.0	

The Becraft member is well developed and sharply defined both lithologically and paleontologically. It is at least 87 feet thick and it may possibly be over 100 feet, and much thicker than it is in the typical New York section and nearer to that of the Port Jervis, New York, section.[1]

The New Scotland member is about 25 feet thick and contains much white chert. The Coeymans member is an almost white qaurtzitic sandstone, a feature not known in the Helderberg of Maryland west of this point. This pure sandstone is probably caused by the carrying away by

[1] Barrett, S. T. Ann. N. Y. Lyceum Nat. Hist., vol. xi, 1876, pp. 290-299.

infiltrating waters of the calcareous cementing material and its replacement by a siliceous cement. This sandstone was long believed to be Oriskany and mapped as such. Later it was considered New Scotland by Rowe[1] and Ulrich and Stose.[2] It has more recently been shown to be of Coeymans age by Swartz who found a characteristic Coeymans fauna in it. The following fossils were collected on the road crossing the crest of Elbow Ridge just south of the Maryland-Pennsylvania line: *Gypidula coeymanensis* (a), *Leptæna rhomboidalis* (a), *Strophonella punctifera, Rhipidomella oblata ?, Dalmanella* sp., *Pleurodictyum lenticulare, Favosites helderbergiæ.* It is interesting to note that a thin sandstone occurs near the base of the Coeymans at a number of localities west of Cumberland, a feature best seen at Dawson.

IX. Section at Ernstville

At Ernstville opposite Cherry Run, about one-half mile north of the canal, is an abandoned quarry in which the upper part of the Helderberg and the Oriskany are shown. There is a broad, low anticline which strikes across the river at this place appearing along the Baltimore and Ohio Railroad on the south side of the Potomac, a short distance west of Cherry Run. It then disappears rapidly beneath the younger rocks to the southward. The section is as follows, according to the measurements of R. B. Rowe:

HELDERBERG FORMATION

Becraft Member	Vertical thickness feet	Total vertical thickness
Light gray massive limestone with many chert bands. Fossiliferous. *Spirifer concinnus* (rr), *Rensselæria subglobosa* (r), *Schuchertella woolworthana* (aa), *Rhipidomella oblata* (a)....	20.0	42.0
Dark bluish-gray massive limestone with occasional layers of black shale. Limestone layers are about 4 feet thick with shale beds between. Very fossiliferous. In massive layers and nodules of chert are *Spirifer cyclopterus* (aa), *S. perlamellosus* (r), *Nucleospira ventricosa* (c), *Uncinulus vellicatus* (a), *Eatonia singularis* (rr), *Plethorhyncha præspeciosa* (r), *Leptæna rhomboidalis* (a), *Rhipidomella oblata* (r), *Edriocrinus pocilliformis* (aa), *Streptelasma strictum* (r), *Aulopora schohariæ*	22.0	22.0
Thickness of Becraft member exposed......................	42.0	

[1] Lower Devonian of Maryland. Dissertation for degree of Doctor of Philosophy in the Johns Hopkins University.

[2] Pawpaw-Hancock Folio, U. S. Geol. Survey, 1912.

In the quarry and on the talus slopes above are blocks of chert with Oriskany fossils, large blocks of conglomeratic sandstone that must have come from the top of the Oriskany, and some boulders of limestone with Oriskany fossils.

There is scarcely room for more than 25 feet of Oriskany here. None is seen in place and the Romney shale occurs in such proximity that the Oriskany cannot be very thick.

X. Section at Cherry Run, West Virginia

A much greater section of the Lower Devonian is exposed on the south side of the river on the Baltimore and Ohio Railroad about ¾ of a mile west of Cherry Run. Here the river and railroad have both tended to strip the rocks of their covering. The most conspicuous part of this section is its lower member which forms a cliff 40 to 60 feet high, directly along the railroad track. The fossils are not plentiful and are difficult to obtain. The following section was measured by Charles Schuchert.

ORISKANY FORMATION	Vertical thickness feet	Total vertical thickness
Light gray limestone. *Spirifer arenosus* (c), *S. murchisoni* (aa), *Anoplotheca flabellites* (aa), *Rensselæria marylandica* (r)	10.0	160.0
HELDERBERG FORMATION		
Becraft Member		
Dark blue arenaceous limestone with lumps of black chert. The fauna is most abundant in the upper half. *Rensselæria subglobosa, Anoplotheca flabellites, Spirifer cyclopterus, S. concinnus, Cyrtina rostrata, Eatonia medialis, E. peculiaris* (r), *Uncinulus vellicatus, Rhipidomella assimilis*	85.0	150.0
Thickness of Becraft member	85.0	
New Scotland Member		
Gray heavy bedded limestone with chert. Mostly covered....	50.0	65.0
Light gray cherty limestone. *Spirifer macropleurus* (aa), *S. cyclopterus* (aa), *S. perlamellosus* (a), *Trematospira equistriata* (rr), *Anoplotheca concava* (r), *A. flabellites* (r), *Rhipidomella oblata* (r), *Dalmanella perelegans* (r), *D. eminens* (r), *Streptelasma* (?), *Atrypina imbricata* (rr), *Eatonia singularis* (?), *Leptæna rhomboidalis* (r), *Uncinulus vellicatus* (c), *Camarotœchia altiplicata* (r)	15.0	....
Thickness of New Scotland member exposed	65.0	

Hindia sphæroidalis, Streptelasma strictum, Favosites conicus, Striatopora bella, Aulopora schucherti were found in the New Scotland in the woods south of the cut.

In the North Mountain at the eastern end of the cut on the Baltimore and Ohio Railroad at the watchman's hut is a limited but good exposure of the Becraft member of the Helderberg formation. About 15 feet are exposed. To the west of this section the Romney shale is seen. The limestone is light gray and the siliceous fossils weather out and are found in the dirt under the cliff. The following species were secured here: *Favosites conicus, Spirifer concinnus* (r), *S. cyclopterus* (r), *S. perlamellosus* (rr), *Nucleospira elegans* (rr), *N. ventricosa* (rr), *Meristella arcuata* (rr), *Eatonia peculiaris* (c), *Uncinulus abruptus* (rr), *U. vellicatus* (r), *Rhipidomella assimilis* (aa), *Edriocrinus pocilliformis* (rr), *Favosites conicus* (a).

SECTIONS OF ORISKANY FORMATION

The following sections[1] show the characteristic features of the Oriskany. They are considered in the order of their geographic occurrence from the west to the east.

I. Section at Monster Rock

At Monster Rock opposite Keyser is an overturned fold exposed in the cut of the West Virginia Central Railroad. The first bed of the section lies to the west, with the second and third above it in regular order. This condition, however, is soon altered for the older rocks rapidly bend over to the eastward and resume their normal position. The thickness of the Oriskany here appears low in comparison with that at 21st Bridge where the opportunity of measuring it is better. The disturbance at the Oriskany-Romney contact may account for this. The section is as follows according to the measurements of R. B. Rowe:

	Vertical thickness feet	Total vertical thickness
ROMNEY FORMATION		
Onondaga Member		
Fine black shale. Oriskany-Romney contact at base.		

[1] Contributed by R. B. Rowe, Charles Schuchert, and C. K. Swartz.

ORISKANY FORMATION

Ridgely Sandstone Member	Vertical thickness feet	Total vertical thickness
Light gray quartzitic sandstone dipping from 60° to 67° to the eastward. There is considerable disturbance at the Oriskany-Romney contact but the thickness cannot be less than 210 feet. *Spirifer arenosus* (r)	210.0	277.0

Shriver Chert Member

Black nodular chert with gray shale partings. *Anoplotheca flabellites* (r), *Spirifer tribulis* (rr), *Meristella lentiformis* ? (r), *Chonetes hudsonicus* (r)	67.0	67.0

II. Section at 21st Bridge

On the West Virginia side of the Potomac River at 21st Bridge, the Baltimore and Ohio Railroad cuts across an anticline of Oriskany giving an exposure from the New Scotland member of the Helderberg to the very top of the Oriskany. The exposure is clean cut and complete, showing the contact between the Helderberg and the Oriskany. Of the latter there are few better exposures in Maryland. At the west side of the cut near the bridge the rocks lie quite horizontal and gradually dip as one goes away from the bridge until the top of the Oriskany lies at a very high angle. The section as worked out by Schuchert and Rowe is as follows:

ORISKANY FORMATION

Ridgely Sandstone Member	Vertical thickness feet	Total vertical thickness
Heavy-bedded arenaceous limestone, gradually changing downward into a black chert or siliceous shale. In the lowest beds are found *Spirifer cumberlandiæ*, *S. concinnoideus*, and *Eatonia sinuata*. Fossils, however, are rare until 100 feet above the base of this division, where the characterizing Hipparionyx fauna attains greater individual and specific representation, culminating in the upper 100 feet	258.0	328.0

Shriver Chert Member

Bedded and nodular chert and siliceous shale, with a sparse fauna distinct from the Hipparionyx fauna above and from the Helderbergian below. Near the base are found *Anoplotheca flabellites* (aa), *Stropheodonta arctimuscula* (r), and Ostracoda. Just below the middle occur *Anoplotheca flabellites* (c), *Spirifer tribulis* (c), *S. paucicostatus*, *Beachia suessana* var. *immatura*, *Anoplia nucleata*, *Pholidops multilamellosa*, *Tentaculites aculus* and *Diaphorostoma desmatum*. Near the top is an abundance of ostracoda and some *Chonetes hudsonicus*	90.0	90.0

HELDERBERG FORMATION

New Scotland Member

Cherty limestone.

In a cut on the Georges Creek and Cumberland Railroad, just east of Winchester Road Station, the black chert beds of the Shriver Chert member of the Oriskany are exposed. The chief features of this exposure are the weathered condition in which the chert is found and the ease with which the fossils may be obtained from it. It is the best locality for Lower Oriskany fossils in this region. The chert is found at the east end of the cut, weathered into arenaceous beds which are highly colored, alternating in thin bands of various shades of brownish-red and pink. It is said that when the cut was first made these colors appeared on the surface. Now one generally has to break a fresh surface to see them. Not a great deal of the section is shown here and the fossils are best obtained from the loose blocks in the cut.

The fauna consists of: *Pholidops tumida* (aa), *Chonetes hudsonius* (aa), *Anoplia nucleata* (r), *Beachia suessana* var. *immatura* (r), *Spirifer tribulis* (a), *S. tribularius* (r), *Anoplotheca flabellites* (aa), *Meristella lentiformis* (rr), *Tentaculites acus* (rr), *T. elongatus* (rr), *Platyceras* small species, ostracods and a fish spine.

A few yards to the west of the exposure of the Helderberg at Cash Valley near Cumberland the black chert of the Shriver Chert member is taken out for road metal. It is weathered to a yellowish or brownish mixture of clay and sand. This is one of the best places to secure the fossils of this member, but the specimens and species are few in number. They include: *Pholidops multilamellosa, Chonetes hudsonicus, Beachia suessana* var. *immatura, Spirifer paucicostatus, S. tribulis, S. tribuarius, Anoplotheca flabellites* (c), and *Tentaculites acus.*

III. Section at Devil's Backbone

The remarkable section of the Helderberg at the Devil's Backbone has been described on preceding pages. An excellent exposure of the Oriskany is also to be seen at this place. The section is as follows, according to the measurements of Schuchert:

ORISKANY FORMATION

Ridgely Sandstone Member	Vertical thickness feet	Total vertical thickness
Chiefly dark gray, massive, arenaceous limestone. In the upper portion *Anoplotheca flabellites* (aa), *Spirifer arenosus* (a), *S. murchisoni* (a), *Stropheodonta magnifica* (a), and *Hipparionyx proximus* (a) occur. In the lower portion *Spirifer intermedius* (aa), *S. cumberlandiæ* (aa), *Anoplotheca flabellites* (aa), *A. fimbriata* (a), *Chonostrophia complanata* (rr), and *Anoplia nucleata* (c)	130.0	246.0
Shriver Chert Member		
Bluish-black cherty to dark gray arenaceous limestones, heavy-bedded above, passing below into thinner beds. In the upper portion *Spirifer tribulis* (r), *S. paucicostatus* (r), *Anoplotheca flabellites* (aa) occur. In the lower portion *Anoplotheca flabellites* (a) occurs	116.0	116.0

IV. Sections near Ridgely

At Miller's Station, about 1 mile south of Ridgely Station, on the West Virginia Central Railroad, there is a considerable talus from the Oriskany cliffs above. The rock has disintegrated and many fossils can be collected, especially the strophemenoid shells that are very scarce at the other Oriskany collecting grounds. Some blocks of the Helderberg also are in the talus slope, but they can be easily distinguished. The following species were obtained from the Ridgely member of the Oriskany: *Spirifer arenosus* (aa), *S. cumberlandiæ* (r), *S. angularis* (a), *Meristella lata* (rr), *Rensselæria marylandica* (r), *Beachia suessana* (aa), *Anoplotheca flabellites* (c), *A. fimbriata* (r), *Eatonia pecularis* (r), *Plethorhyncha speciosa* (r), *Leptæna rhomboidalis* (r), *Stropheodonta magnifica* (c), *S. magniventra* (r), *Chonostrophia complanata* (c), *Chonetes rowei* (r), *Dalmanella planiconvexa* (r), *Orbiculoidea ampla* (rr), *Megambonia lamellosa* (rr), *Megambonia* sp. (rr), *Avicula recticosta* (rr), *A. textilis* var. *arenaria* (r), *A. textilis* (?) (r), *Platyceras magnificum* (c), *Diaphorostoma ventricosum* (c), *Homalonotus major* (rr), *H. vanuxemi* (rr).

Ridgely at the north end of Knobly Mountain is perhaps the most satisfactory collecting ground for Oriskany fossils about Cumberland. At this point 50 or 75 feet of the upper part of the Oriskany is exposed. On the right side of the railroad track before one reaches the railroad station, in a low bank from 5 to 10 feet high, fossils can be seen in considerable numbers and many perfect ones may be obtained.

On the left side of the wagon road, just a few feet beyond the railroad station, is a bank 20 feet or more high from which large collections have been obtained. The formation here dips quite sharply to the eastward and is apparently disintegrated throughout. It contains softer portions parallel to the bedding, usually of small extent, but at times attaining considerable dimensions, that are locally known as "sand-pockets." It is from these that the beautiful specimens of the region are obtained.

A few yards south of Ridgely the West Virginia Central Railroad has begun a cut through the ridge which has been left unfinished. The sand-pockets in this are numerous, sometimes containing fossils and sometimes being perfectly barren. The fossils are very fragile with the tests thoroughly silicified. The extensive weathering which the Oriskany has undergone can be well seen here. In the center of the cut the beds are massive and very calcareous. As they approach the surface on both sides of the ridge they become porous, brown, poorly cemented sandstones.

The northern end of Knobly Mountain gives the following species obtained in the Ridgely member of the Oriskany: *Spirifer arenosus* (aa), *S. murchisoni* (a), *S. gordoni* (r), *S. cumberlandiæ* (r), *S. tribulis* (r), *S. intermedius* (a), *S. perdewi* (r), *Metaplasia pyxidata* (r), *M. lentiformis* (rr), *Anoplotheca flabellites* (c), *A. fimbriata* (r), *Rensselaeria marylandica* (r), *Beachia suessana* (r), *B. cumberlandiæ* (r), *B. ovalis* (rr), *Oriskania lucerna* (r), *Eatonia peculiaris* (aa), *E. sinuata* (r), *Plethorhyncha speciosa* (a), *P. barrandii* (rr), *P. pleiopleura ?* (rr), *Rhynchotreta cumberlandica* (rr), *Camarotœchia oriskania* (rr), *Hipparionyx proximus* (rr) *Stropheodonta magnifica* (r), *S. becki* (rr), *Schizophoria oriskania* (r), *Rhipidomella musculosa* (aa), *Dalmanella planiconvexa* (r), *Anomalocystites disparilis* (r), *Tentaculites arenosus* (rr), *Platyceras gebhardi* (aa), *P. ventricosum* (aa), *P. magnificum* (c), *P. tortuosum* (c), *P. reflexum* (r), *P. subconicum* (c), *Diaphorostoma ventricosum* (c), *Cyrtolites* (?) *expansus* (rr), *Dalmanites* sp. (rr), *Favosites conicus* (rr), *Edriocrinus sacculus* (aa) *Technocrinus spinulosus* (rr), *T. andrewsi* (r), *T. striatus* (rr), *T. sculptus* (r).

About a mile to a mile and a half south of Ridgely on the road east of Knobly Mountain, the road-bed dips below three or four layers of the uppermost beds and at some places exposes upwards of 10 feet of soft, dark yellow sandstone. At the base on the right side of the road is a trilobite bed where numerous fine but friable specimens of *Dalmanites multiannulatus* have been gathered. Still farther south along the road the Oriskany-Romney contact and several feet of black shales are seen. The following fossils were obtained in the Oriskany at this place: *Spirifer murchisoni* (r), *Cyrtina rostrata* (r), *Orbiculoidea ampla* (rr), and *Dalmanites multiannulatus* (aa).

V. Section on Williams Road East of Cumberland

About 3½ miles east of Cumberland on the Williams Road an excellent section of the Devonian is exposed embracing the strata from the Oriskany to the Parkhead member of the Jennings formation. The fossils are not abundant in the Oriskany and the species were all collected from the upper 16 feet. The rock is a coarse gray sandstone sometimes gritty and sometimes calcareous. The contact between the Oriskany and the Romney is here splendidly shown, much better than at Monster Rock and quite as well as at the iron bridge over Licking Creek below Warren Point, Pennsylvania. The section of the Oriskany of this place is as follows:[1]

	Vertical thickness feet	Total vertical thickness
ROMNEY FORMATION		
Onondaga Member		
Black shales broken into very thin pieces.		
ORISKANY FORMATION		
Ridgely Sandstone Member		
Coarse sandstone sometimes gritty and sometimes calcareous containing *Spirifer arenosus* (r), *S. tribulis* (c), *Metaplasia pyxidata* (a), *Cyrtina rostrata* (r), *Anoplotheca flabellites* (r), *Meristella lata* (r), *Rensselæria marylandica* (r), *Beachia suessana* (r), *Plethorhyncha speciosa* (r), *Chonetes hudsonicus* (r), *Anoplia nucleata* (r), *Rhipidomella musculosa* (r), *R. marylandica* (r), *Dalmanella planiconvexa* (aa), *Schuchertella becraftensis*, *Diaphorostoma ventricosum* (rr), *Cyrtolites expansus* (rr)	40.0	40.0
Concealed.		

[1] Measured by R. B. Rowe.

VI. Section at North Branch

The black chert beds of the Shriver Chert member of the Oriskany with a portion of the arenaceous Ridgely member above them are exposed at the south end of Nicolas Mountain on the Oldtown Road about 1 mile east of North Branch Station. The exposure is not complete enough to give either the top of the Helderberg or the Oriskany-Romney contact. This and the Winchester Road exposures are among the best for fossils of the Shriver Chert member. The rocks are in the center of an anticline which is more plainly shown on the south side of the river.

ORISKANY FORMATION

Shriver Chert Member	Vertical thickness feet	Total vertical thickness
Light gray sandstone with much black chert in nodules and thin layers. *Spirifer murchisoni* (aa), *S. arenosus* (a), *Metaplasia pyxidata* (aa), *Anoplotheca flabellites* (aa), *A. fimbriata* (r), *A. dichtoma* (c), *Meristella lentiformis* (r) ?, *Schuchertella becraftensis* (rr), *Chonetes hudsonicus* (rr), *Orbiculoidea ampla* (rr), *Lingulapholis terminalis* (c)	100.0	185.0
Black or blue chert in nodular and lenticular masses with considerable arenaceous material. *Spirifer tribulis* (a), *S. arenosus* (?), *Meristella lentiformis* (aa), *Anoplotheca flabellites* (aa), *Anoplia nucleata* (r), *Eatonia medialis* (r)	10.0	85.0
Black or blue-black chert in nodular and lenticular masses containing *Spirifer tribulis* (aa), *S. paucicostatus* (r), *Meristella lentiformis* (rr), *Stropheodonta arctimuscula* (r)........	75.0	75.0
Thickness of Shriver Chert member........................	185.0	

VII. Section near Collier's Run

On the east side of Nicolas Mountain, about 300 yards above the Romney-Oriskany contact near Collier's Run on Williams Road, is an excellent place for collecting Oriskany fossils. The following fossils were obtained here: *Spirifer arenosus* (a), *S. intermedius* (r), *S. cumberlandiæ* (a), *S. tribulis* (rr), *Metaplasia pyxidata* (a), *Anoplotheca flabellites* (a), *A. fimbriata* (r), *Rensselæria marylandica* (a), *Beachia suessana* (c), *Plethorhyncha speciosa* (c), *P. pleiopleura* (r), *Eatonia peculiaris* (aa), *E. sinuata* (rr), *Stropheodonta magnifica* (r), *Rhipidomella musculosa* (a), *Platyceras gebhardi* (a), *P. ventricosum* (a), *P. nodosum* (c).

VIII. Section at Tonoloway

The Oriskany sandstone is well exposed in the cut of the Western Maryland Railroad at Tonoloway, opposite Great Cacapon, West Virginia. The following section was measured by G. W. Stose and E. O. Ulrich.[1]

	Vertical thickness feet	Total vertical thickness
ROMNEY FORMATION		
Onondaga Member		
Black and drab shale.		
ORISKANY FORMATION		
Ridgely Member		
Soft, porous, brown fossiliferous sandstone, some beds a fine dark vitreous quartz conglomerate. Very fossiliferous layer at base	40.0	417.0
Massive beds, 10-20 feet thick, of white fossiliferous quartzose sandstone	85.0	377.0
Softer, thinner-bedded, fossiliferous sandstone, weathering yellowish	90.0	292.0
Hard, quartzose sandstone	2.0	202.0
Soft, thin-bedded, yellowish sandstone. Few fossils	45.0	200.0
Covered. Soft sandstone débris	140.0	155.0
Thickness of Ridgely member	412.0	
Shriver Chert Member		
Yellow, probably calcareous, fossiliferous shale with much chert, containing Oriskany fossils	15.0	15.0
Thickness of Oriskany	417.0	
HELDERBERG FORMATION		
New Scotland Member		
Residual clay often limestone filled with white blocky chert. Fossiliferous	12.0	....

The thickness of the Oriskany at this locality is greater than that observed elsewhere in Maryland. The usual thickness in the Cumberland area is about 350 feet, while on Elbow Ridge, but 15 miles northeast of this place, it is but 52 feet thick. The beds also change from a calcareous sandstone near Hancock to an arenaceous limestone in the eastern section.

[1] Pawpaw-Hancock Folio, U. S. Geol. Survey, 1912, p. 9.

IX. Section at Hancock

About 1½ miles west of Hancock Station, on the West Virginia side of the Potomac, is the Hancock White Sand Works. Here the Oriskany is a pure white sandstone, sometimes a little gritty. At its most extensive outcrop, known locally as "Lovers Leap," about 130 feet is exposed, the remainder being covered by talus. Some of these sandstone beds are very fossiliferous while others are comparatively barren.

Beautiful white casts of the following fossils were obtained here: *Spirifer arenosus* (aa), *S. murchisoni* (rr), *S. intermedius* (rr), *Rensselæria marylandica* (aa), *Beachia suessana* (r), *Eatonia peculiaris* (rr), *Plethorhyncha barrandii* (rr), *Diaphorostoma ventricosum* (aa), *Platyceras magnificum* (c), *P. tortuosum* (r), *Megambonia lamellosa* (r), *Homalonotus* sp. (rr), *Megistocrinus* sp. (c).

The origin of these glass-sand pockets in the Oriskany, of which this is an especially large one, is a matter of interest. The rock is almost pure silica and must have been thoroughly washed at the time of the deposition or by infiltrating waters which have carried away the iron and other impurities found in the Oriskany elsewhere. It may also be a combination of both methods. Certainly in this region the wave-work must have cleaned the sand to some extent for it is a very white and pure sandstone over a considerable area, *i. e.,* as far west as Tonoloway Hill. Since, however, that portion fit for glass sand is only found in pockets and limited lenses and is much softer than the rest, it seems probable that the percolating waters carried away the calcareous cementing material and such other impurities as exist in the rock surrounding these pockets and lenses.

X, Section at Warren Point, Pennsylvania

Both the Helderberg and Oriskany are exposed at this place. Under the south end of the iron bridge over Licking Creek the following short section is shown with the Oriskany-Romney contact.[1]

	Vertical thickness feet	Total vertical thickness
ROMNEY FORMATION		
Onondaga Member		
Black and gray argillaceous and arenaceous shales with a basal conglomerate. *Ambocœlia umbonata* (r), *Rhipidomella cyclas* ? (r), *Styliolina fissurella* (a), *Phacops rana* (r).		

[1] Measured by R. B. Rowe.

ORISKANY FORMATION	Vertical thickness feet	Total vertical thickness
Dark blue arenaceous limestone with bands of fine conglomerate or grit. These bands are sometimes several inches in thickness and consist of coarse sand with calcareous cement. At the top are 5 or 6 inches of coarse heavy conglomerate, with large smooth quartz pebbles. *Rensselœria marylandica* (r), *Spirifer murchisoni* (r), *Plethorhyncha barrandei* (r).........	13.0	18.0
Dark blue limestone with layers of black chert..............	5.0	5.0
Covered.		
Thickness of Oriskany formation exposed..................	18.0	

This is the best exposure of the Oriskany-Romney contact to be seen in this region, and adds considerable to the evidence we already have of a temporary land area at the close of the Oriskany. The conglomerate at the top of the Oriskany was formed when the land was rising and the basal conglomerate at the bottom of the Romney was formed while the land was sinking at the beginning of Romney deposition. The upper conglomerate of the Oriskany was only partially destroyed by erosion during its emergence and pebbles derived from this upper conglomerate are found for several feet in the base of the Romney.

On the north side of the creek about one-quarter of a mile east of the north end of the bridge the same succession is shown in several small abandoned quarries. The section[1] there is as follows:

ROMNEY FORMATION *Onondaga Member*	Vertical thickness feet	Total vertical thickness
Black and gray argillaceous shale.		
Covered.		
Massive coarse conglomerate with large pebbles. Base of the Romney	0.5	65.0
ORISKANY FORMATION		
Massive coarse conglomerate, with large smoothly worn quartz pebbles, containing Oriskany fossils..................	1.5	64.5
Massive light gray limestone with bands of conglomerate or grit near bottom. Conglomerate bands are several inches in thickness and consist of small pebbles and coarse sand. *Spirifer arenosus* (r), *S. murchisoni* (c), *Meristella lata* (aa), *M.*		

[1] Measured by R. B. Rowe.

	Vertical thickness feet	Total vertical thickness
gigantea (a), *Rensselæria marylandica* (c), *Beachia ovalis* (rr), *Stropheodonta magnifica* (rr), *Leptæna rhomboidalis* var. *ventricosa* (r), *Chonostrophia complanata* (rr), *Dalmanella planiconvexa*, *Lingulapholis terminalis* (rr), *Avicula textilis arenaria* (rr), *A. gebhardi* (rr), *Diaphorostoma ventricosum* (rr), *Platyceras nodosum* (r), *P.* cf. *gebhardi* (a)	12.0	63.0
Covered	10.0	51.0
Light gray massive arenaceous limestone	8.0	41.0
Covered	2.0	33.0
Heavy dark gray limestone with conglomeratic bands at top. Bands four or five inches thick consisting of small quartz pebbles and coarse sand. *Diaphorostoma ventricosum* (rr)	10.0	31.0
Covered	6.0	21.0
Conglomeratic dark gray limestones. Fine pebbles and coarse sand throughout this limestone	3.0	15.0
Total thickness of Oriskany formation	52.5	

HELDERBERG FORMATION

Becraft Member

Light gray massive limestone. *Spirifer concinnus* (aa), *S. cyclopterus* ? (r), *Meristella arcuata* (c), *Schuchertella woolworthana* (rr)	12.0	12.0

The Oriskany consists of about 52 feet of limestone with scattered beds of coarse sand and also some layers of black chert. This is in very strong contrast with the Oriskany exposed at Hancock, only a short distance farther west, where it is almost pure silica throughout. The conglomerate at the base of the Romney is much heavier than that in the same position on the south side of the creek.

SYSTEMATIC PALEONTOLOGY

OF

THE LOWER DEVONIAN DEPOSITS OF MARYLAND

BY

R. S. BASSLER, T. P. MAYNARD, D. W. OHERN,
CHARLES SCHUCHERT, C. K. SWARTZ,
AND E. O. ULRICH

SYSTEMATIC PALEONTOLOGY

LOWER DEVONIAN

COELENTERATA .... C. K. SWARTZ.

ECHINODERMATA.

CYSTOIDEA .... CHARLES SCHUCHERT.

CRINOIDEA .... D. W. OHERN.

VERMES .... D. W. OHERN.

MOLLUSCOIDEA.

BRYOZOA .... E. O. ULRICH AND R. S. BASSLER.

BRACHIOPODA ..... CHARLES SCHUCHERT AND T. P. MAYNARD.

MOLLUSCA.

PELECYPODA .... D. W. OHERN AND T. P. MAYNARD.

GASTROPODA .... D. W. OHERN AND T. P. MAYNARD.

CEPHALOPODA .... D. W. OHERN AND T. P. MAYNARD.

ARTHROPODA.

TRILOBITA .... D. W. OHERN AND T. P. MAYNARD.

OSTRACODA .... E. O. ULRICH AND R. S. BASSLER.

COELENTERATA

Subbranch PORIFERA

Class SPONGIAE

Subclass SILICISPONGIAE

Order LITHISTIDA

Suborder EUTAXICLADINA

Genus HINDIA Duncan

Hindia sphæroidalis Duncan

Plate XVII, Figs. 1-4

Calamopora fibrosa Roemer, 1860, Sil. Fauna des Westl. Tenn., p. 20, pl. ii, fig. 2 (non Goldfuss).
Monticulipora petropolitana F. Roemer, 1861, Die foss. Fauna d. Sil. u. Diluvial-Geschiebe von Sadewitz.
Astylospongia inornata Hall, 1863, 16th Rept. N. Y. State Cab. Nat. Hist., p. 70.
Sphærolithes nicholsoni Hinde, 1875, Abstract Proc. Geol. Soc., No. 305, p. lxxxviii, in Quart. Jour. Geol. Soc., vol. xxxi.
Hindia sphæroidalis Duncan, 1879, Ann. Mag. Nat. Hist., ser. v, vol. iv, p. 84, pl. ix.
Hindia fibrosa Hinde, 1883, Cat. Foss. Sponges of Brit. Mus., p. 57, pl. xiii, fig. 1.
Hindia fibrosa F. Roemer, 1885, Lith. Errat. in Pal. Abhand., herausg. von Dames u. Kayser, vol. ii, p. 63 (310), pl. iv (27), fig. 17.
Hindia fibrosa Rauff, 1886, Sitzungsber. d. Niederrh. Gesell. für Nat. und Heilk. zu Bonn, Sitz. von Mai 10, 1886, pp. 163-172.
Favosites sp. Steinmann, 1886, Neues Jahr für Min., vol. i, Heft 1, p. 91.
Hindia fibrosa Hinde 1887, Ann. and Mag. Nat. Hist., ser. v, vol. xix, p. 75.
Hindia sphæroidalis Ulrich, 1890, Geol. Survey Ill., vol. viii, p. 226, figs. 9, 10, on p. 224.
Hindia fibrosa Girty, 1895, Rept. N. Y. State Geologist for 1894, p. 263, pl. ii, fig. 2.
Hindia fibrosa Weller, 1903, Pal. N. J., vol. iii, p. 297, pl. xxxii, figs. 1, 2.

Description.—Spherical, consisting of minute spicules uniting to form a series of delicate, straight canals which radiate from the center of the sponge and increase by bifurcation. The canals open upon the surface by polygonal orifices. The minute structure of this species was worked out

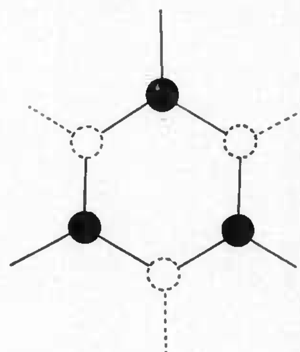

FIG. 3.—Diagram showing the manner in which spicules unite to form canals (modified from Rauff).

by Rauff[1] and subsequently discussed critically by Hinde,[2] Ulrich,[3] and Girty.[4]

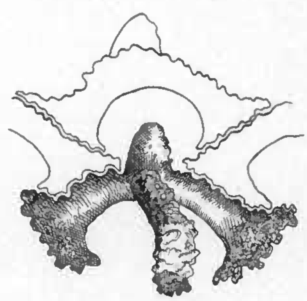

FIG. 4.—Sketch showing the interlocking spicules of Hindia fibrosa (after Rauff).

Rauff showed that it consists of spicules, each of which bears 4 rays which diverge from a common center. Three of the rays are stout, slightly

[1] Sitzungsber. der Niederrh. Gesell. in Bonn, Sitzung von Mai 10, 1886, pp. 163-172.
[2] Ann. Mag. Nat. Hist., 1887, ser. v, vol. xix, p. 75.
[3] Geol. Survey Ill., 1890, vol. viii, p. 226.
[4] 14th Ann. Rept. N. Y. State Geol. for 1894, p. 263.

curved, concave on the inner side, denticulate on the outer side, and have expanded denticulate extremities. The fourth ray is small and directed towards the exterior. It is often abortive. The whole structure consists of superimposed series of these spicules. The manner in which they unite to form the canals is illustrated diagrammatically in fig. 3. Three spicules, whose centers form the angles of the cell, lie on one level while three alternating spicules, whose centers are dotted in the diagram, lie at a slightly higher level in the structure, their rays descending obliquely upon

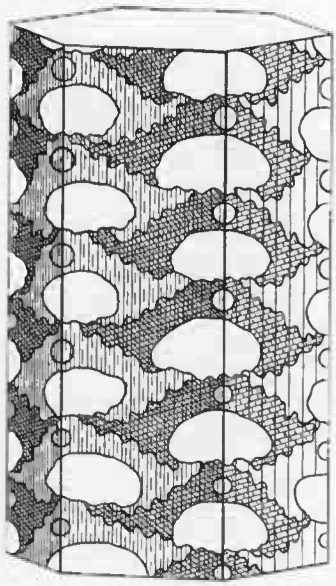

FIG. 5.—Diagram showing the spicules of Hindia fibrosa uniting to form a hexagonal canal (after Rauff).

the rays of the first set, the third layer repeating the first, etc. In this manner walls are built up around the canals which are perforated by openings, placing the interior of the adjacent canals in communication. The form of an individual spicule and the manner in which it articulates with its neighbors is shown in fig. 4 while the manner in which they unite to form the walls of the canal is shown in fig. 5.[1] Excellently preserved specimens showing the inner structure are found at Keyser, West Virginia.

[1] Both figs. 4 and 5 are after Rauff, Sitzber. d. Niederrh. Gesell. in Bonn, Sitz. von Mai, 1886, pp. 165, 167, who drew them in an inverted position in original paper. Fig. 3 is modified from Rauff, fig. 3, p. 169.

The position of the genus has been much discussed. Steinmann regarded it as a form of Favosites. Rauff determined its true character, showing that it is a sponge and regarded it as one of the siliceous sponges.

Diameter of spheres, 25 mm. or at times a little greater. They are frequently somewhat distorted by compression.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. In Tentaculite subzone at Keyser, West Virginia; Cash Valley, Maryland. NEW SCOTLAND MEMBER. 21st Bridge; Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

Subbranch CNIDARIA

CLASS ANTHOZOA[1]

Subclass TETRACOROLLA

Family ZAPHRENTIDAE

Genus STREPTELASMA Hall

STREPTELASMA STRICTUM Hall

Plate XVII, Figs. 5-9

Streptelasma (Petraria) stricta Hall, 1874, 26th Rept. N. Y. State Mus. Nat. Hist., p. 114.

Streptelasma stricta Hall, 1879, 32d Rept. N. Y. State Mus. Nat. Hist., p. 142.

Streptelasma strictum Hall, 1887, Pal. N. Y., vol. vi, p. 1, pl. i, figs. 1-10.

Streptelasma strictum Girty, 1895, 48th Ann. Rept. N. Y. State Mus., 1894, vol. ii, p. 300.

Description.—" Corallum simple, conical, very gradually and regularly enlarging; straight or very slightly curved, except at the apex, which is sometimes more abruptly bent. Exterior marked with strong undulations of growth and numerous fine concentric striæ; external rays very prominent, from forty-five to fifty at a point where the diameter of the corallum is 15 mm.; the increase in number taking place usually at three distinct points, but sometimes at only two.

[1] The study of the Lower Devonian corals of Maryland is based on material which in some species was not well preserved or was inadequate in amount to secure assured results in organisms of such difficulty. C. K. S.

"Calyx deep, sides thin and nearly erect; a flat space at the bottom. In one calyx, having a diameter of 20 mm., there are fifty-four lamellæ; alternate lamellæ extending only a short distance from the walls at the base of the calyx and frequently coalescing with the primary lamellæ. For some distance below the calyx-margin the lamellæ are of the same size, their edges smooth and rounded, becoming sharp below, and their sides often distinctly granulose or spinulose. The primary lamellæ unite and coalesce at the center of the calyx, forming an indistinct plate or vesiculose core from 3 to 5 mm. in diameter. Fossette obscure or obsolete. This species is distinguished by the usually rigid straightness of its form, and the strongly ribbed exterior." Hall, 1887.

Length, 25 mm.; diameter of calyx, 16 mm.

The specimens observed agree fully with those described by Hall from New York.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Maryland. Abundant at Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

STREPTELASMA CUMBERLANDICA n. sp.

Plate XVIII, Figs. 1, 2

Description.—Corallum simple, conical, curved, enlarging regularly in diameter from apex to calyx. Annulated by shallow constrictions, striated longitudinally by septal furrows. Calyx not observed. Septa about 130 in number, alternating in length. Some of primary septa unite in center to form a pseudo-columella. Secondaries varying in length, their average length nearly half that of primaries. Tabulæ present but apparently few.

Length, 75 mm.; diameter of calyx, 50 mm.

Two specimens have been observed which appear distinct from any previously described species. The smaller of these is much less curved than the specimen figured.

Occurrence.—HELDERBERG FORMATION. Near Cumberland, the precise locality and horizon being unknown.

Collection.—Maryland Geological Survey.

Genus ZAPHRENTIS Rafinesque

ZAPHRENTIS RŒMERI Milne-Edwards and Haime

Plate XVIII, Figs. 3-7

Zaphrentis rœmeri Milne-Edwards and Haime, 1851, Polypiers Fossiles des Terr. Pal., p. 341.

Zaphrentis rœmeri Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. i, figs. 1-21.

Zaphrentis rœmeri Hall, 1887, Pal. N. Y., vol. vi, p. 2, pl. i, figs. 11, 12.

Zaphrentis rœmeri ? Weller, 1903, Pal. N. J., vol. iii, p. 270.

Description.—Corallite simple, conical, curved near apex, gradually enlarging from apex to calyx. Annulated by strong constrictions between which are fine transverse striæ; very distinctly striated longitudinally by furrows marking extremities of septa. Increasing by calicular gemmation, a smaller calyx arising from the center, or side, of the old in such a manner as to produce projecting sharp-edged annulations formed by the edges of old calyx.

Theca formed by the fusion of ends of septa. Calyx often very irregular in shape due to method of reproduction, deep, its sides erect or spreading. Septa alternately long and short, usually not extending fully to center, irregularly spaced and variously bent, about 60 to 65 in individual, 22 to 25 mm. in diameter. Fossula not very distinct. In cross-section primary septa vary in length, usually falling short of center, secondary septa much shorter, their length variable. Septa irregularly curved. Tabulæ numerous, close. In many individuals the tabulæ appear few and distant, probably due to poor preservation, although it may be varietal.

Length, 45 mm.; diameter of calyx, 20 mm.

The exact stratigraphic position of the Maryland Helderberg material is not assured.

Occurrence.—HELDERBERG FORMATION. Cumberland; Devil's Backbone; Knobly Mountain 6 miles south of Cumberland; Martin Mountain. ORISKANY FORMATION, RIDGELY MEMBER. Near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Zaphrentis keyserensis n. sp.

Plate XIX, Figs. 1-4

Description.—Corallite simple, conical, slightly curved, diameter increasing slowly near apex, more rapidly above this point for a short distance and then slowly towards calyx. Exterior annulated by pronounced constrictions placed at irregular distances; striated longitudinally by septal furrows. Calyx not observed. Primary septa 35 to 40 in specimen 25 to 30 mm. in diameter, most of which do not reach center. A few rudimentary septa are present, alternating with the primary. Tabulæ numerous, close.

Diameter of largest individual observed, 30 mm.; length, 80 mm.

This species approaches *Z. rœmeri.* It differs in attaining a much larger size, in being scarcely curved, and in its less conspicuous secondary septa.

Occurrence.—Helderberg Formation, Keyser Member. Keyser, West Virginia, in *Favosites helderbergiæ* var. *præcedens zone.*

Collection.—Maryland Geological Survey.

Family CYATHOPHYLLIDAE

Genus CYATHOPHYLLUM Goldfuss

Cyathophyllum clarki n. sp.

Plate XIX, Figs. 5-9

Description.—Corallite simple, conical, nearly straight or slightly curved, increasing more rapidly in diameter near apex; becoming nearly cylindrical near calyx. Theca annulated by fine striæ and more remote constrictions, constrictions deep in some cases. The weathered individuals have longitudinal furrows which mark position of septa.

Calyx not quite as deep as wide, its base concave, its sides ascending or nearly erect, diameter of calyx increasing near margin. Septa about 50 to 60, primaries reaching center, secondaries not quite so long. Cross-section shows septa as regular radiating lines, primaries reaching center, secondaries a little thinner and shorter than the primaries, the space between them occupied by numerous dissepiments which become more distant towards center of corallite. Longitudinal section shows dissepiments intersecting septa so as to produce somewhat elongated vesicles. The outer vesicles are somewhat larger, their longer axes ascending obliquely towards exterior. Vesicular tissue not so well defined towards center of corallite.

Length, 30 mm.; diameter of calyx, 15 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland; Devil's Backbone; Pinto; Martin Mountain.

Collections.—Maryland Geological Survey, U. S. National Museum.

CYATHOPHYLLUM RADICULUM Rominger ?

Plate XIX, Figs. 12-17

Cyathophyllum radicula Rominger, 1876, Geol. Survey Mich., vol. iii, p. 109, pl. xxxix, fig. 3.

Description.—Simple, conical slightly curved corallite; frequently bearing root-like protusions near apex for attachment to other bodies. Exterior annulated by shallow, somewhat irregular constrictions, striated longitudinally by distinct septal furrows. Calyx moderately deep, its shape somewhat variable, in some specimens base broad, concave, sides erect, abruptly expanding at margin, in others the base smaller, sides less erect, producing a more conical opening. Septa about 40 in individuals 4 mm. in diameter, nearly equal in length, continued as low furrows upon calyx bottom to center, their edges denticulate. Inner structure not seen.

Length, 10 to 14 mm.; diameter of calyx, 2 to 8 mm.

The individuals observed are somewhat questionably referred to *C. radiculum* described by Rominger from the Niagara formation of Iowa, Michigan, and Indiana. It differs from the typical form in its somewhat smaller size and less sharply annulated theca. The resemblance is, however, very close. This species is probably a Cyathophyllum though its inner structure was not observed.

Its exact horizon is unknown. Probably Keyser member.

Occurrence.—HELDERBERG FORMATION. Near Cumberland

Collection.—Maryland Geological Survey.

Cyathophyllum oherni n. sp.

Plate XIX, Figs. 10, 11

Description.—Corallum simple, conical, slightly curved, apical angle large. Theca annulated by fine concentric lines and shallow constrictions, striated vertically by furrows which mark position of septa. Calyx conical, shallow, its depth $\frac{1}{3}$ to $\frac{2}{3}$ width, sides ascending. Septa about 65, nearly equal in length, reaching center. Cross-section shows numerous dissepiments between septa, forming vesicles. Exterior vesicles larger. Longitudinal section not observed. Increasing by calicular gemmation and fission. Two individuals only observed, which are attached by the sides due apparently to growth by fission.

Size of large individual: Diameter of calyx, 22 mm.; length, 33 mm.

This species differs from *C. clarki* in its much larger apical angle and its larger size. Its exact horizon is unknown.

Occurrence.—Helderberg Formation. Martin Mountain, Allegany County.

Collection.—Maryland Geological Survey.

Cyathophyllum schucherti n. sp.

Plate XX, Figs. 5-9

Description.—Corallum compound consisting of branching cylindrical corallites, branches ascending and diverging at acute angles. Exterior bearing distant annular constrictions between which are faint, transverse striæ; striated longitudinally by distinct septal furrows. Calyx shallow, bottom concave, sides ascending, bearing about 40 septa which alternate slightly in strength. Septa denticulate on edges, continued as ridges to center of calyx.

Cross-sections show primary septa extending to center and alternating with somewhat shorter secondary septa. Vesicles numerous between septa, becoming large toward periphery, inner vesicles smaller; vesicular tissue extending one-half distance to center, absent in central area. In longitudinal sections vesicles appear elongated, their longer diameter ascending obliquely toward exterior. Tabulæ not distinctly observed.

Diameter of large corallite about 10 mm.

The specimens are frequently invested with a deposit which appears as a dense outer tissue in which no distinct structure is visible and the nature of which is problematical. This species resembles *Diphyphyllum integumentum* which is abundant in the Decker Ferry of New Jersey. It differs, however, from that species in its inner structure and its more cylindrical corallites. Its generic position is not fully assured. It suggests Diphyphyllum but the tabulæ characteristic of that genus have not been observed. This species is abundant in the coral reef of the *Favosites helderbergiæ* var. *præcedens zone.*

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Pinto, Cash Valley, Devil's Backbone, Maryland; Hyndman, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

CYATHOPHYLLUM MARYLANDICUM n. sp.

Plate XXI, Figs. 1, 2

Description.—Corallum compound, consisting of branching cylindrical corallites. Exterior bearing distant flattened annulations, between which are faint transverse striæ; longitudinally striated by distinct septal furrows. Calyx shallow, conical, bearing about 24 subequal septa, some of which reach the center, their upper edges strongly denticulate. Cross-sections show that the septa are very thick, uniting by their outer edges to form a thick wall. Dissepiments present, not numerous, poorly preserved.

This species resembles *C. schucherti* but differs in having fewer septa and dissepiments. The intimate structure is not well preserved in the specimens observed and its generic relations are not assured. It resembles a Diphyphyllum but the tabulæ characteristic of the genus have not been observed.

Diameter of branches, 8 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—Maryland Geological Survey.

CYATHOPHYLLUM INEQUALE (Hall)

Plate XX, Figs. 1-4

Columnaria inequalis Hall, 1882, Pal. N. Y., vol. ii, p. 323, pl. lxxii, figs. 3*a*, *b*, 4*a*-4*c*.

Acervularia ? *inequalis* Hall and Whitfield, 1873, 23d Rept. N. Y. State Mus. Nat. Hist., p. 233.

Acervularia communis Simpson, 1889, Trans. Amer. Philos. Soc., vol. xvi, p. 459, and text fig.

Prismatophyllum inequalis Weller, 1903, Pal. N. J., vol. iii, p. 219, pl. xvii, figs. 12, 13.

Description.—Corallum compound, composed of closely united polygonal corallites, which radiate from a common center and increase by interstitial gemmation. Corallites unequal in size, larger individuals 4 to 6 mm. diameter. External walls appear somewhat zigzag in cross-sections. Septa about 30 to 36 in large individuals. Primary septa unequal in length, some reaching center. Secondary septa a little shorter. Septa are not flat but appear as undulating lines in transverse sections. Cross-sections show an outer zone of vesicles occupying about ½ diameter of corallite, the width of zone being about one-half length of primary septa; septa carinate in central part which is without vesicles. Longitudinal sections show vesicles to be elongate, their longer diameter being directed upwards and outwards; vesicles curved, their convex side directed upward and outward.

Diameter of largest specimen observed, 110 mm. Corallites diameter, 4 to 6 mm.

This species resembles *C. rugosum* from which it differs in much smaller size of corallites, fewer septa, inequality of length of primary septa, and no observed tendency of corallites to break apart. It resembles some species of Acervularia but does not have apparent inner wall of that genus. It occurs abundantly in the *Cladopora rectilineata zone* of the Decker Ferry of New Jersey. In Maryland it is found in the *Cladopora rectilineata zone* near base of Keyser and according to Ulrich in the Keyser coral zone.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Martin Mountain, Allegany County.

Collection.—Maryland Geological Survey.

Genus HELIOPHYLLUM Hall

HELIOPHYLLUM cf. CORNICULUM Lesueur

Plate XXI, Figs. 3-6

Caryophyllia cornicula Lesueur, 1820, Mem. du Mus., t. vi, p. 297.

Zaphrentis cornicula Milne-Edwards and Haime, 1851, Polypiers Foss. des Terr. Pal., p. 327, pl. vi, figs. 1*a-e*.

Cyathophyllum cornicula Rominger, 1876, Geol. Survey Mich., vol. iii, p. 102, pl. xxxv.

Heliophyllum corniculum Grabau and Shimer, 1909, North Amer. Index Foss., vol. i, p. 68, fig. 104.

Heliophyllum corniculum Cleland, 1911, Wisconsin Geol. Survey, Bull. xxi, p. 29, pl. i, fig. 2.

Description.—Corallite simply conical, symmetrically curved; expanding rapidly near apex. Exterior annulated by shallow constrictions 2 to 3 mm. apart, with finer transverse striæ between, and striated longitudinally by septal furrows. Calyx large, 22 mm. wide, 12 mm. deep in largest specimen observed, sides ascending for about $\frac{1}{3}$ distance above base, becoming erect near margin; bottom slightly elevated, smooth in center. Septa about 80, primary septa about 40, ascending upon convex bottom of calyx but not reaching its center, which is smooth; secondary septa slightly narrower, not ascending upon elevated calyx bottom. Cardinal septum in a distinct fossula which is situated upon convex side of corallum. Septa carinate, their edges denticulate. Inner structure not observed.

A large individual is 43 mm. long; diameter of calyx, 27 mm.

A single good individual has been observed which differs slightly from the typical form in the smooth calyx bottom and more erect sides. The resemblance is, however, so close that it has not seemed wise to regard it as a new species. The smaller individual figured is doubtfully referred to this form. The stratigraphic position of this species is not assured.

Occurrence.—HELDERBERG FORMATION. Martin Mountain, Allegany County.

Collection.—Maryland Geological Survey.

Genus COLUMNARIA Goldfuss

Columnaria ? helderbergiæ n. sp.

Plate XXI, Figs. 10, 11

Description.—Corallum compound, consisting of closely united prismatic, somewhat flexuous corallites which diverge from point of attachment. Corallites unequal in size, 3 to 4 mm. in diameter; bearing 20 or more narrow longitudinal septa. The septa are about 0.5 mm. apart, of variable width being 0.3 to 1 mm. wide in specimen observed, thick at their junction with walls of corallite, becoming thin on inner edge where they are set with spinulose points. Tabulæ close, 6 to 8 in space of 5 mm.; nearly horizontal.

Corallum large, its size unknown, diameter possibly as much as 100 mm.

A single fragment of the corallum of this species was observed in which no mural pores could be detected. The septa are of such size and number as to suggest the genus Columnaria. The horizon of the specimen is unknown but it was associated in the collection with *F. favosus* var. *integritabulatus* which occurs near the base of the Helderberg of Maryland.

Occurrence.—Helderberg Formation, Keyser Member. Warrior Mountain, Allegany County.

Collection.—Maryland Geological Survey.

Family CYSTIPHYLLIDAE

Genus CYSTIPHYLLUM Lonsdale

Cystiphyllum fasciculatum n. sp.

Plate XXI, Figs. 7-9

Description.—Corallum aggregate, consisting of clusters of subparallel flexuous, cylindrical corallites. Distance between corallites varying from zero to more than their diameter. Epitheca delicately striated transversely, bearing occasional annulations. Corallite formed of vesicular tissue; diameter of vesicles 1 to 4 mm. in transverse sections. In longitudinal sections vesicles appear elongate, their longer diameter directed upward and outward; central vesicles somewhat larger; septa and tabulæ absent.

Corallites nearly 1 cm. in diameter.

This species closely approaches *Cystiphyllum aggregatum* Billings. The corallites of the latter species are much larger, being at times 1 inch in diameter and bear pronounced epithecal protrusions, a feature not observed in the individuals described.

Occurrence.—HELDERBERG FORMATION. Near Cumberland; crest of Warrior Mountain 1 mile north of Signal Station.

Collections.—Maryland Geological Survey, U. S. National Museum.

CYSTIPHYLLUM sp.

Description.—Several fragments of a species having a simple conical corallum and clearly referable to this genus are found in the Helderberg of Maryland. They are, however, too poor to permit of specific determination.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Pinto.

Collection.—Maryland Geological Survey.

Suborder TABULATA

Family FAVOSITIDAE

Genus FAVOSITES Lamarck

FAVOSITES HELDERBERGIÆ Hall

Plate XXII, Fig. 1

Favosites helderbergiæ Hall, 1874, 26th Rept. N. Y. State Mus., p. 111.
Favosites helderbergiæ Hall, 1879, 32d Rept. N. Y. State Mus., p. 145.
Favosites helderbergiæ Hall, 1883, Rept. State Geol. of N. Y. for 1882, pl. iv, figs. 1, 2; pl. v, figs. 1-3; pl. vi, figs. 1-8.
Favosites helderbergiæ Hall, 1887, Pal. N. Y., vol. vi, p. 8, pl. iv, figs. 1, 2; pl. v, figs. 1-3; pl. vi, figs. 1-8.
Favosites helderbergiæ Girty, 1895, 48th Rept. N. Y. State Mus. for 1894, vol. ii, p. 302.
Favosites helderbergiæ Weller, 1903, Pal. N. J., vol. iii, p. 270.
Favosites helderbergiæ Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 85, fig. 138.

Description.—" Corallum consisting of large, lenticular, depressed convex or hemispherical masses; base covered by a strongly wrinkled epitheca.

Cell tubes polygonal; their inner surface showing evidence of a few strong longitudinal striæ. Septa frequent, from ten to fifteen in the space of 10 mm.; thickness equal to that of the cell walls. Mural pores in one or two ranges, comparatively large, circular, with margins distinctly elevated. Cell walls thin, but frequently much thickened near the surface by silification, and sometimes granulose or spinose on the inner face. On some specimens the cells, at the surface, are nearly equal, having a diameter of about 1.5 mm.; on other specimens the diameter varies from .66 mm. to 1.5 mm. On many specimens some of the cell tubes are larger and less angular than those surrounding them, being a little more than 2 mm. in diameter." Hall, 1887.

A few specimens have been observed in the Coeymans of Maryland which may be referred to this species, although their shape is not clearly shown to be hemispherical, which is the chief distinction between the typical form and the variety *præcedens.*

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Dawson, Maryland; Warren Point, Pennsylvania. NEW SCOTLAND MEMBER. Devil's Backbone.

Collection.—Maryland Geological Survey.

FAVOSITES HELDERBERGIÆ VAR. PRÆCEDENS Schuchert

Plate XXII, Figs. 2-7

Favosites helderbergiæ var. *præcedens* Schuchert, 1903, Amer. Geol., vol. xxxi, p. 164.

Description.—Corallum very irregular in shape, varying from subhemispherical to pyriform, clavate or almost digitate. Even the most nearly hemispherical specimens have an undulating surface or lobate protrusions. Consisting of numerous intimately united prismatic corallites which diverge from point of attachment. Epitheca not observed. Corallites subequal in some specimens, in others rather unequal in diameter. Walls thick. Tabulæ close, varying in distance from $\frac{1}{3}$ diameter to once diameter of tube. Mural pores in 1 to 2 rows, their edges raised, diameter about 25 mm.; distance in specimen figured about .75 mm.

Diameter of corallites 1 to 1.5 mm. In some small specimens referred to this species corallites are less than 1 mm. diameter.

Three closely related forms have been described, *F. niagarensis* Hall from the Lockport limestone, *F. helderbergiæ* Hall from the Coeymans of New York, *F. helderbergiæ* var. *præcedens* Schuchert from the Cobleskill of New York. It seems probable that they are but one species. Hall comments upon the similarity of *F. helderbergiæ* to *F. niagarensis* and states that the latter differs in having more numerous diaphragms and in having the mural pores on the lateral faces instead of near the angles of the cells. As Lambe,[1] however, states, Hall's figures of *F. niagarensis* show that the distance of tabulæ is very variable while he illustrates its mural pores in the same position as in *F. helderbergiæ*. The difference, therefore, resolves itself into the more irregular shape of corallum, somewhat greater average distance of tabulæ and difference of stratigraphic horizon. Of these the manner of growth would appear the chief difference, the specific value of which may be questioned.

Schuchert[2] has established *F. helderbergiæ* var. *præcedens* for the irregularly shaped specimens from the Cobleskill of New York which agree in other respects with *F. helderbergiæ*. He says: "*F. niagarensis* is usually small and spheroidal or irregular in form in the Rochester shale, while *F. helderbergiæ* of the Coeymans limestone is often in large, lenticular, depressed convex or hemispherical masses. The Cobleskill specimens are spheroidal to lenticular colonies up to six or eight inches in diameter, and the other characters are also those of *F. helderbergiæ*, and not of *F. niagarensis*. Since the Cobleskill specimens never attain the size of the largest *F. helderbergiæ* (sometimes having a diameter of two feet in Albany County) to which they are related, it seems inadvisable to retain longer Hall's provisional identification. It may be known as *F. helderbergiæ præcedens*."

The variety described by Schuchert seems identical in all essential respects with *F. niagarensis* Hall, except in the lesser average distance of its tabulæ, a very variable feature in this genus. This is the most common species of this genus in the Helderberg of Maryland, being very profuse in the upper Stromatopora beds of the Keyser member, wherever exposed.

[1] Contributions to Canadian Pal., Revision Paleozoic Corals, vol. iv, 1889, pt. i, p. 7.

[2] Amer. Geol., vol. xxxi, 1903, p. 164.

Diameter of corallum 100 mm. in large specimens, but usually smaller.

A small variety with unusually small corallites is found associated with the usual form at some places. It does not appear to differ in other respects.

Occurrence.—Helderberg Formation, Keyser Member. Devil's Backbone in Stromatopora beds; Cash Valley in Stromatopora beds; Pinto in coral beds; 1¼ mile southeast of Yerkes Mill, Flintstone, Maryland; near Seymour; in coral bed Keyser, West Virginia; Hyndman, Pennsylvania, in Upper Stromatopora beds. The smaller variety occurs in Stromatopora beds at Devil's Backbone; at Cash Valley, Maryland; Keyser, West Virginia.

Collection.—Maryland Geological Survey.

Favosites pyriformis Hall

Plate XXIII, Figs. 1-4

Asterocerum pyriforme Hall, 1852, Pal. N. Y., vol. ii, p. 123, pl. 34*a*, figs. 1*a-e*.
Favosites pyriforme Weller, 1903, Pal. N. J., vol. ii, p. 220, pl. xvii, figs. 3-5.

Description.—Corallum pyriform to subhemispherical, consisting of closely united prismatic corallites. Epitheca not observed. Corallites very unequal in size, 1 to 2 mm. diameter. Walls thin, bearing 12 or more longitudinal rows of well-developed squamules in interior of tubes. Tabulæ close, usually less than diameter of tubes apart. Mural pores in several rows.

Corallum attaining a diameter of over 1 foot, usually much smaller.

The shape of this coral is quite variable, usually pyriform when small, subhemispherical when large, quite irregular when very large. It closely resembles *F. helderbergiæ* but differs in its thinner walls and rows of squamulæ. It also seems to be confined to a lower horizon in Maryland where it has been observed only in the lower beds of the Keyser member.

Occurrence.—Helderberg Formation, Keyser Member. Cookerly, below Stromatopora bed associated with *Cladopora rectilineata;* Perdew's farm north end of Martin Mountain; Williams Road 1¼ miles east of Rush at base of Keyser member; Hillside 4400 feet N. 10° east of Signal Station on Warrior Mountain at base of Keyser member.

Collection.—Maryland Geological Survey.

FAVOSITES CONICUS Hall

Plate XXIII, Figs. 5-7

Favosites conica Hall, 1874, 21st Rept. N. Y. State Mus., p. 112.
Favosites conica Hall, 1879, 32d Rept. N. Y. State Mus., p. 146.
Favosites conicus Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. iii, figs. 4, 6-13.
Favosites conicus Hall, 1887, Pal. N. Y., vol. vi, p. 9, pl. iii, figs. 4, 6-13.
Favosites conicus Girty, 1895, 48th Rept. N. Y. State Mus. for 1894, vol. ii, p. 302.

Description.—" Corallum forming conical masses; flattened at the base, which is covered by a strong epitheca, marked with concentric wrinkles and undulations and radiating undulations formed by the cell tubes. Cells arising from the center of the base from an undefined central axis and quite abruptly curving to the surface, increasing by interstitial additions; polygonal, from four to eight sided; diameter at the surface varying from 1.5 to 3.5 mm.; walls comparatively strong; interior with evidences of numerous spinules or small nodes. Septa of about the same strength as the walls, irregularly arranged, varying from eight to fifteen in the space of 10 mm. Mural pores comparatively large, circular, with distinctly elevated margins, disposed in one, two and sometimes three ranges. Where one or two ranges occur the pores are regularly arranged one above the other; where three ranges occur the disposition is more irregular." Hall, 1887.

Longer diameter of corallum 60 mm.

Specimens agree well with those from the Helderberg of New York.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cherry Run, West Virginia. BECRAFT MEMBER. Baltimore and Ohio Railroad cut through North Mountain 1 mile west of North Mountain Station, abundant. ORISKANY FORMATION, RIDGELY MEMBER. Cumberland; Knobly Mountain near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

FAVOSITES BASALTICUS Goldfuss

Plate XXIII, Figs. 5-7

Calamopora basaltica Goldfuss, 1829, Petrefacta Germaniæ, vol. i, p. 78, pl. xxvi, fig. 4*a* (in part).
Favosites Gothlandica Billings, 1859, Canadian Jour., n. s., vol. iv, p. 104. figs. 2, 3, 4.

Favosites basaltica Billings, 1859, *ibid.*. p. 106, fig. 8.
Calamopora epidermata Rominger, 1862, Amer. Jour. Sci., 2d ser., vol. xxxiv, p. 396.
Favosites Gothlandica Nicholson, 1874, Pal. Ont., p. 45 (with reference only to the coral from the Corniferous limestone and Hamilton formation).
Favosites Forbesi Nicholson, 1874, Pal. Ont., p. 48, pl. vii, fig. 8; pl. viii, fig. 4.
Favosites Forbesi var. *tuberosa* Nicholson, 1879, Pal. Tab. Corals, p. 62, pl. iii, figs. 2, 2*a-e*.
Favosites epidermatus Rominger, 1876, Geol. Survey Mich., Foss. Corals, p. 28, pl. viii, figs. 1, 2, 3.
Favosites tuberosus Rominger, 1876, *ibid.*, p. 30, pl. ix, figs. 1, 2.
Favosites tuberosa Hall, 1876, Illus. Dev. Foss., pl. vi, fig. 6; pl. viii, figs. 1-7. pl. xi, fig. 1; *ibid.*, var., pl. i, fig. 1; pl. iv, fig. 1; pl. vii, fig. 1.
Favosites epidermata Hall, 1876, Illus. Dev. Foss., pl. vi, figs. 1-5; pl. xii, figs. 6, 9-13; *ibid.*, var. *corticosa*, pl. x, figs. 1-6; pl. xi, figs. 11, 12.
Favosites tuberosa Whiteaves, 1889, Contr. Can. Pal., vol. i, pt. ii, p. 121.
Favosites basaltica Lambe, 1889, *ibid.*. vol. iv, pt. i, pp. 8-10; pl. i, figs. 3, 3*a*.

Description.—Corallum subhemispherical, consisting of numerous closely united prismatic corallites, epidermis not observed. Corallites subequal in size, their walls moderately thick. Mural pores in several rows, diameter of pores about 0.3 mm. Tabulæ often flexuous, close, distance between tabulæ about 0.5 to 1 mm. Squamulæ large, numerous.

Diameter of larger corallites 2.5 to 3 mm.

The limits of the species *F. gothlandicus* and *F. basalticus* are very insecure. Nicholson regards the more diagnostic distinctions to be that *F. gothlandicus* has corallites of subequal size with thin walls, while *F. basalticus* (*F. forbesi* according to Nicholson) has very unequal corallites with thicker walls. He records both species in the Silurian and the Devonian. Lambe distinguishes them by the fact that *F. gothlandicus* has spines while *F. basalticus* has squamulæ in corallites and restricts the former to the Silurian and the latter to the Devonian.

The presence or absence of squamulæ is, however, not a trustworthy diagnostic since Lambe remarks that squamulæ are often not preserved in *F. basalticus* while Nicholson cites squamulæ in Silurian species and spines in Devonian species of Favosites. A single specimen has been observed whose exact stratigraphic position is not known. Its corallites are subequal but bear numerous squamulæ upon their walls.

Occurrence.—HELDERBERG FORMATION. Near Cumberland.

Collection.—Maryland Geological Survey.

FAVOSITES FAVOSUS VAR. INTEGRITABULATUS n. var.

Plate XXIV, Figs. 1, 2

Description.—Corallum subhemispherical, attached by a small surface, consisting of intimately united prismatic cells. Epitheca not observed. Corallites large, very unequal in size, diameter of larger corallites 3 to 5 mm. Walls thin, mural pores usually in one, sometimes in two rows, about 0.4 mm. diameter, rather distant. Tabulæ complete, varying in distance from 1 to 5 mm. or more. Squamulæ not detected in thin sections, apparently absent.

Diameter of corallum 100 to 150 mm.

This species closely resembles *F. favosus* of the Niagara and is probably a variety of it. No marginal depressions could, however, be detected in the tabulæ a feature commonly seen in that species. It differs from *F. basalticus* in the larger diameter of its corallites, absence of squamulæ (although squamulæ are often not preserved in that species), and more remote septa. The species is very abundant in the coral bed at the base of the Keyser member. It has not been observed at a higher horizon.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. South side of hill situated 4400 feet in an air line north 10° east of Signal Station on Warrior Mountain; east of Flintstone.

Collection.—Maryland Geological Survey.

FAVOSITES ? SCHRIVERI (Herzer)

Plate XXIV, Figs. 3-6

Thecia schriveri Herzer, 1902, 10th Ann. Rept. Ohio Acad. Sci., p. 54, pl. 10, fig. 15.

Description.—" Corallum ramose, preserved piece one inch and a half in length, and one-half inch thick. Orifices large, nine to one inch, walls stout, sides of tubes fluted by three striæ, causing the dentated structures of orifices. Mural pores large and sparingly [developed]. Specimen poorly preserved by silicification but still presenting its characteristic order." Herzer, 1902.

The specimens examined show the following additional features not described by Herzer. Corallum branching dichotomously, attached by a broadly expanded base which is striated upon surface of attachment. Corallites terminate at right angles to surface, their walls very thin within corallum but abruptly thickened at orifice. Sides of walls striated longitudinally by 12 broad striæ; appearing also to be striated transversely. Walls pierced by many irregularly openings, a feature due perhaps to state of preservation. Mural pores rarely determinable. Tube closed by a tabula situated just below orifice, other tabulæ rarely preserved.

Stems attaining a diameter of 25 mm. Diameter of corallites 2 to 2.5 mm.

The generic relationships of this species are not assured because of the state of preservation of material. The species does not appear to belong to the genus Thecia which is described as having thickened walls produced by fusion of septa, and a false cœnenchyma, while its septa extend to near center of corallites. The species is referred to the genus Favosites until more perfect material is discovered. The specimens found by Herzer were erroneously referred to the Medina (Tuscarora).

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. North side of Monster Rock, Western Maryland Railroad opposite Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus STRIATOPORA Hall

STRIATOPORA BELLA n. sp.

Plate XXV, Figs. 1, 2

Description.—Corallum branching, dendroid, consisting of closely united prismatic corallites which ascend along axis and then bend abruptly, terminating obliquely upon surface; corallites quite unequal in diameter, more or less irregular in cross-section. Calyx funnel-shaped, its base formed by a broad, flat tabula, its sides striated by twelve low ridges, its edges thin and slightly crenulated by the termination of the ridges. Walls of calyx perforated by large scattered pores. An occasional pore is seen to pierce the tabulæ in the single specimen observed.

Diameter of corallum 5 to 10 mm. Diameter of orifices varying with maturity of corallite from 1 to 2.5 mm.

This species differs from *S. issa* Hall in its less conical calyx with less prominent furrows. It differs from *S. cavernosa* Rom. which has more funnel-like calyces with obtuse edges.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cherry Run, West Virginia.

Collection.—U. S. National Museum.

STRIATOPORA sp.

Plate XXV, Fig. 3

Description.—Corallum compound, dendroid, branching; consisting of numerous closely united prismatic corallites which ascend obliquely upward and outward from axis and terminate obliquely upon surface. Calyces unequal in size, funnel-shaped, depth about one-half width, their sides straight, outline angular. Internal structure not observed.

Diameter of branches 3 mm.; diameter of calyx 1 mm.

This species strongly suggests *Striatopora flexuosa* of the Niagara of New York but is a much more delicate form. A single specimen has been seen.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, 63 feet below base of Lower Stromatopora bed.

Collection.—Maryland Geological Survey.

Genus CLADOPORA Hall

CLADOPORA RECTILINEATA Simpson

Plate XXV, Figs. 4-7

Cladopora rectilineata Simpson, 1889, Trans. Amer. Philos. Soc., n. ser., vol. xvi, p. 459, fig. 30.

Cladopora rectilineata Weller, 1903, Pal. N. J., vol. iii, p. 221, pl. xvii, figs. 14-17.

Description.—Corallum ramose, branching dichotomously, stems circular, their diameter 1.5 to 2.5 mm.; consisting of intimately united corallites, which ascend parallel to the axis and then turn outwards, terminating quite obliquely on the surface. Orifices forming 8 to 10 rows of which 3 or 4 are visible on one side. Walls of corallite moderately thick at axis of corallum, increasing in thickness towards orifice where walls are about as thick as width of orifice. Calyx funnel-shaped, oblique to surface, forming a lip below and a broad concave space above; orifices distant about 0.5 mm. in specimens observed, arranged in vertical rows separated by somewhat irregular ridges. The orifice contracts below into a narrow tube whose walls are nearly as thick as its internal diameter. A line is observed through center of walls in thin sections showing that adjacent corallites are separate. Tabulæ and pores not observed.

Diameter of corallite 1.5 to 2 mm.

This species is restricted to a zone above the base of the Keyser member where it is profuse, being found at most localities where that horizon is exposed.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Knobly Mountain, 6 miles south of Cumberland; Pinto; Cookerly; Devil's Backbone; Flintstone.

Collection.—Maryland Geological Survey.

CLADOPORA CF. RECTILINEATA Simpson var.

Description.—A variety of this species differs from the typical form in having larger branches (2 to 4 mm. diameter) and hence more numerous corallites, about 20 corallites occurring in the larger branches. A few tabulæ are present. This species suggests *Cladopora multiseriata* Weller of the Coeymans of New Jersey, but differs in having smaller corallites, about 10 or 11 occurring in a space of 5 mm. while 5 to 7 occupy the same space in the form described by Weller. Associated with *Cyathophyllum inequale* upon a specimen whose exact horizon is not known.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Locality unknown, perhaps east of Flintstone.

Collection.—Maryland Geological Survey.

CLADOPORA MULTISERIATA Weller

Cladopora multiseriata Weller, 1903, Pal. N. J., vol. iii, p. 271, pl. xxvi, figs. 2, 3.

Description.—" Corallum consisting of cylindrical branches, which occasionally divide. Corallites cylindrical, directed obliquely to the axis of the branches, apparently free from septa or tabulæ, arranged in twelve or thirteen vertical series; the apertures in adjacent series being more or less irregularly alternate. Because of the obliquity of the corallites, their apertures are elliptical, the peripheral borders regular, subangular. The diameter of the branches is from 2 mm. to 3.5 mm. with six or seven corallites occupying a space of 5 mm. longitudinally." Weller, 1903.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Near Cumberland. Between the Bryozoan subzone and the overlying Stromatopora bed (fide Ulrich).

Collection.—U. S. National Museum.

Genus PLEURODICTYUM Goldfuss

PLEURODICTYUM LENTICULARE (Hall)

Plate XXVI, Fig. 1.

Michelinia lenticularis Hall, 1874, 26th Rept. N. Y. State Mus., p. 113.
Michelinia lenticularis Hall, 1879, 32d Rept. N. Y. State Mus., p. 145.
Michelinia lenticularis Hall, 1883, Rept. N. Y. State Geol. for 1882, pl. iii, figs. 1, 2, 3, 5.
Michelinia lenticularis Hall, 1887, Pal. N. Y., vol. vi, p. 7, pl. iii, figs. 1, 2, 3, 5.
Pleurodictyum lenticulare Beecher, 1891, Trans. Conn. Acad., vol. viii, p. 207.

Description.—Corallum compound, consisting of short, closely united, polygonal corallites. Outer walls of corallites perforate. Calyx shallow, septa consisting of spines varying in size, arranged in lines on sides of calyx and irregularly clustered in center. Number of septa not clearly determinable, apparently nearly 20. The walls of calyx perforated by irregularly placed pores, about 0.2 mm. in diameter. In the specimen observed the corallites number 16 and the corallum is attached at base to shell of a brachiopod.

Diameter of corallites 5 to 6 mm., length approximately the same.

This species was named *Michelinia lenticularis* by Hall who did not satisfactorily determine its intimate structure. It is not a species of Michelinia and lacks the distinctive features of that genus. It was correctly referred to the genus Pleurodictyum by Beecher.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

Family AULOPORIDAE

Genus AULOPORA Goldfuss

AULOPORA SCHOHARIÆ Hall

Plate XXVI, Figs. 2, 3

Aulopora schohariæ Hall, 1874, 26th Rept. N. Y. State Mus., p. 110.
Aulopora schohariæ Hall, 1879, 32d Rept. N. Y. State Mus., p. 142.
Aulopora schohariæ Hall, 1883, Rept. N. Y. State Geol. for 1882, pl. ii, figs. 1-6.
Aulopora schohariæ Hall, 1887, Pal. N. Y., vol. vi, p. 3, pl. ii, figs. 1-6.

Description.—"Corallum consisting of elongate, tubular, thick-walled cells, gradually enlarging to the aperture; increasing, sometimes by one individual budding from the basal part of the calyx and continuing in direct line; at other times there is a double latero-basal gemmation, the tubes growing at an angle of about 45° to the parent. Exterior transversely wrinkled. All the tubes after budding assume an erect position and cease growth." Hall, 1887.

Diameter at smaller end 0.8 mm., at aperture 1.5 mm.; length from 5 to 7 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Hyndman, Pennsylvania. BECRAFT MEMBER. Ernstville.

Collection.—Maryland Geological Survey.

AULOPORA SCHUCHERTI n. sp.

Plate XXVI, Figs. 4, 5

Description.—Corallum consisting of elongate tubular cells, branching repeatedly, the branches uniting by their walls to form an intricate network from which numerous short branches ascend. Exterior annulated by fine striations. The branches terminate in circular calyces of variable depth, their depth being in some specimens less and in others greater than width. Base of calyx occasionally divided transversely by a low ridge.

Diameter of branches, 1.5 mm.

This species closely resembles *A. tubula* with which it may be conspecific. It differs in branching more intricately, while the branches are more intimately united by frequent fusion of their walls.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser West Virginia; Cookerly *Cladopora rectilineata zone,* Cash Valley, Devil's

Backbone, Hancock, Maryland; Hyndman, Pennsylvania. NEW SCOTLAND MEMBER. Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus CERATOPORA Grabau

CERATOPORA ? MARYLANDICA n. sp.

Plate XXVI, Figs. 6, 7

Description.—Corallites consisting of prostrate tubular cells, branching irregularly; walls of adjacent branches uniting to form irregular clusters. Branches ascending, increasing in diameter rapidly for a short distance near base, then very gradually towards calyx. Theca striated transversely by fine lines with occasional deeper furrows. Walls cystose. Calyx funnel-shaped; depth variable, its sides faintly striated. Orifice circular.

Diameter of orifice, 2.5 to 3 mm.

This species resembles *C. jacksoni* of the Hamilton of Michigan but is much smaller and also differs in its proportions. The generic position of this species is not assured. Its branches are not attached to other organisms as in the genus Aulopora. In habit it closely resembles the genus Ceratopora of Grabau but the cysts do not clearly show the spines supposed to be characteristic of that genus. But two clusters have been observed. Additional material may give clearer evidence as to its generic relations.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tentaculite zone at Keyser, West Virginia, 2 miles northwest of Six-Mile House on road to Hazen, Maryland.

Collection.—U. S. National Museum.

Family HALYSITIDAE

Genus HALYSITES Fischer

HALYSITES CATENULATUS Linné

Plate XXVI, Fig. 8

Tubipora catenularia Linné, 1767, Syst. Nat., 12th ed., p. 1270.
Catenipora escharoides Hall, 1852, Pal. N. Y., vol. ii, p. 127, pl. xxxv, figs. 1*a-c*

Description.—"Coral in hemispheric masses, composed of oval tubes placed laterally in juxtaposition in a single series, or separated by a cellular interspace; lines of tubes arranged in reticulated form, with unequal interspaces. Tubes within, septate transversely and striated longitudinally, externally transversely striated, and sometimes with more elevated ridges at equal intervals. This coral is so well known by its peculiar net-like structure, that a description seems scarcely necessary. It presents considerable variety, however, in the mode of its reticulation and the size of the spaces. The openings of the tubes upon the surface are oval, though often varying in size, and the whole expansion is frequently very thin and slender, and in other cases thick and strong. The greater number of specimens found in New York are siliceous, the interior structure is not well preserved; and the transverse septa seen only at irregular intervals. The striæ noticed in the interior of the tube are distinct crenulated ridges like the bases of lamellæ, and give to the well preserved tubes a very characteristic feature." Hall, 1852.

Diameter of tubes about 2 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Cash Valley, Pinto, Rawlings.

Collection.—Maryland Geological Survey.

CLASS HYDROZOA

Subclass STROMATOPOROIDEA

Section MILLIPOROIDAE

Family STROMATOPORIDAE

Genus STROMATOPORA Goldfuss

STROMATOPORA CONSTELLATA Hall

Plate XXVII, Figs. 1-6; Plate XXVIII, Figs. 1-2; Plate XXIX;

Plate XXX, Fig. 1

Stromatopora constellata Hall, 1852, Pal. N. Y., vol. ii, p. 324, pl. lxxii, figs. 2*a*, *b*.
Stromatopora concentrica Hall, 1852, Pal. N. Y., vol. ii, pl. lxxiii, figs. 2, 2*a*, 2*b*.
Cœnostroma constellatum Spencer, 1882, Bull. Univ. State of Missouri, vol. i, No. 1, p. 48, pl. vi, fig. ii.
Stromatopora constellata Whiteaves, 1896, Can. Rec. Sci., vol. vii, p. 137.

cf. *Stromatopora hudsonica* Dawson, 1879, Quart. Jour. Geol. Soc., vol. xxxv, p. 52, pl. iv, figs. 9*a* and 9*b*; pl. v, fig. 10.

cf. *Stromatopora hudsonica* Nicholson, 1891, Mon. Brit. Strom., p. 172.

cf. *Stromatopora hudsonica* Nicholson, 1891, Ann. and Mag. Nat. Hist., p. 312, pl. viii, figs. 1-3.

Stromatopora constellata Parks, 1908, Univ. Toronto Studies, Geol. Ser., No. 5, pp. 44-46.

Description.—"Massive, hemispheric, spheroidal or irregular; composed of thin concentric layers, which are penetrated by minute vertical tubes or cells; surface of layers nodose, each elevation being marked by an irregular stellate impression with undulating and bifurcating rays; intermediate spaces smooth, or having only the minute cell apertures. This species presents no important characters to distinguish it from the *S. concentrica,* except the uneven surface of the laminæ, and the stellate impressions upon these elevations. The size of the minute cell is apparently the same as in *S. concentrica;* and in such specimens as break only vertically there is no positive means of distinguishing this species beyond the undulations of the laminæ which correspond to the uneven surface. It seems, indeed, probable that it may be only a variety of the *S. concentrica,* presenting this peculiarity in its mode of growth." Hall, 1851.

The species is further described by Parks as follows: "Cœnosteum massive, hemispheric, spheroidal or irregular. The commonest type is hemispheric, and in this form the species reaches a large size, possibly a foot or more in diameter. Latilaminar structure distinct, but the latilaminæ vary greatly in thickness. Exfoliation easy, presenting smooth or gently undulating surfaces. Small, low, rounded mamelons may be present or absent; when present they are situated about 5 mm. apart. Small astrorhizal systems appear on nearly all surfaces, even where no other structure is observable; they are very small—not more than 2 mm. in diameter—and with very few branches. The spacing of these systems is extremely variable—from 3 to 6 or 7 mm. As I have already stated, the distribution of astrorhizæ is of little or no diagnostic value. In the variety with mamelons, the astrorhizæ generally coincide in position with these eminences, but even this is not rigidly true. The skeletal matter consists of radial pillars and concentric laminæ, which are intimately fused, but not sufficiently so to obliterate their individuality. On an average seven pillars appear in a distance of 1 mm. The skeletal matter is rather coarsely porous.

"Vertical sections show the vertical and horizontal elements forming a network with relatively thick meshes. The cut ends of the astrorhizal canals are apparent as interspaces of a more or less rounded character, and the zooidal pores as minute tabulate tubes between the pillars. When the section is thick the laminæ are most pronounced and continuous, because the zooidal tubes are of such small caliber that the section exceeds them in thickness; the thinner the section the more zooidal tubes are seen to hold their course through the laminæ. This is an obvious fact, but one must remember it, or there is grave danger of misinterpretation.

"Tangential sections show the astrorhizal canals as prominent features, and the minute round orifices representing the cross-section of the zooidal pores."

The individuals referred to this species in Maryland may be grouped into three rather well-defined types as follows:

Type a. Characterized by possessing a cœnosteum of medium size, laminæ strongly curved, so that they appear very curly when weathered, mamelons small or absent, atrorhizæ inconspicuous, their branches short, colonies forming thick reefs of great extent. This is the most abundant type and agrees well with Parks' description.

Type b. Differs from preceding chiefly in much larger size of cœnosteum which is often more than 12 inches in diameter, laminæ less curved, mamelons often more conspicuous, colonies less given to forming reefs.

Type c. Possessing large mamelons and very large intricately branched astrorhizæ which may even be nearly a centimeter in diameter. The astrorhizæ resemble those of Parks' *S. corallifera* so that tangential sections strongly suggest that species. It differs from it in its thicker laminæ and more distinct latilaminæ, in the size of the mamelons and the astrorhizæ. It corresponds with Hall's figures of *S. constellata* with which it also accords in its intimate structure.

This is the most abundant stromatoporoid of the Helderberg and forms extensive reefs in the upper part of the Keyser member.

A few localities only are given in the following paragraph:

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Corriganville, Devil's Backbone, Cash Valley, Cumberland, Maryland; Keyser, West Virginia; Hyndman, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus SYRINGOSTROMA Nicholson

SYRINGOSTROMA BARRETTI Girty

Plate XXVIII, Figs. 3, 4

Syringostroma barretti Girty, 1895, 48th Rept. N. Y. State Mus., vol. ii, p. 296, pl. vii, figs. 5, 6.

Syringostroma barretti Parks, 1909, Univ. Toronto Studies, Geol. Ser., No. 6, pp. 16-19.

Stromatopora barretti Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 45, fig. 72.

Description.—"Cœnosteum large, hemispherical, spreading. Latilaminæ distinct, more or less labyrinthine towards the center, on the periphery flowing in broad folds. They end abruptly on the under side, and are attached directly without an epitheca. Laminæ parallel and gently flexuous. Astrorhizæ not numerous, but large and conspicuous. The nucleus of an astrorhizal system is sometimes represented by an axial tube, and the laminæ at that point are often elevated into a low monticule. Skeletal tissue finely fibrous, but a little coarser than in *S. centrotum.*

"This species is characterized by the infundibuliform, concentric growth and the flat base without an epitheca (?). Without the aid of thin sections, the outer surface of the type specimen appears dense, fine-grained, and structureless, except for latilaminæ, which separate in unusually thin sheets. Sections near the surface are without monticules, astrorhizæ and axial tubes, exhibiting only the uniform, porous skeleton and fibrous structure. The same surface characters are presented by the basal portion and suggests an epitheeate condition, but it has not the polished surface and concentric wrinkles characteristic of the epitheca in *Favosites.*" Girty, 1895.

Radial sections show thin, remote, horizontal laminæ, about 1 mm. apart, each appearing as a delicate fiber crossing space between pillars. Vertical pillars distant, 4 or 5 in 1 mm., separated by wide tubular spaces.

Tangential sections show large astrorhizæ which usually have an axial tube and stout branches. Skeletal tissue dense, ends of vertical pillars not distinct. The skeletal tissue is much denser than in other species of the fauna, presenting a fine granular appearance in sections.

This form differs from other species of the fauna in having a finer reticulated fiber, much more distant horizontal laminæ, and much larger tubular spaces between the vertical pillars, imparting a much coarser appearance to the structure than that observed in other forms. Sections of some specimens cut a little obliquely appear as if without regular arrangement as shown on the accompanying plate. Such specimens seem to agree so closely with Parks' *Stromatopora clarkei* as to lead the writer to believe that the latter species may be identical with this. *S. clarkei* also occurs in the same general faunal association as this species does in Maryland. Abundant in the Rawlings Stromatopora reef about 50 to 60 feet above the base of the Keyser member, associated with *Cladopora rectilineata*. It occurs also at Cedarville, New York.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cut of Baltimore and Ohio Railroad south of Cookerly.

Collection.—Maryland Geological Survey.

SYRINGOSTROMA CENTROTUM Girty

Plate XXVIII, Figs. 5, 6; Plate XXX, Fig. 2

Syringostroma centrotum Girty, 1894, 48th Rept. N. Y. State Mus., vol. ii, p. 293, pl. vii, figs. 1, 2.

Syringostroma centrotum Parks, 1909, Univ. Toronto Studies, Geol. Ser., No. 6, pp. 12-14.

Stromatopora centrota Grabau and Shimer, 1909, N. Amer. Index Foss., vol. i, p. 45, fig. 72.

Description.—" No specimens in this collection are entire, but all evidence points to an originally spheroidal form for the cœnosteum. One specimen appears to have had a diameter of about 27 cm. when entire. The concentric character of the structure is usually quite striking. Some specimens are readily separated into thin sheets or latilaminæ. . . . . Tangential sections do not remain parallel to the surface in this species, except over small areas, for the curvature is not regular but flexuous, and the latilaminæ are more or less foliaceous and imbricating. Thus extended sections cut the frequent monticules at all angles and appear like panels of curly maple.

"In specimens which break along the latilaminæ the surface is seen to be vermiculate and porous, thickly covered with prominent conical elevations. This characteristic vermiculate structure is shown also in tangential sections, and is not due to weathering and preservation. Astrorhizæ are numerous, but small and inconspicuous, as if they were merely the usual porous structure intensified. They are distributed over the surface, and are often to be found on the sides of the monticules. The monticules, as shown by radial section, are usually superimposed throughout one latilamina, but in two consecutive latilaminæ this may or may not be the case. They are often pierced by straight central canals directed radially. These canals often extend through one whole set of monticules. They have no proper walls, and, therefore, cannot be referred to 'Caunopora' tubes or tubicolous annelids. When broken transversely the mamelons are seen to be distinctly porous. The pores, or canals, are often arranged in concentric series, coincident with the cut edges of the intersected laminæ, and evidently represent sections of the astrorhizal canals.

"Weathered fractures and properly oriented sections show that the radial pillars are strong, parallel, and continuous through several layers of the cœnosteum. They are united at more or less regular intervals by concentric partitions which have the porous structure above described. These concentric laminæ appear to be composed of inosculating fibers forming a reticulate skeleton, and not of lateral arms given off in a whorl around each pillar as in the genus *Actinostroma*. Vertical sections through a monticule show that the radial pillars are not parallel as elsewhere, but are inclined at a slight angle away from the imaginary axis of the monticule." Girty, 1894.

The monticules are elevated, conical, about 3 to 3½ mm. apart. Radial sections show thin horizontal laminæ about 3 of which occur in 1 mm.; vertical pillars about 7 in 1 mm. The laminæ curve strongly upwards in passing through the monticules. Tangential sections show groups of concentric circles which are sections of monticules; monticules pierced by axial tubes; astrorhizæ scarcely distinguishable, sections of vertical pillars irregular in shape.

This species is distinguished from others in the fauna by its numerous closely set, elevated, conical monticules and by its internal structure. It has been observed at one horizon only in Maryland, being found in a coral reef at the base of the Keyser member, where it is locally abundant.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. South slope of hill 4400 feet in an air line north 10° east of Signal Station on Warrior Mountain.

Collection.—Maryland Geological Survey.

Family IDIOSTROMIDAE

Genus IDIOSTROMA

IDIOSTROMA sp.

Description.—A species of the genus Idiostroma is present in the Stromatopora reefs of the Helderberg, but satisfactory sections showing its intimate structure have not been obtained. It has cylindrical branches 5 to 10 mm. in diameter.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Near Cumberland.

Collection.—Maryland Geological Survey.

ECHINODERMATA

Subbranch PELMATOZOA

CLASS CYSTOIDEA

Family CAMAROCYSTIDAE

Genus CAMAROCRINUS Hall

CAMAROCRINUS STELLATUS Hall[1]

Plate XXXI, Figs. 1-5

Camarocrinus stellatus Hall, 1879, 28th Rept. N. Y. State Mus. Nat. Hist., Mus. ed., p. 207, pl. xxxv, figs. 1-8; Extract, 4°, 1880, p. 5, pl. xxxv, figs. 1-8, pl. xliv, figs. 1-5.

Camarocrinus stellatus Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 269, 270.

[1] This is now known to represent a part of a crinoid and not a cystid.

Description.—This species is readily separated from *C. saffordi* by its more depressed form, larger and more open basal area, and the finely granular nature of the plates of the outer integument. These granules flow variously together and the plates are more or less stellate. In some individuals this character is more marked than in others, so that the degree of stellation is variable and individual, but it never takes place so prominently as in some examples of *C. ulrichi stellifer*.

The largest specimen has a diameter of 12.5 cm.

This species also occurs rarely in the Manlius at Schoharie, New York.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia, below Gypidula zone, abundant; Devil's Backbone, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family ANOMALOCYSTIDAE

Genus ANOMALOCYSTITES Hall

ANOMALOCYSTITES (?) DISPARILIS Hall

Plate XXXII, Figs. 1-3

Anomalocystites disparilis Hall, 1859, Pal. N. Y., vol. iii, p. 145, pl. lxxxviii, figs. 1-4, 1861.

Anomalocystites disparilis Woodward, 1880, Geol. Mag., dec. ii, vol. vii, p. 193, pl. vi, figs. 2, 3.

Anomalocystites (?) *disparilis* Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, p. 207, text fig. 22.

Description.—"Body longitudinally subelliptical in outline (when viewed from the anterior or posterior direction), concavo-convex, with the margins strongly angular. Basal plates, or plates of the first series, on the concave side, two, somewhat triangular and strongly curvilinear, together giving a deep crescent-form outline to the base; on the convex side, three plates. Second range on the concave side, a single large plate which is slightly curved on the lower side; the lower angles truncate and the sides vertical, one longer than the other, and unequally indented above for the reception of two plates, and on the upper left-hand angle for the reception of an irregular plate. Third range consisting of three plates. Fourth range unknown. Convex or posteal side above the basal plates composed somewhat irregularly of six ranges of plates, having 3+4(5?)+5+4+4 plates respectively, above which the structure is unknown. Lateral or radial plates three known on each side in direct succession, the lower one elongated and very unequally five-sided; the lower angular extremity resting one side against the long basal plate of the concave side, and the opposite shorter side resting upon the sloping edge of the adjoining basal plate of the convex side. The second radial plates rest, one side against the lateral margins of the large central plate of the concave side, and the opposite sides adjoin the plates of the convex side; thus, with the base and summit, giving one of those plates an irregular hexagonal and the other a heptagonal form. Third radial or angular plates heptagonal. Fourth radials unknown. Column unknown." Hall, 1859.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—U. S. National Museum.

Family CALLOCYSTIDAE

Subfamily APIOCYSTINAE

Genus LEPOCRINITES Conrad

LEPOCRINITES GEBHARDII Conrad

Plate XXXII, Figs. 4-7

Lepocrinites gebhardii Conrad, 1840, 4th Ann. Rept. N. Y. Geol. Survey, p. 207.

Lepocrinites gebhardii Vanuxem, 1842, Rept. 3d Dist. N. Y. Geol. Survey, p. 117, text fig. 4.

Lepocrinites gebhardii Mather, 1843, Rept. 1st Dist. N. Y. Geol. Survey, p. 346, text fig. 4.

Lepocrinites gebhardi Hall, 1843, Rept. 4th Dist. N. Y. Geol. Survey, tab. ill. 27, fig. 4.

Lepocrinites gebhardii Owen, 1846, Amer. Jour. Sci., 2d ser., p. 49, fig. 4.

Lepocrinites gebhardii Lincklaen, 1861, 14th Rept. N. Y. State Cab. Nat. Hist., p. 58, pl. ix, fig. 11.

Lepadocrinus gebhardi Hall, 1859, Pal. N. Y., vol. iii, p. 127, pl. vii, figs. 1-20, 1861.

Lepadocrinus gebhardi Haeckel, 1896, Die Amphorideen und Cystoideen, Beitr. Morph. u. Phyl. d. Echinodermen, p. 135.

Apiocystites gebhardii Jaekel, 1899, Stammesgeschichte der Pelmatozoen, i, p. 282, fig. 59 on p. 280.

Lepocrinites gebhardii Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, p. 215.

Description.—" Body oblong, oval or ovoid, compressed at the sides, unsymmetrical, being much more gibbous on the lower part of the posteal or ovarian side than on the opposite; usually abruptly rounded above and obliquely subtruncate below. The basal series consists of four unequal plates, 1, 2, 3, 4; the second series of five, 5, 6, 7, 8, 9; the third series of four, 10, 11, 12, 13; and the fourth or supraovarian of five, 14, 15, 16, 17, 18; making the formula B, $4+5+4+5$. The supraovarian plate extends downwards on each side, half enclosing the aperture: ovarian and circa-ovarian plates unknown. Plates of the summit unknown. A reniform depression and anal pore a little upon the left of the center.

" Arms four, consisting of an anterior and posterior pair, which lie in shallow grooves along the rounded angles of the body, reaching nearly or quite to the base, and rising much above the surface of the adjoining plates; the anterior pair nearer to each other than the posterior pair, extending downward nearly to the base. The arms are composed of a double series of plates, each alternate one being similar. A range of minute ossicula extends along the center of the groove between the plates of the arms, from which diverges a shorter range to the sinuosities of the arms, where originate the fingers or pinnules. Fingers slightly alternate, but preserving the appearance of being in pairs or opposite; composed of a double series of ossicula, closely interlocking at their contiguous wedgeform margins, and standing erect from the surface of the body, or lying close upon the arms and infolded in pairs beneath each other. Surface of plates granulate; the granulations without definite arrangement, or in concentric lines parallel to the margins of the plate, and often elongated in the same direction, sometimes even forming continuous ridges. The pectinated spaces on the basal plate, and on 12 and 13, are elongate reniform, and those on the adjoining plates are triangular; neither being symmetrical or equilateral. From twenty to thirty bars may be counted in each of the pectinated spaces.

" Column composed of two distinct parts: the upper, consisting of about fifteen articulations, is flexible; and the lower part, larger and of greater length, consists often of nearly twice as many joints, which are anchylosed together, and usually covered on the exterior by a calcareous secretion of greater or less thickness." Hall, 1859.

Base of several columns evidently belonging to this species comprise all the writer has seen of this form.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Devil's Backbone.

Collection.—U. S. National Museum.

LEPOCRINITES MANLIUS Schuchert

Plate XXXII, Figs. 8, 9; Plate XXXV, Figs. 15, 16

Lepocrinites manlius Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 214, 215, pl. xxxvii, figs. 2, 3; pl. xxxix, figs. 15, 16; text fig. 23.

Description.—Each ambulacrum a little longer than half the length of the theca and bearing on each side about 12 brachioles (or 24 to an ambulacrum), of which none is preserved.

Basal pectinirhomb largest, with about 40 dichopores, while the 2 upper ones each have about 35.

The conspicuous valvular pyramid of the anus is composed of 6 triangular plates surrounded by a circle of about 18 very small pieces. All these parts are deeply set between plates 7, 8, and 13.

Hydropore small, placed just below the conspicuous madreporite. Both are situated on plate 21, making the abutment on one side for two ambulacra.

Column unknown. In the cystid layer, however, occur the fused leech-shaped pieces of the column, so characteristic of Lepocrinites. They are smaller than in *L. gebhardii* and, as they occur in the same zone as the theca of *L. manlius,* it is probable that these pieces belong to the latter species.

Compared with *L. gebhardii* of the Coeymans, *L. manlius* is considerably smaller, in form more pyriform than subquadrate, has considerably longer ambulacra, and the plate ornamentation is far more decided.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

Genus TETRACYSTIS Schuchert

TETRACYSTIS CHRYSALIS Schuchert

Plate XXXII, Figs. 10, 11

Tetracystis chrysalis Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 218, 219; pl. xxxiv, figs. 9, 10; pl. xl, figs. 1-3; text fig. 25.

Description.—Ambulacra narrow, depressed, not excavated into the thecal plates, and extending to the column. Ambulacrals very long and narrow, about 20 in a column. Ambulacralia extremely small, about 12 to 14 to each ambulacral. Brachioles very slender, about 11 on each side of an ambulacrum or about 88 to each theca; length unknown.

Pectinirhombs each with from 25 to 35 dichopores.

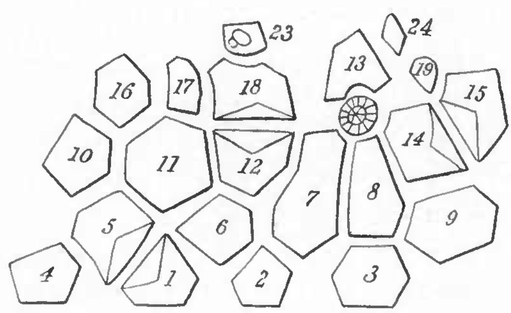

FIG. 6.—Analysis of *Tetracystis chrysalis* Schuchert.

Hydropore on plate 23 comparatively large and easily seen; immediately behind it is a shallow pit with numerous pores, indicating the madreporite.

Anal area very prominent owing to the elevated anal margins of plates 7, 8, 13, and 14, and composed of an outer circle of 17 small pieces and a highly elevated pyramid of 7 pieces.

Column unknown.

Length of theca of type 23 mm.; width 17 mm.; depth 13 mm. A single specimen has a length of 24 mm.; breadth 15 mm.; depth 13 mm. For general form, shape of individual plates and their ornamentation, see the figures and diagram, fig. 6.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

Genus JAEKELOCYSTIS Schuchert

Jaekelocystis hartleyi Schuchert

Plate XXXII, Figs. 12-16

Jaekelocystis hartleyi Schuchert, 1903, Amer. Geol., vol. xxxii, p. 231.
Jackelocystis hartleyi Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 224, 225; pl. xxxvii, figs. 4-8; text fig. 27.

Description.—Ambulacra narrow, excavated into, and but slightly elevated above, the theca, and in normal specimens extending to the column. Each pair of ambulaera, or R I and R II, R IV, and R V, converging and almost touching each other near the column. In one individual R I is but half the normal length and R II is almost aborted, having but 6 brachioles. In another individual R I is entirely undeveloped, while in a third specimen R II is absent. In a fourth specimen R V is forked, the branch developing on the left. In full-grown specimens, there are about 34 brachioles to each ambulacrum, 17 on either side. Brachioles stout and folded over each other medially; length unknown but apparently quite short. Ambulacral grooves narrow and shallow, with very minute ambulacralia.

Dichopores on plates 1, 12, and 14 not shown at the surface, being deeply situated within small oval pits, each with a rim highly elevated above the surface of these plates. Those on plates 5, 18, and 15 show the dichopores with the excavation deepest orally, and are here delimited by a crescentic lip. About 8 folds in each rhomb.

Hydropore conspicuous, situated on a small piece placed above and between plates 18 and 13. No madreporite discernible.

Anal pyramid small, not strongly elevated, composed of 6 pieces, but made quite prominent by the protrusion of the bounding margins of thecal plates 7, 8, 13, and 14.

Column comparatively stout, and, as is usual in cystids, composed of thick segments near the theca. Length unknown.

This beautiful, regular, but small cystid is readily distinguished from the other species of Jaekelocystis by the pyriform outline, strong sculpturing, and the more prominent ambulacra. *J. papillata* is also easily identified by the much finer papillose ornamentation.

Length of a full-grown theca 15 mm.; width and depth about 11 mm. For general form, shape of individual plates and their ornamentation, see the figures and diagram, fig. 7.

This is a very abundant species at Keyser associated with *Sphærocystis multifasciata, S. globulans,* and *Pseudocrinites gordoni.*

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

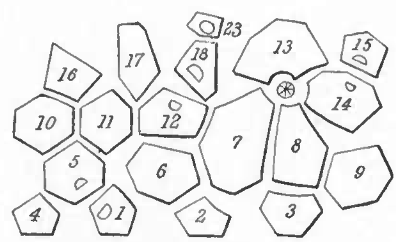

FIG. 7.—Analysis of *Jaekelocystis hartleyi* Schuchert.

JAEKELOCYSTIS PAPILLATA Schuchert

Plate XXXIII, Figs. 1, 2

Jaekelocystis papillatus Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, p. 225, pl. xxxvii, figs. 9, 10.

Description.—Anal area less prominent than in the other species of this genus, and bounded by plates 7, 8, 13, and only a very small part of 14.

This species differs from *J. hartleyi,* to which it is closely related, in the more globular theca, fewer brachioles, absence of grooves along the suture lines of the plates and the papillose sculpturing of the plates; also in the fact that the discrete halves of the pectinirhombs are alike and not with one-half buried deeply in a pit with a high rim. Each ambulacrum has from 11 to 12 brachioles on each side, while in *J. hartleyi* there are 17 in the same length. The pectinirhombs likewise have more dichopores, there being from 12 to 15 in each, while in *J. hartleyi* there are only about 8.

Length of the largest theca 15 mm.; width and depth 12 mm. For general form and sculpturing, see pl. xxxiii, figs. 1, 2.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

JAEKELOCYSTIS AVELLANA Schuchert

Plate XXXIII, Figs. 3, 4

Jaekelocystis avellana Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, p. 226, pl. xxxvii, figs. 11, 12; text fig. 28.

Description.—Theca shaped like a hazelnut, the resemblance suggesting the name, about 10 mm. in length and breadth, in the largest of three known examples. Plates nearly smooth; for their individual form, see the diagram (fig. 8) and pl. xxxiii, figs. 3, 4.

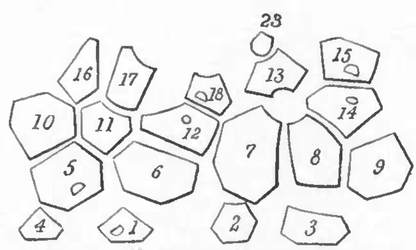

FIG. 8.—Analysis of *Jaekelocystis avellana* Schuchert.

Ambulacra narrow, but appearing wide on account of their lying in rather deeply excavated thecal grooves, with sharply elevated margins, extending to the lower ends of the second or to the top of the basal circle of thecal plates. The 4 ambulacra are regularly disposed and do not converge. Nature of brachioles unknown, about 26 on each ambulacrum, or 13 on each side. Ambulacrals thick, causing the ambulacral furrow to be narrow; ambulacralia not preserved. Hydropore conspicuous and situated as in *J. hartleyi*. Anal pyramid not preserved. Anal area less conspicuous, but otherwise as in *J. hartleyi*. Pectinirhombs as in the species just cited, with 1 or 2 dichopores less to each rhomb. Column unknown.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

Genus PSEUDOCRINITES Pearce

PSEUDOCRINITES GORDONI Schuchert

Plate XXXIII, Figs. 5-9; Plate XXXV, Figs. 11-13

Pseudocrinites gordoni Schuchert, 1903, Amer. Geol., vol. xxxii, p. 235.
Pseudocrinites gordoni Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 229-231, pl. xxxvi, figs. 8-12; pl. xxxix, figs. 11-13; text fig. 29.

Description.—Ambulacra angularly elevated, prominent, extending around the entire periphery of the theca, and touching the column in specimens 20 mm. or more in length. In some of these mature specimens the ambulacra, when near the column, are deflected, and one or both will pass on the same side for a short distance in front of it. In smaller specimens the ambulacra do not quite reach the column, and in one having a thecal length of 15 mm. they stop within 3 mm. of the stalk. In the largest specimen there are 40 brachioles on each side of an ambulacrum, while in one having a thecal length of 15 mm. there are about 21. Length of brachioles not definitely known; those of the apical region not less than 11 mm., stout, and with about 17 pieces in each column. Ambulacral groove wide and covered by a complex series of small and large ambulacralia. Basal pectinirhomb smallest, in the largest specimen having about 80 grooves; that on plates 12 and 18 has about 90, and the one on plates 14 and 15 is the largest, with about 120. Hydropore minute, closely adjoining the madreporite. Anal pyramid depressed, consisting of 7 somewhat ornamented plates surrounded by a circle of 8 larger plates of irregular size and definite sculpture. Column slender. Length unknown.

P. gordoni is the most prolific of American Pseudocrinites. The nearly circular outline of the theca and the greater number of brachioles distinguish this species from *P. clarki* and *P. perdewi*. Of forms with nearly circular theca *P. stellatus* differs in the very prominent sculpturing and the smaller number of brachioles, while *P. claypolei* differs in the vermiform sculpturing and fewer brachioles.

P. gordoni undergoes but little modification in form. In general the outline is circular, but occasionally a specimen is a little more elongate and in rare cases one is more transverse. Of the latter, one has a thecal length of 29 mm.; breadth 33 mm.; and depth 19 mm. There is very little abnormal material. One specimen has the amblacrum R IV abutting against the lower pectinirhomb instead of passing to the left of it. In another basally compressed individual, both ambulacra are bowed toward the anal side, particularly R IV, causing the opposite side of the theca to be more convex and almost angulated on the left.

Length of the largest theca 32 mm.; greatest width 32 mm.; depth 21 mm. For general form, shape of individual plates and their ornamentation, see the figures and diagram, fig. 9.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia. Common.

Collection.—U. S. National Museum.

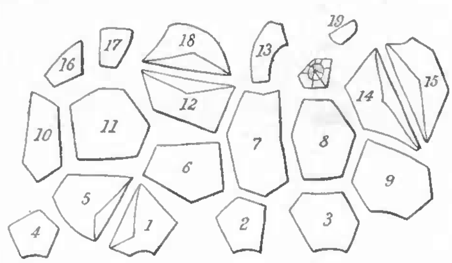

FIG. 9.—Analysis of *Pseudocrinites gordoni* Schuchert.

PSEUDOCRINITES SUBQUADRATUS Schuchert

Plate XXXIV, Figs. 1, 2

Pseudocrinites subquadratus Schuchert, 1904, Smith. Misc. Col., vol. xlvii. pt. ii, No. 1482, pp. 234, 235, pl. xxxv, figs. 4, 5.

Description.—Ambulacra prominent, rounded on the top, extending to the column, composed of 26 comparatively stout basement plates bearing 13 brachioles on one side of each ambulacrum. Brachioles short, very slender, about 5 mm. long, and having about 10 plates in each column. Ambulacral groove large. Ambulacralia not preserved. Pectinirhombs on plates 1 and 5, 12 and 18, about equally large and having about 33 dichopores, while that on plates 14 and 15 is largest and has 43. Madreporite prominent, situated as usual on plate 18; the hydropore is very minute. Anal area as in *P. clarki,* prominent, consisting of 2 circles of pieces, the outer one made up of 4 or 5 right posterior plates, 3 minute pieces on the left, and plate 13. The inner pyramid is not preserved in the specimen at hand.

This species is most closely related to *P. elongatus,* but the greater size and elongated theca of the latter will readily distinguish it. *P. clarki* is similar, but the greater size, oval outline, and the differently sculptured plates will serve to identify it.

Length of the only known specimen 16 mm.; width 12 mm.; depth 9 mm. The base of the theca is comparatively large, indicating a stout column; the oral end is flattened. Between the two flattened ends the theca is slightly convex, giving it the subquadrate outline indicated by the specific name. The sculpturing of the thecal plates is decidedly vermiculate, and not radiate as in most other species.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone.

Collection.—U. S. National Museum.

PSEUDOCRINITES ABNORMALIS Schuchert

Plate XXXIII, Figs. 10-12

Pseudocrinites abnormalis Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 231, 232, pl. xxxv, figs. 10-12; text fig. 30.

Description.—Pectinirhombs about equally large and each has from 65 to 70 folds. Basal pectinirhomb on plates 5 and 6 and not, as usual in this genus, on plates 1 and 5. In other words, this pectinirhomb is confined to the second circle of plates and is not divided, one-half of the rhomb being in the basal and the other half in the second row. Ambulacra as in *P. gordoni,* with about 34 brachioles on one side of each ambulacrum.

This species has the general expression of *P. gordoni,* except that the outline of the theca is regularly oval instead of nearly circular. It differs, also, in having the basal pectinirhomb on plates 5 and 6 instead of on plates 1 and 5. That the two forms are really closely related is shown by the arrangement of the anal plates. In *P. abnormalis,* as in *P. gordoni,* these are composed of 2 complete circles of plates, while in the group typified by *P. clarki* the outer circle consists of plate 13 and several small pieces restricted to the posterior half. Because of this close resemblance the writer regards the present specimen as abnormal in development, or a monstrosity, but thinks it best to give it a name, for easy reference. Were it not for the very close identity in all specific characters save the abnormal position of the basal pectinirhomb, one would be led to distinguish *P. abnormalis* as the type of a new genus. That the position of the basal pectinirhomb is abnormal is shown by the shape of plate 1, but especially by plate 6, which is notched to receive all the anterior edge of plate 1.

Length of the only specimen, 29 mm.; width 22 mm.; depth 14 mm.

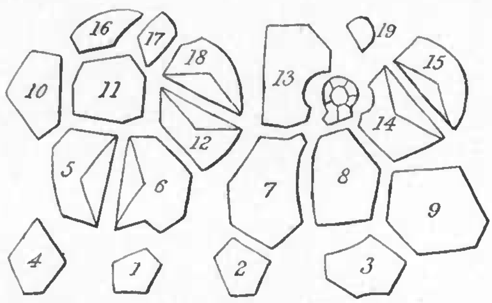

FIG. 10.—Analysis of *Pseudocrinites abnormalis* Schuchert.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

PSEUDOCRINITES STELLATUS Schuchert

Plate XXXIII, Figs. 13, 14; Plate XXXV, Fig. 7

Pseudocrinites stellatus Schuchert, 1903, Amer. Geol., vol. xxxii, p. 236.
Pseudocrinites stellatus Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 232, 233, pl. xxxv, figs. 8, 9; pl. xxxix, fig. 7.

Description.—Ambulacra well defined, flat topped, extending around the entire periphery of the theca and touching the column. Ambulacrals large. Each ambulacrum in full-grown specimens has about 36 brachioles; in a small specimen having a thecal length of 15 mm., there are but 24 brachioles. Brachioles usually not preserved. Ambulacral groove wide, roofed by a median double row of tiny angular ambulacralia arranged in short crescents, and outside of these by a single row of much larger, strongly elevated plates, each one of which is as large as two of the ambulacrals. Basal pectinirhomb with about 60 dichopores, that of plates 12 and 18 with 80, and of 14 and 15 with 90. Madreporite quite large for Pseudocrinites, but the hydropore is exceedingly minute. Anal area small, composed of 2 circles of plates; the outer has 7 nodose pieces and the inner depressed pyramid has the same number of plates. Column slender. Its length is unknown.

This species is readily distinguished from all other Pseudocrinites by the strongly stellate sculpturing of the plates. *P. gordoni* differs further in having many more brachioles.

Length of a large specimen 25 mm.; breadth 23 mm.; depth about 15 mm. Mr. Hartley has a specimen 32 mm. long and 30 mm. wide.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

PSEUDOCRINITES CLARKI Schuchert

Plate XXXIII, Figs. 15-18; Plate XXXV, Fig. 14

Pseudocrinites clarki Schuchert, 1903, Amer. Geol., vol. xxxii, p. 237.
Pseudocrinites clarki Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 233, 234, pl. xxxvi, figs. 4-7; pl. xxxix, fig. 14.

Description.—Ambulacra in mature specimens very prominent, triangular in transverse section, extending around the entire periphery of the theca and touching the column. In the second largest individual each ambulacrum had about 44 brachioles, in another mature but smaller specimen there were only 32. Brachioles unknown, apparently more slender than in *P. gordoni.* Ambulacral grooves narrow, and covered by highly elevated ambulacralia of about the same nature as in *P. gordoni,* but less numerous and the larger plates more nodose.

Basal pectinirhomb in the specimen of average size above mentioned, with about 42 dichopores, that of plates 12 and 18 with about 50, and that of plates 14 and 15, which is the largest, with about 68. In the largest specimen there are as many as 120 in a rhomb. Hydropore minute and closely adjoining the rather large and prominent madreporite, situated, as usual in Pseudocrinites, laterally between the ambulacra on the edge of plate 23.

Anal area well marked, consisting of 2 circles of plates. The outer circle has 4 small plates in the right posterior corner, and these are followed on the left by 3 very much smaller pieces. The latter are not readily seen, and the first impression is that the 4 pieces of the right posterior corner and plate 13 complete the circle. The prominent anal pyramid has 7 triangular pieces. Column stout, composed of thick pieces near the theca. Length unknown.

This species differs from other Pseudocrinites having ambulacra extending to the column, in its regularly oval outline. *P. subquadratus* is a much smaller species, subquadrate in outline, and with different thecal sculpturing. *P. elongatus* is more elongate subquadrate.

Length of largest theca 44 mm.; greatest width 30 mm.; depth 22 mm. Length of an average specimen 30 mm.; greatest width 22 mm.; depth about 16 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

PSEUDOCRINITES ELONGATUS Schuchert

Plate XXXIV, Figs. 3, 4

Pseudocrinites elongatus **Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 235, 236, pl. xxxv, figs. 6, 7; text fig. 31.**

Description.—Ambulacra prominent, extending around the entire periphery of the theca and touching the column. As the top of the theca is broken away, the exact number of brachioles cannot be counted, but, on the basis of brachioles preserved and the close relationship to *P. subquadratus*, the total number on each side of an ambulacrum is estimated to be between 26 and 28. Ambulacral groove large and deep; ambulacralia not preserved. Basal pectinirhomb has about 65 dichopores, that of plates 12 and 18 and 75, and of plates 14 and 15 about 110.

As the various forms of Pseudocrinites are easily recognized on account of their constant characters, the writer does not hesitate to describe this broken specimen as a new species. Its greatly elongate, narrow form distinguishes it from all the others. *P. elongatus* is closely related to *P. subquadratus,* as both have the same general form, size of ambulacral plates, and sculpture, but the former is readily separated by being more elongate with the sides of the theca straighter, and more especially by the far greater size, being 2½ times larger than *P. subquadratus.*

Oral end of the only specimen broken away, but the length seems to have been about 40 mm.; width 23 mm.; depth 17 mm.

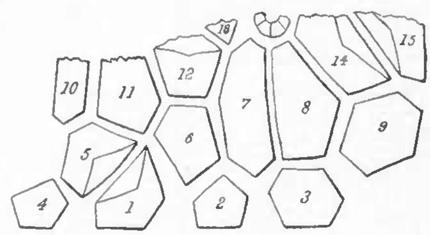

FIG. 11.—Analysis of *Pseudocrinites elongatus* Schuchert.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. L. Perdew's farm, Pleasant Valley, west of Martin Mountain.

Collection.—U. S. National Museum.

PSEUDOCRINITES PERDEWI Schuchert

Plate XXXIV, Figs. 5-7; Plate XXXV, Figs. 8-10

Pseudocrinites perdewi Schuchert, 1903, Amer. Geol., vol. xxxii, p. 238.
Pseudocrinites perdewi Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 236, 237, pl. xxxvi, figs. 1-3; pl. xxxix, figs. 8-10; text fig. 32.

Description.—General form pear-shaped, with the sides appressed. Ambulacra wide, very prominent, with vertical angulated sides and flat or slightly trough-shaped oral surfaces. In specimen no. 1, the 2 ambulacra taper rapidly and extend along the periphery of the theca for one-third its length. In no. 2, they are just one-half the length of the theca, in no. 3, nearly two-thirds the length, while in no. 4, they are about one-half the length. This shows that the length of mature ambulacra is somewhat variable, extending from one-half to two-thirds the thecal length. The ambulacrum nearest the anal region is always somewhat shorter. Number of brachioles on one side of each ambulacrum varying with age, there being in the youngest known specimen (no. 1) about 5, in a mature individual (no. 3) about 19, and in the largest example (no. 4) about 22. Ambulacral grooves narrow in comparison with the large size of the ambulacrals, and covered by very small rectangular ambulacralia which are sharply elevated into a median ridge. There are usually from 10 to 12 ambulacralia to each ambulacral, but in different specimens the number varies. The branches going to the brachioles at the lateral ends of the plates have the ambulacralia as well developed as the median series. Brachioles slender, composed of rather large, elongate, smooth pieces. Those at the distal ends of the ambulacra have 6 pieces in

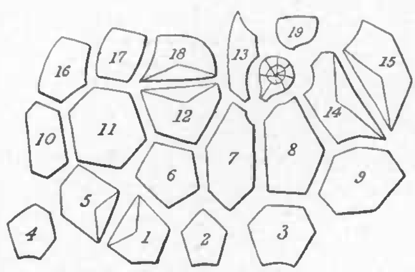

FIG. 12.—Analysis of *Pseudocrinites perdewi* Schuchert.

a column 4 mm. long; seemingly these brachioles did not exceed 12 mm. in length.

Anal area small, not prominent, and composed of 2 circles of plates. The outer circle has from 7 to 9 pieces of unequal size, and the flat pyramid has 7 or 8 equal triangular pieces. The madreporite is rather large for Pseudocrinites, but the hydropore is minute, and both are placed within a distinct hollow separating the ambulacra of one side. Basal pectinirhomb smallest, that of plates 14 and 15 largest. Column slender, tapering rapidly for a short distance from the theca, and composed of pieces of equal thickness. Length unknown.

This splendid large and odd Pseudocrinites is readily distinguished from all other species of the genus by the short, high, and angulated ambulacra. The form of the theca and the plate sculpturing are also characteristic.

The four following specimens represent four stages in the growth of this species:

	Length	Width	Depth	Brachioles (total)	Rhomb 1-5	Rhomb 12-18	Rhomb 14-15
Specimen 1 ..	16 mm.	11 mm.	9 mm.	23	20 dichop.	34 dichop.	40 dichop.
Specimen 2 ..	24 mm.	17 mm.	12 mm.	48	42 dichop.	48 dichop.	58 dichop.
Specimen 3 ..	35 mm.	27 mm.	15 mm.	76	53 dichop.	65 dichop.	82 dichop.
Specimen 4 ..	57 mm.	39 mm.	?20 mm.	90	82 dichop.	114 dichop.	148 dichop.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

Genus TRIMEROCYSTIS Schuchert

TRIMEROCYSTIS PECULIARIS Schuchert

Plate XXXIV, Figs. 8-10

Trimerocystis peculiaris Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, pp. 239, 240, pl. xxxv, figs. 1-3; text fig. 34.

Description.—Ambulaera prominent, rounded, extending along three sides, bent around the excavated base of the theca, and touching the

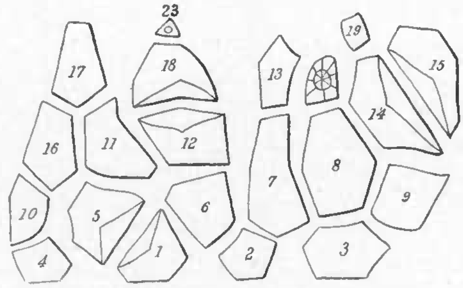

FIG. 13.—Analysis of *Trimerocystis peculiaris* Schuchert.

column. Each ambulacrum has on one side about 30 brachioles, or 60 to each ray, and about 180 on the entire theca. Brachioles apparently not very stout nor long, and composed of rather large pieces. Ambulacral grooves narrow, but deep, and covered by a series of small ambulacralia arranged much as in *Pseudocrinites perdewi,* with the pieces somewhat larger.

Basal pectinirhomb and that on plates 12 and 18, each with about 75 dichopores, and that on plates 14 and 15 with about 110. Madreporite large and the hydropore immediately in front of it somewhat larger than in Pseudocrinites. Both are situated on plate 23. Anal pyramid composed of 7 pieces, and surrounded by another circle of larger pieces of which there appear to be 7 or 8. The anal area lies between plates 7, 8, 13, and 14. Column very stout. Length unknown. Length of theca 35 mm.; width 26 mm.; depth 20 mm. Base of theca deeply excavated and occupied by a stout column.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia. Just below Gypidula zone.

Collection.—U. S. National Museum.

Subfamily CALLOCYSTINAE

Genus SPHÆROCYSTITES Hall

SPHÆROCYSTITES MULTIFASCIATUS Hall

Plate XXXIV, Figs. 11, 12; Plate XXXV, Figs. 1-4

Sphærocystites multifasciatus Hall, 1859, Pal. N. Y., vol. iii, p. 130, pl. 7*a*, figs. 1-4, 1861.

Sphærocystis multifasciatus Haeckel, 1896, Beitr. Morph. u. Phyl. d. Echinodermen, p. 133.

Sphærocystites multifasciatus Jaekel, 1899, Stammesgeschichte der Pelmatozoen, i, p. 289.

Sphærocystites multifasciatus Schuchert, 1903, Amer. Geol., vol. xxxii, p. 233.

Sphærocystites multifasciatus Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 250, 251, pl. xxxviii, figs. 1, 2; pl. xxxix, figs. 1-4; text figs. 38, 39.

Description.—Ambulacra 4, branching rapidly and with no apparent regularity, the branches varying from 14 in the youngest to 27 in the largest theca. These spread between and around the anus and pectinirhombs until the greater portion of the thecal surface is occupied by them, obscuring the suture lines between the thecal plates. Brachioles widely separated, about 3 in 5 mm.; club-shaped, tapering to a point, and about 3 mm. long. Ambulacrals large, to each of which there are about 5 ambulacralia. Dichopores in sharply delimited, low, angulated, discrete pits; in other words, the grooves of the 2 parts of the pectinirhombs do not meet each other at the suture lines of the plates of which they are a part, but are restricted to the prominent pits. From 40 to 45 grooves in each pit. Anal pyramid depressed, composed of 6 pieces and surrounded by a ring of 3 large aboral and 7 small oral pieces. Hydropore minute, closed by a pyramid of 4 pieces, and situated immediately in front of the large madreporite occupying the greater portion of plate 18.

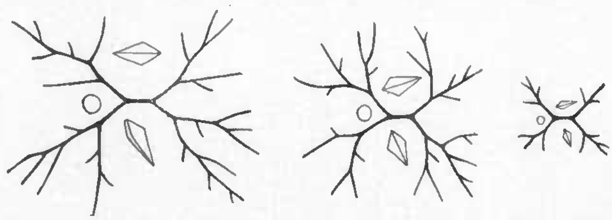

FIG. 14.—Diagrams showing the manner and number of ambulacral branches in a young, adult, and old specimen of *Sphærocystites multifasciatus* Hall.

Column slender, with about 16 stout and equally large segments beneath the theca, followed by others of unequal size of which the larger segments are widely separated. Length of one of the largest theca 19 mm.; transverse diameter in both directions 24 mm. Another large theca has a length of 19 mm.; diameter in the direction of the two upper pectinirhombs

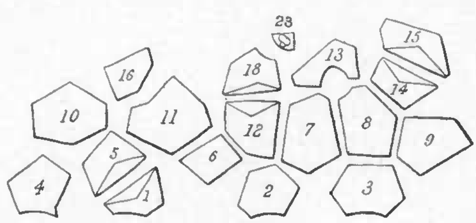

FIG. 15.—Analysis of *Sphærocystites multifasciatus* Hall.

20 mm., and in the opposite direction through the anus 22 mm. A greatly depressed specimen has a length of 13 mm., and a diameter of 20 mm. A young theca has a length and diameter of 9 mm. Base of theca more or less excavated, greatest in the depressed specimens. Plate 12 rests on basal plate 2.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia. Abundant. Cumberland, Maryland.

Collection.—Maryland Geological Survey.

SPHÆROCYSTITES GLOBULARIS Schuchert

Plate XXXIV, Figs. 13, 14; Plate XXXV, Figs. 5, 6;
Plate XXXVI, Fig. 1

Sphærocystites globularis Schuchert, 1903, Amer. Geol., vol. xxxii, p. 233.
Sphærocystites globularis Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, pp. 252, 253, pl. xxxviii, figs. 3-5; pl. xxxix, figs. 5, 6; text figs. 40, 41.

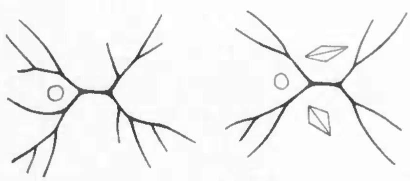

FIG. 16.—Diagrams showing the number of ambulacral branches in two specimens of *Sphærocystites globularis* Schuchert.

Description.—Ambulacra branching with no apparent regularity, the branches in adults varying between 9 and 14. Ambulacralia about 7 to each ambulacral. Anal pyramid depressed, composed of 8 pieces, and sur-

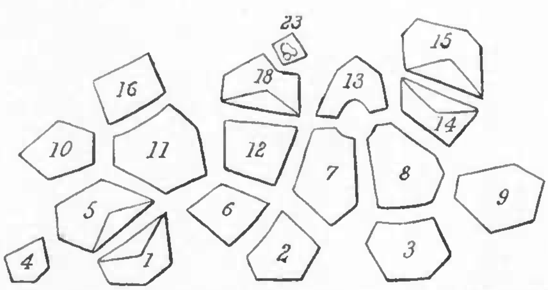

FIG. 17.—Analysis of *Sphærocystites globularis* Schuchert.

rounded by a ring of 4 large and 10 small plates. Hydropore minute, closed by a pyramid of 5 pieces, and situated immediately in front of the elongate dumb-bell-shaped madreporite on plate 21. Column tapering rapidly for a very short distance and then hardly at all throughout the remainder of its length. Total length about 95 mm., with the root end about 7 mm. high. First 11 segments beneath the theca thinnest, with angulated peripheries, followed by about 65 segments of nearly equal size and rounded edges.

This species is readily distinguished from the associated *S. multifasciatus* by the globular form of the theca, the non-excavated base, the smaller number of ambulacral branches, thus causing the surface to appear smoother; finally, by the higher position of plate 12, which does not attain the basal row as in that species.

Length of a large and regular theca 22 mm.; transverse diameter 20-21 mm. Base not excavated. Plate 12 resting on plate 6 of the second circle.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Maryland; Keyser, West Virginia.

Collection.—U. S. National Museum.

SPHÆROCYSTITES GLOBULARIS VAR. OVALIS Schuchert

Plate XXXVI, Fig. 2

Sphærocystites globularis ovalis Schuchert, 1904, Smith. Misc. Col., vol. xlvii, pt. ii, No. 1482, p. 253, pl. xxxviii, fig. 6.

Description.—Associated with *S. globularis* are specimens that attract attention on account of their more elongate and regularly ovate thecæ. These specimens never attain the size of that species, however, and they commonly retain a portion of the column, a feature much more rare than in the variety *ovalis*. In addition to the smaller size, and the rounded-ovate outline of the theca, the variety is further distinguishable in always having the 4 ambulacra less bifurcate. The number of branchlets varies between 5 and 10, the average being 6 or 7. In 13 specimens, the ambulacra divided as follows: 1 with 5 branchlets, 4 with 6, 4 with 7, 2 with 8, 1 with 9, and 1 with 10. In *S. globularis* the average number of branchlets is between 10 and 12.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

CLASS CRINOIDEA

Order CAMERATA

Family THYSANOCRINIDAE

Genus THYSANOCRINUS Hall

THYSANOCRINUS EUGENIUS n. sp.

Plate XXXVI, Figs. 3-7

Description.—Body medium in size, urn-shaped, truncate dorsally, the infrabasals and the lower parts of the basals forming the base of the body; wall of body almost straight below arm bases. Infrabasals 5, protruding beyond the periphery of column; basals 5, largest of the calyx, extremely convex; posterior basal larger than the rest and truncate above; the 4 lateral basals hexagonal, angular above; radials larger than costals, very convex and prominent heptagonal, angular below, truncate above; costals 2 x 5, very convex, prominent, the first hexagonal, truncate above and below, the second pentagonal, truncate below, angular above, each side of angle bearing a distichal; distichals 4 (?) x 10, the first larger than the rest which are transversely elongate, the last one often bearing a short, stout spine; arms 10, simple, biserial, composed of alternating cuneiform plates, and often bearing at fairly regular intervals a single spine or even a pair; pinnules not seen; intercostals 3—one in the first series, large hexagonal—two in the second series, hexagonal, smaller than the first and situated above it and between the second costals; interdistichals 5 or more, small; interradial areas much depressed below the radial; anal interradial wider than the others, the first plate large, conspicuous, highly convex, resting on upper truncated edge of posterior basal and between the postero-lateral radials, three plates in the second series, the middle one most prominent and resting directly upon the first series, other series present (indeterminate in specimens examined), the middle one always the more prominent by its convexity. Stem and tegumen unknown.

Four individuals of this species are known to the writer. Of these two have spinose arms while the others seem to be without this feature. Nevertheless, unless further collections show this to be other than a specific variation, all must be regarded as one species.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—U. S. National Museum.

Family MELANOCRINIDAE

Genus TECHNOCRINUS Hall

TECHNOCRINUS SCULPTUS (Hall)

Plate XXXVI, Figs. 10, 11

Mariacrinus (*Technocrinus*) *sculptus* Hall, 1859, Pal. N. Y., vol. iii, p. 143, pl. lxxxvi, figs. 13, 14, 1861.

Description.—"Body unknown. Base urn-shaped, gradually expanding above, abruptly expanded at the junction of the column: cavity for the insertion of the column large. Basal plates marked by strong sharp ridges, which diverge from the base to the upper margins, and unite upon the lines in the direction from the angles to the base of the plates." Hall, 1859.

This species is known only from the basal and first radial plates. The writer has not seen it.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (fide Hall).

Collection.—American Museum of Natural History.

TECHNOCRINUS STRIATUS (Hall)

Plate XXXVI, Figs. 8, 9

Mariacrinus (*Technocrinus*) *striatus* Hall, 1859, Pal. N. Y., vol. iii, p. 142, pl. lxxxvi, figs. 12 and 5-11, 1861.

Description.—"Body unknown. Surface of plates marked by strong elevated striæ, diverging from the center. Basal plates four, wider than long, small. First radial plates wider than high. Column small." Hall, 1859.

This species is known only from the basal and first radial plates. The writer has not seen it.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (fide Hall).

Collection.—American Museum of Natural History.

TECHNOCRINUS ANDREWSI (Hall)

Plate XXXVIII, Fig. 2

Mariacrinus (Technocrinus) andrewsi Hall, 1859, Pal. N. Y., vol. iii, p. 141, pl. lxxxvi, figs. 1-4, 1861.

Technocrinus andrewsi Wachsmuth and Springer, 1897, Mem. Mus. Comp. Zool., No. 20, p. 306, pl. xxiv, fig. 3.

Description.—"A rather large species. Calyx to the arm bases hemispherical; plates moderately convex, surrounded by sets of short marginal ridges passing inward, three to four to each side of the plate, and by small pits along the sutures; the center of the plates perfectly smooth. Basals wider than high. Radials large, about as long as wide. First costals of the form of the radials, but considerably smaller; the second still smaller, narrower as well as shorter. Distichals one, axillary; supporting in the calyx two rather large palmars, followed by several cuneate, interlocking free plates, and these by two rows of subquadrangular pieces, united by a sharply zigzag suture. Arms four to the ray, strong, flat, and of almost uniform width throughout. Pinnules contiguous. Interbrachials four or five: 1, 2, 1, 1, all comparatively large. Column round, large, tapering; the joints rather long and slightly rounded exteriorly." Wachsmuth and Springer, 1897.

The writer has seen only the exterior mould of the lower part of the calyx of an individual of this species. It is larger than Hall's type, but the plates that can be made out indicate that it belongs to this species. The type came from Cumberland.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (fide Hall), Hancock.

Collection.—Maryland Geological Survey.

TECHNOCRINUS SPINULOSUS (Hall)

Plate XXXVII, Figs. 1, 2

Mariacrinus (Technocrinus) spinulosus Hall, 1859, Pal. N. Y., vol. iii, p. 140, pl. lxxxv, figs. 1-18, 1861.

Technocrinus spinulosus Wachsmuth and Springer, 1897, Mem. Mus. Compt. Zool., No. 20, p. 305, pl. xxii, fig. 3.

Description.—" Calyx subglobose, the arm bases slightly contracting. Plates of the dorsal cup marked by a central spine or node, surrounded by smaller nodes, which vary in number among the plates. From the nodes two to four parallel ridges pass out to the sides, and these are continued upon adjoining plates. Near the arm bases the ridges gradually disappear, and the plates are marked only by a central spine.

"Basals four, of medium size, forming a shallow basin with five sets of four ridges, each set communicating with those upon the radials. Radials and costals nearly as wide as long, decreasing in size upwards; the second costal but half the size of the first. Distichals one to each side of the costal axillaries. The first palmar enclosed in the calyx. Arms twenty, stout, rounded; composed at their bases of cuneate pieces, which interlock farther up, and gradually become biserial. Interbrachials apparently four. All other parts of the calyx unknown. Column slightly pentagonal, each alternate joint provided with a node or short spine at the margin." Wachsmuth and Springer, 1897.

Two imperfect specimens from the Oriskany comprise all that the writer has seen. The species is well marked and although the specimens are imperfect they are readily recognized as belonging to this species. Hall's type of this, as of all other species of this genus, was found near Cumberland.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—U. S. National Museum.

TECHNOCRINUS (?) LEPIDUS n. sp.

Plate XXXVII, Figs. 3-5; Plate XXXVIII, Fig. 1; Plate XXXIX

Description.—Specimen large; calyx cup-shaped, depressed dorsally, somewhat constricted at arm bases; plates generally highly convex, smooth. Basals not discernible in specimens observed; costals 2, second pentagonal and axial; distichals 2 x 10, the first usually hexagonal, the second pentagonal, hexagonal or heptagonal and axillary; palmars 2 x 20, of irregular shape, each second one bearing an arm; intercostals 3, one in the first series, hexagonal, situated above and between the radials and between the first costals, two in the second series, situated between the second and costals, and above and between the second costals and the intervening intercostal of the first series; interdistichals several (7-10), of irregular size, shape and arrangement, all smaller than the corresponding distichals, some much smaller; interpalmars about 5, variable in size, arrangement and shape; interaxillaries 3, with supplementary smaller ones between the bases of the arms, the first interaxillary situated above and between the first costals, the second and third succeeding in order, each limited laterally by the palmars; between the bases of each pair of arms originating from the same costal is one or more small plates.

Arms 20, biserial, extremely long and carrying multitudinous long pinnules, composed of several acutely spheroid alternating plates which are followed by regularly arranged alternating cuneiform plates. The lower plates of the calyx cannot be made out with certainty in any of the specimens at hand. The genus Technocrinus has been found so far only in the Oriskany of Maryland. To it are referred provisionally certain large, pinnuliferous specimens from the region of Hancock. These are all in the form of natural moulds of the exterior. The interior casts are also found, but in the latter no arrangement of plates can be made out. The chief difference between the genus as defined by Wachsmuth and Springer and the specimens here referred to it, is in the distichals. When, however, it is remembered that the definition of the genus was based on two species, it is not surprising that such deviations should arise as other species are discovered. Mr. Springer, to whom the specimens under consideration were submitted, would refer them provisionally to this genus and the writer is of the opinion that further collections will show this to be correct. In one specimen the arms measure more than 22 cm. in length.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cacapon Bridge; Pennsylvania Sand Quarry, 3 miles north of Berkeley Springs, West Virginia.

Collection.—Maryland Geological Survey.

Order FISTULATA

Family CALCEOCRINIDAE

Genus CALCEOCRINUS Hall

CALCEOCRINUS MARYLANDICUS n. sp.

Plate XL, Figs. 1-3

Description.—Body robust, laterally compressed. Basal disk of medium size, highly convex. Basals three, probably anchylosed, the suture lines barely discernible. Anterior basal U-shaped, truncate anteriorly. Lateral radials large, irregularly hexagonal, strongly convex and cinctured transversely. Anterior radials small as compared with the laterals, triangular, not in contact, apices ending near the bottom of a deep circular depression. The first brachial of the anterior ray large, wider than high, quadrangular, its lower angles in contact with the lateral radials and lower lateral brachials. The lower lateral brachials two, separated by depression, but evidently joined by syzygy, the suture lines, however, being discernible; the lower one much wider than high, quadrangular, separated from the radial below by a gaping suture; the upper one pentagonal, axial, supporting on its horizontal edge a vertically ascending arm, and on its vertical side another axial plate which likewise bears an arm and a plate and so on until the number of lateral arms is eight; the axial plates form a marked ridge running along the bases of the arms. Lateral arms cylindrical, branching at about every fourth joint, which is nodose. Anterior arm much more robust than the lateral, cylindrical, its plates separated by deep incisions, not branching at least below the twelfth plate. Anal plates two, triangular, separated from the basal disk by a deep semicircular fossa, and truncate above.

The upper surfaces jointly support a large anal tube which is larger at its base than the anterior arm, and decreases in size upward at least to the third plate where the tube disappears within the enfolding lateral arms. The posterior half of this anal tube is composed of large semicylindrical plates, but the anterior (interior) portion is invisible. Stem robust, composed evidently of plates uniform in size. The species is based on a specimen in the Museum of the Maryland Aeademy of Scienees collected by John Widgeon. This specimen seems, however, quite distinct from any heretofore described, and so far as the writer knows is the first occurrence of this genus in the Lower Devonian. The writer is informed that when found the stem was separated from the calyx so that only presumably are they the same individual. The upper portion of the arms has been broken off.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Quarry opposite Keyser, West Virginia.

Collection.—Maryland Academy of Sciences.

Family CYATHOCRINIDAE

Genus HOMOCRINUS Hall

HOMOCRINUS PROBOSCIDALIS Hall

Plate XL, Figs. 4, 5

Homocrinus proboscidalis Hall, 1859, Pal. N. Y., vol. iii, p. 138, pl. lxxxv, figs. 24, 25, 1861.

Description.—"Body subturbinate; base large. Basal plates wider than long, hexagonal. Radial plates about as long as wide; brachial plates resting upon the truncated edges of the radial plates.

"Arms bifurcating upon the third brachial plate, and again upon the third and fifth or sixth plate above the first bifurcation: bifurcation apparently equal. Proboscis long, fusiform, very slender below, and acquiring its greatest diameter at about two-thirds the distance from base of body to summit of proboscis. Column unknown." Hall, 1859.

The writer has not seen this species.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (fide Hall).

Collection.—American Museum of Natural History.

HOMOCRINUS HARTLEYI n. sp.

Plate XL, Fig. 6

Description.—Calyx small, broadly invert-conical, expansion regular from base of calyx to base of arms. Under basals 5, pentagonal, the lateral edges converging downward, lower edge coincident with the faces of the column. Basals large, largest of the calyx, convex, the four laterally situated are pentagonal, the posterior hexagonal and truncate above bearing the anal. Radials alternating with the basals and resting above and between the four simple and pentagonal, the right posterior one being not easily made out, but apparently unlike others, upper edge of all notched but not profoundly. Anal large. Lower arm plates rather small, wider than high and profoundly convex, making the calyx deeply excavated between the arm bases. Column pentagonal, enlarged above. Arms and tegmen unknown.

The species is based on one specimen in the collection of Mr. Hartley, but is quite clearly marked as a new species. It is larger than any other American form referred to this genus known to the writer except *Homocrinus polyxo* (Hall) from the Waldron Niagara. It has not, however, the interplate ridges of that species and the radially situated plates are not so deeply notched.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—Frank Hartley.

Family AGASSIZOCRINIDAE

Genus EDRIOCRINUS Hall

EDRIOCRINUS SACCULUS Hall

Plate XL, Figs. 7-12

Edriocrinus sacculus Hall, 1859, Pal. N. Y., vol. iii, p. 143, pl. lxxxvii, figs. 1-22, 1861.

Edriocrinus sacculus Weller, 1903, Geol. Survey N. J., Pal., vol. iii, p. 342, pl. xlv, figs. 3-5.

Description.—"Body more or less obconic or turbinate below and cylindrical above, varying in its proportions of length and breadth. Base varying in form from turbinate to hemispheric, solid, often obliquely truncate or indented below: upper margin marked by six subangularly concave depressions for the insertion of the radial and anal plates. Radial plates large, longer than wide, inserted into the depressions in the margin of the base, gradually expanding towards the upper margin which is thickened externally, slightly concave for the reception of the plates of the arm. Arms broad at the base, composed of numerous very short transversely linear plates, of which ten or twelve or more occur below the first bifurcation: first bifurcation in the middle, and each side again bifurcating on the third or fourth plate above, with each division bifurcating once or twice beyond this; making eight or ten or more divisions at the extremities. Anal plates two, the lower large and of the same form as the radial plates; the second one small and short. Proboscis and summit unknown. Column, none; affixed to foreign bodies by the solid base." Hall, 1859.

This is the most common crinoid of the Oriskany. Usually the arms have been broken off but in the fine collection of Mr. Hartley is a group of two, both of which are nearly perfect, and others preserving fragments of the arms. It was upon collections from Cumberland that Hall based his original description and account of the habits of the genus.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Knobly Mountain, near Cumberland; east side Nicholas Mountain and elsewhere in Maryland; Franklin, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

EDRIOCRINUS POCILLIFORMIS Hall

Plate XL, Figs. 13-15

Edriocrinus pocilliformis Hall, 1859, Pal. N. Y., vol. iii, p. 121, pl. v, figs. 8-12, 1861.

Edriocrinus pocilliformis Meek and Worthen, 1868, Geol. Survey Ill., vol. iii, p. 370, pl. vii, figs. 5*a*, *b*.

Edriocrinus pocilliformis Keyes, 1894, Missouri Geol. Survey, vol. iv, pt. i, p. 221, pl. xxx, fig. 7.

Edriocrinus pocilliformis Talbot, 1905, Amer. Jour. Sci., 4th ser., vol. xx, p. 23, pl. iv, figs. 1-6.

Description.—" Base hemispheric or subturbinate, often less than a hemisphere, externally smooth or finely granulate: upper margin scolloped with five large and one smaller depression for the insertion of the radial and anal plates. Interior more or less deeply concave, with depressions corresponding to those on the edge of the cup; the concavity not parallel to the exterior convexity. Radial plates and arms unknown." Hall, 1859.

" Infrabasals present but so fused that their number is uncertain. Height from one-half to two-thirds that of the cup as ordinarily found. Basals five, completely fused with each other and with the infrabasals or distinguished from the latter as a narrow protruding band. Suture lines sometimes apparent on the interior. Upper margin scolloped for the attachment of the radials and the anal plates. Height about half that of the infrabasals. Radials five, often as high as the infrabasals and basals combined, and like them, fused to form a part of the cup. In most instances, however, the suture lines between the radials are plainly discernible. As a rule, the union between the radials and basals is not so strong as that of basals with infrabasals; and the cup is generally broken off at the top of the basals. Since in no specimens are brachials preserved, the union of brachials with radials must have been still weaker. Anal plates as high as the radials, but only half as wide. Radials and anal gently convex, sloping in all directions from the center of the plate. Arms and ventral disc unknown. The attachment scar is visible on a number of specimens, and in some is a short distance up on the side of the cup, rather than on the bottom." Talbot, 1905.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cumberland, Maryland; Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

VERMES

CLASS ANNELIDA

Genus CORNULITES Schlotheim

CORNULITES CINGULATUS Hall

Plate XL, Fig. 16

Cornulites cingulatus Hall, 1888, Pal. N. Y., vol. vii, p. 20 (supplement to vol. v), pl. cxvi, fig. 29.
Cornulites cingulatus Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 27, pl. ii, figs. 35-38.
Cornulites cingulatus Weller, 1903, N. J. Geol. Survey, Pal., vol. iii, p. 272, pl. xxxii, fig. 3.

Description.—"Tube very flexuous, with regularly transverse but unequally distant, sharply angled or evenly rounded annulations." Hall, 1888.

"Shell having the form of a gradually tapering, more or less curved or flexuous, annulated cone. On the internal casts the annulations have the aspect of insheathed cones, the slope being abrupt below and gradual above. The width of the annulations is variable, but is usually a little less than 1 mm.; they are somewhat irregular, there occasionally being one which does not entirely surround the tube." Weller, 1903.

A single specimen from the Keyser member appears to belong to this species and is the only one which the writer has seen from the Lower Devonian of the State.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Pinto.

Collection.—U. S. National Museum.

MOLLUSCOIDEA

CLASS BRYOZOA

Order CTENOSTOMATA

Family RHOPALONARIIDAE

Genus RHOPALONARIA Ulrich

RHOPALONARIA ATTENUATA Ulrich and Bassler

Plate XLVI, Fig. 1

Rhopalonaria attenuata Ulrich and Bassler, 1904, Smith. Misc. Coll., vol. xlv, p. 268, pl. lxvi, figs. 4, 5.

Description.—Several imperfectly preserved specimens from the Keyser limestone at Cash Valley agree very well with this widely distributed Silurian species, although it is possible that better specimens might show more relationship to the Devonian species of the genus. The various forms of Rhopalonaria are exceedingly alike and in the absence of good specimens, close specific determination is almost impossible. It must also be remembered that in this genus practically all the species are represented only by the clay filled or empty excavations left by the parasitic zoarium which excavated the surface of its host.

The zoarium of *Rhopalonaria attenuata* is adnate, and is usually about half embedded in its host which most often is a coral, crinoid stem, or brachiopod. The zoœcia are unknown, in fact the excavations undoubtedly represent only the creeping basal portion of the zoarium. As will be noted from fig. 1 on pl. xlvi, this basal portion consists of well-defined fusiform internodes or cells connected by delicate stolons, all being arranged in a pinnate manner. The extreme tenuity of its parts and the rigidity of their arrangement are particularly characteristic of the present species.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family ASCODICTYONIDAE

Genus ASCODICTYON Nicholson and Etheridge, Jr.

ASCODICTYON SILURIENSE Vine

Plate XLVI, Fig. 2

Ascodictyon stellatum var. *siluriense* Vine, 1882, Quart. Jour. Geol. Soc. London, vol. xxxviii, p. 52, figs. 1, 2.

Ascodictyon stellatum var. *siluriense* Vine, 1884, Ann. & Mag. Nat. Hist., ser. v, vol. xiv, p. 81.

Ascodictyon stellatum var. *siluriense* Vine, Proc. Yorkshire Geol. and Polyt. Soc., vol. ix, p. 184, pl. xii, fig. 6.

Ascodictyon siluriense Vlne, Proc. Yorkshire Geol. and Polyt. Soc., vol. xll, p. 88, pl. ii, fig. 1.

Ascodictyon siluriense Ulrich and Bassler, 1904, Smith. Misc. Coll., Quart. Issue, vol. xlv, p. 286, pl. lxviii, figs. 11, 12.

Description.—Vesicles pyriform, small end more or less drawn out, 0.1 mm. to 0.2 mm. in diameter, and 0.3 mm. to 0.5 mm. in length, arranged in clusters of four to eight, with groups of four or five occurring oftener than six to eight. Connecting threads about 0.03 mm. in thickness, comparatively straight, with clusters of vesicles occurring at intervals of 2.5 mm. or more.

The Maryland specimen identified with this widespread Silurian species agrees in all essential details with the above description. The preservation of this specimen, however, is not of the best and it is possible that more material may show differences of varietal if not specific importance.

The only known specimen from this horizon is incrusting a brachiopod.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collection.—U. S. National Museum.

Order CYCLOSTOMATA

Family CERAMOPORIDAE

Genus CERAMOPORA Hall

CERAMOPORA ? INCONDITA n. sp.

Plate XLI, Figs. 13-17; Plate XLIV, Figs. 1-3

Description.—Zoarium beginning as a crust on foreign bodies which it may cover entirely or spread beyond, often growing by superposition of layers 3 to 5 mm. in thickness, into small, irregular, sometimes knotty masses. Surface rough, apparently without well-distinguished maculæ. Zoœcial apertures nearly or quite direct, irregular, more often ovate than of any other shape, the lunarial side commonly the most narrowly curved part of the outline; 4 to 5 in the space of 3 mm. Mesopores very variable in size and distribution, averaging about two to each zoœcium and usually less than half the diameter of the latter, though sometimes exceeding that dimension. Lunarium crescentic in shape when normal, but usually appearing more like irregularly disposed knots arising from the wall.

In vertical section the walls of the tubes are at first rather thin; however, they soon increase in thickness and become very irregular with alternating light and dark spots, and here and there evidence of a large connecting pore. The mesopores which give one more the impression of an irregular cellular or spongy tissue than of tubes, originate with the thickening of the zoœcial walls. Thin diaphragms occur in the zoœcial tubes, usually a little more than their own diameter apart.

In tangential sections the proximal portions of the tubes are thin walled and prismatic, farther out they are irregularly ovoid with thick, almost spongy, walls in which it is difficult to distinguish the lunarium. In certain areas, probably representing maculæ, which occur at long intervals, the mesopores are more abundant than in the intervening spaces.

This peculiar species agrees fairly well in internal structure with *Ceramopora imbricata,* the type of the genus, excepting that it has not the basal spongy tissue characterizing that form, and has diaphragms which have not been discovered in *C. imbricata.* But the zoœcia and mesopores have the same indefinite wall structure and large openings in the walls allowing neighboring tubes to communicate with each other and the interstitial pores, that, in connection with the peculiar basal tissue, caused Ulrich[1] to restrict the genus Ceramopora to the type species. Continued studies have caused us to think less of the basal tissue as a diagnostic character, yet the genus remains sharply distinguished from the other genera of the family.

Occurrence.—Helderberg Formation, Keyser Member. Abundant near Cumberland, Pinto, Maryland; Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

[1] Geol. Surv. Illinois, vol. viii, 1890, p. 493.

Family FISTULIPORIDAE

Genus FISTULIPORA McCoy

FISTULIPORA MACULOSA (Hall)

Plate LI, Figs. 1, 2

Callopora maculosa Hall, 1883, Rept. State Geol. N. Y. for the year 1882, pl. xiv, figs. 1-8.

Lichenalia maculosa Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 30, pl. xiv, figs. 1-8.

Description.—Zoarium consisting of irregular, explanate, layers which by superimposition often form large masses. The individual layers vary in thickness from 1 to 8 mm. and exhibit a strongly wrinkled epitheca on the under surface. Zoœcial apertures broadly oval; length .33 mm., width .25 mm., irregularly disposed, sometimes in contact but most often separated by vesiculose interspaces. Surface marked by maculæ whose centers are distant from each other by about 6 mm.

Not uncommon in the New Scotland limestone at several localities in New York.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. North foot of Moore Knob, Washington County.

Collection.—U. S. National Museum.

Genus FISTULIPORELLA Simpson[1]

Description.—" Zoarium laminar or massive from superposition of successive layers of growth; cells tubular; pseudoseptate; apertures subcircular, enclosed in a sloping, polygonal, vestibular area. On the interapertural surface, in addition to the vesicular cavities, are small oval apertures, with equally elevated peristomes; intercellular space vesiculose." Simpson, 1894.

Type: *Fistulipora constricta* Hall. Hamilton of New York.

The only peculiarity mentioned in the above description is the presence of "small oval apertures, with equally elevated peristomes" on the elevated interzoœcial spaces. As the writers understand the type species, Mr. Simpson failed to grasp the most essential characters distinguishing that species, in common with a number of other forms, from other genera of

[1] Fourteenth Ann. Rept. State Geol. N. Y. for the year 1894, p. 560.

the family, and, in particular, Fistulipora. The elevation of the interapertural space to form the so-called vestibular area is by no means a constant character even in the same individual of *F. constricta*. Then as to the oval interzoœcial cells, they are distinguishable only where the surface has been somewhat worn; the perfect condition, which is clearly indicated on some of the specimens, showing that they are only remnants of an extra superficial, cellulose tissue formed by the abundant development and lateral confluence of rod-like prolongations of the walls of the vesicles through the dense outer layer that occurs in all Fistuliporidæ. Possibly these oval outlined remnants in *F. constricta* lodged a distinct type of zooid, since very similar cells occur in other species in which the superficial cellulose tissue is very incompletely developed.

The writers conception of the essential characters of the generic group for which the name Fistuliporella is adopted, is based principally upon the either isolated and spine-like or laterally confluent prolongations of the interstitial walls, which in the former case appear as mere granulations or spines upon the surface, and in the latter form a wholly superficial, cellulose tissue. In tangential sections, these structures are seen to be developed only in the outer parts of the zoarium, beginning as swellings of the walls of the vesicles just before the development of the dense tissue characteristic of the mature region. In this dense tissue through which these structures pass, they appear either as isolated dots or as laterally united rows of such dots, their position in all cases corresponding to that of the wall of the last interstitial vesicle. Used in this sense, the genus will include, besides Simpson's type, *Lichenalia cornuta* and *L. ramosa* Hall and Simpson, *Fistulipora eriensis, spinulifera,* and *utriculus* Rominger, and *F. interaspera* Hall and Simpson, from the Hamilton, the species next described and several undescribed forms from the Niagaran strata.

FISTULIPORELLA CUMULATA n. sp.

Plate XLI, Figs. 1-5

Description.—Zoarium forming by the superposition of successive layers of growth, rounded or irregular masses 20 to 30 mm. in diameter; individual layers 1 to 3 mm. in thickness. Surface even, but exhibiting sharply defined, subsolid, slightly depressed, grano-cellulose maculæ at regular intervals of about 2 mm. measuring from center to center. Zoœcial apertures trilobate or subcircular, very slightly oblique, small, 8 to 9 in 2 mm., those surrounding the maculæ, little, if any, larger than the others. Lunarium prominent, sharply elevated, forming about one-third or a little less of the circumference of a zoœcium. Interzoœcial spaces flat or gently convex and abundantly granulose.

In sections the zoœcia are seen to be circular in the less matured region but strongly trilobate in the superficial region; here also the lunaria are well developed. In the maculæ and interzoœcial spaces the granulæ are arranged in rows corresponding with the outer walls of the vesicles. The vesicles are small, usually in two rows between neighboring zoœcia. At the surface they are, as is usual in this genus, filled with a dense secondary deposit of tissue through which, however, the rods terminating in the superficial granulæ, penetrate. As may be seen also in vertical sections, these rods are almost limited to the dense outer deposit. The zœcial tubes have diaphragms distributed rather regularly at intervals about equalling their own diameter. Vesicles rather regularly arranged, averaging 9 to 10 in .5 mm. vertically.

This form is closely allied to the Hamilton species *F. cornuta* (Hall and Simpson), but is smaller in all its dimensions except the size of the zoarium. In form and size of its zoœcia, it agrees more closely with an undescribed species occurring in the Waldron shale of Indiana.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley, Pinto, Maryland; Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

FISTULIPORELLA QUINQUEDENTATA n. sp.

Plate XLI, Figs. 6-8

Description.—Zoarium forming a thin crust on foreign bodies, usually some cyathophylloid coral. Maculæ distinct, substellate, on a plane with the general surface, of moderate size, grano-cellulose. Zoœcial apertures somewhat transverse, the circumference usually appearing a little straightened on the lunarial side, though in fact more sharply curved about the middle of the lunarium. Interzoœcial spaces finely spinulose or appearing cellulose, usually flat, occasionally a little convex, the average width less than the diameter of the zoœcial apertures; 6 to 7 of the latter in 2 mm. Peristome very thin; lunarium but slightly thicker and more elevated, though never very prominent, and carrying three tooth-like projections that are clearly distinguishable at the surface only when the specimen is exceptionally well preserved.

The most striking peculiarity brought out by tangential sections is the three denticles on the lunarium, which, with the usually free ends of the lunarium, project into the zoœcial cavity, giving the posterior side of its circumference the quinque-dentate character that has suggested the name. In other respects, the internal characters are as usual in species of Fistuliporella. Unless these three extra denticles are comparable with the lunarial pores of Anolotichia they are to be considered as a unique feature among Paleozoic bryozoa.

Among stratigraphically associated bryozoa, *Lioclema pulchellum* presents considerable zoarial resemblance, but its internal, as well as finer superficial characters, are so different that it is not likely to be confused with this Fistuliporella.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

FISTULIPORELLA MINIMA n. sp.

Plate XLIII, Figs. 13-16

Description.—Zoarium, in the only specimen seen, a depressed globular mass about 20 mm. in diameter, composed of numerous thin, closely superposed layers, 1 to 3 mm. thick, of which the first probably grew upon some foreign body. Surface, where well preserved, showing small, subsolid maculæ raised into low monticles, a trifle less than 2 mm. apart, measuring from center to center. Zoœcia very small, their apertures rounded or somewhat obscurely trilobate and sunk in depressions so that the lunarium is scarcely discernible at the surface, 11 to 12 in 2 mm. Interapertural spaces a little narrower than the zoœcial tubes, ridge-like, and, in common with the maculæ, minutely granulose.

On account of the partial silicification of the specimen, the thin sections prepared are not wholly satisfactory. They show sufficient of the structure, however, to leave no doubt of the generic affinities.

The extraordinarily small size of the zoœcia is the character principally relied upon in distinguishing this species, and it is so obvious when compared with associated bryozoa that there is no reasonable chance of confusing it with any other species known from these rocks.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley, Maryland; Keyser, West Virginia.

Collection.—U. S. National Museum.

FISTULIPORELLA MARYLANDICA n. sp.

Plate XLV, Figs. 8-11; Plate XLVIII, Fig. 4

Description.—In the general structure and size of the zoœcia this species resembles *Fistuliporella cumulata* but the difference in its method of growth, number and arrangement of the granules, tabulation of the zoœcia and distribution of the vesicles are sufficient for its easy recognition. *F. cumulata* grows into rounded masses by the superposition of successive zoœcial layers, has very numerous and regularly arranged granules, diaphragms in the zoœcial tubes their own diameter apart and crowded vesicules, while *F. marylandica* is ramose in growth with solid branches, has few granules and these irregularly arranged, very few and generally no tabulæ developed in the zoœcial tubes and less crowded vesicles. Another internal characteristic of the present species is the occurrence of six to eight granules in the lunarium.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collections.—Maryland Geological Survey, U. S. National Museum.

FISTULIPORELLA MAYNARDI n. sp.

Plate XLVI, Figs. 3-7

Description.—Zoarium incrusting some foreign object, usually a coral, but forming a lamellate expansion by the superposition of several layers. Surface smooth, with well-marked solid maculæ at intervals averaging 3 mm. Zoœcia rounded, 5 to 6 in 2 mm., with a small distinct lunarium overarching the cavity. Interzoœcial space flat and granulose in some portions of a specimen, but in others, probably more mature areas of the same zoarium, occupied by a ridge-like wall bearing the small overarching lunarium and causing the aperture to be enclosed in a polygonal area.

Internally this species is very similar to associated species of the genus as indicated on pl. xlvi, although a marked difference is noted when the thin section passes through the outer ridge-like wall. This latter character in connection with the growth habit and dimensions of the zoœcia is sufficient for its ready recognition.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus CHILOTRYPA Ulrich

Zoarium small, ramose; branches hollow, lined internally with an epitheca, the central tube being narrow and equal in diameter throughout, or rather large, with irregular contractions and expansions. Zoœcial apertures elliptical, oblique, the lower margin thickened and elevated; diaphragms few or absent; interstitial vesicles commonly occupied by a dense calcareous deposit near the surface.

Type: *Chilotrypa hispida* Ulrich, of the Chester.

The species described below, together with others discovered in the past ten years, necessitates a slight change in the original diagnosis of the genus. The description and original figures of *Callopora venusta* Hall, the type of *Cœlocaulis* Hall and Simpson, indicate that *Cœlocaulis* is a synonym for *Chilotrypa.* However, in Natural History of New York, Palæontology, Vol. VI, pl. 23a, additional figures are given and these indicate other relationships for Cœlocaulis, figs. 1 and 2 showing alliance with Diamesopora, while figs. 3 to 5 indicate relationship with Lioclema or possibly Nicholsonella. It is impossible that these various figures could have been made from specimens belonging to the same species or even genus, and until the original specimens are reexamined and their characters verified, the validity of Cœlocaulis as a genus must remain doubtful.

CHILOTRYPA MICROPORA n. sp.

Plate XLI, Figs. 9-12

Description.—Zoarium rising into irregularly inflated, hollow branches, expanding in the specimens seen, from 5 mm. to about 10 mm. before bifurcation takes place; thickness of zoarial wall usually but little more than 1 mm. Surface even, but presenting well defined, though small, subsolid maculæ, about which the zoœcia are arranged in a radial manner; zoœcial apertures very small, broadly elliptical, a little the highest on the lower or lunarial side, causing them to appear as opening somewhat obliquely; diameter of a single zoœcium .10 to .12 mm., with about 8 in 2 mm. Interzoœcial space one and a half to three times the width of a zoœcium, smooth and slightly concave.

The deposit of sclerenchyma in the interzoœcial spaces at and near the surface, characteristic of the genus, is shown in thin sections. Vertical sections through the center of a branch show the central tube to be wide and irregularly contracting and expanding; the zoœcia are seen to arise from the epitheca, to run nearly parallel with it in the short immature region and then turn abruptly outward to form the mature region. Diaphragms thin, few, two or three being developed in the mature region only. Interzoœcial spaces are filled with large vesicles which become smaller and more numerous toward the surface, and at the surface itself is seen the dense calcareous deposit. In tangential sections, at a level below the deposit, the large, angular vesicles are shown forming but a single row between the small elliptical or nearly circular zoœcia. The lunarium is not sharply defined, being distinguished chiefly by a slight thickening of about half the circumference of each zoœcium. One to three lucid spots may usually be distinguished in the lunarium.

The extraordinarily small size of the zoœcia, coupled with unusually large interstitial vesicles, characterize this species so sharply that comparisons are unnecessary. *Fistuliporella minima,* an associated form, resembles this species somewhat in the size of the zoœcia, but its different habit of growth, granulose surface, distinct lunarium, and unlike internal structure, make up an assemblage of characters so obviously dissimilar that confusion between them is scarcely possible.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

CHILOTRYPA CONSTRICTA (Hall)

Plate L, Figs. 13-15

Trematopora ? constricta Hall, 1883, Rept. State Geol. N. Y. for the year 1882, pl. x, figs. 14-19.

Diamesopora constricta Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 19, pl. x, figs. 14-19; pl. xxiiia, fig. 7.

Description.—This neat little species is readily distinguished from all the associated ramose bryozoa, first by its hollow branches, with their inner surface covered by an epitheca, and second by the strongly elevated margin of the zoœcial apertures. Measuring in a longitudinal direction 7 to 8 zoœcia are found in 2 mm.

The arrangement of the apertures is usually in the regular alternating and imbricating manner shown in fig. 14, although occasionally they are less regular as indicated in fig. 15.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. North foot of Moore Knob, Washington County.

Collection.—U. S. National Museum.

Suborder TREPOSTOMATA

Family HETEROTRYPIDAE

Genus CYPHOTRYPA Ulrich and Bassler

CYPHOTRYPA CORRUGATA (Weller)

Plate XLII, Figs. 5-9; Plate XLIV, Fig. 4; Plate LII, Figs. 1, 2

Monotrypa corrugata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 223, pl. xviii, figs. 1-5.

Description.—Zoarium forming petasiform, hemispherical or rounded masses from 15 to 50 mm. in diameter; basal side usually epithecated; maculæ[1] not elevated, consisting of large zoœcia, the largest attaining

[1] In the terminology heretofore in use, the term "maculæ" is generally restricted to spots or clusters of cells composed principally of mesopores or closed vesicles, but as these clusters are morphologically the same in all the types of bryozoa having them, it will be conducive to uniformity in description to apply the one term "maculæ" to all clusters, whether composed of mesopores, closed vesicles, or merely of larger zoœcia."

twice the diameter of those in the intermacular spaces; zoœcia thin-walled, polygonal, 7 to 8 in 2 mm., counting from the center of a macula; acanthopores not observed at the surface nor are they always present in thin sections, remaining apparently undeveloped in certain periods of growth; in other sections from the same specimen, each angle of junction may be occupied by one, and in some cases they attain considerable size as shown in the figures. True mesopores apparently wanting, the occasional small cells seen probably being young zoœcia. Diaphragms occur in the tubes at distances varying from one to two times their own diameter apart.

This abundant species, in its growth and general characteristics, resembles the *Amplexopora petasiformis* (Nicholson) of the Cincinnati Eden and the two Devonian species, *Monticulipora ? monticula* White of the Hamilton of Iowa, and *M. winteri* Nicholson, of Germany. Neither of the two species last mentioned is known to have acanthopores, while the Ordovician species has duplex walls. We know of no associated species with which *C. rotundata* can be confounded.

The species also occurs in the Lower Decker Ferry at Nearpass Quarry, near Port Jervis, New York.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Cash Valley, Pinto, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family BATOSTOMELLIDAE

Genus BATOSTOMELLA Ulrich

BATOSTOMELLA INTERPOROSA n. sp.

Plate XLV, Figs. 1, 2; Plate XLVIII, Fig. 5

Description.—Zoarium ramose, branching at intervals, varying from 5 to 15 mm., branches cylindrical, 2 to 3 mm. in diameter; surface smooth, the acanthopores in well-preserved specimens giving it a hirsute appearance; zoœcia circular to slightly polygonal, 7 to 8 in 2 mm., generally separated by a row of rounded mesopores variable in size; acanthopores numerous, usually about six surrounding a zoœcium. Diaphragms apparently wanting in both zoœcia and mesopores.

The numerous mesopores opening at the surface distinguish this species particularly. Externally the species suggests Lioclema, but thin sections readily establish the generic position.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus CALLOTRYPA Hall

CALLOTRYPA STRIATA (Hall and Simpson)

Plate L, Figs. 5-8

Callopora (*Callotrypa*) *striata* Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 26, pl. xi, figs. 38-41; pl. xxiii, figs. 13, 14.

Description.—This small, solid, ramose species may be readily distinguished from all associated bryozoa by the abundant mesopores, separating the oval apertures and by the prominent spines at the base of each aperture. Frequently the mesopores are elongated and so disposed that they give a finely striated appearance to the surface. The zoœcial apertures average .17 of a mm. in length with a width about three-fourths the length.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. North foot Moore Knob.

Collection.—U. S. National Museum.

CALLOTRYPA MACROPORA (Hall)

Plate L, Figs. 9, 10

Callopora macropora Hall, 1883 (in part), Rept. State Geol. N. Y., pl. xi, figs. 23-29.

Callopora (*Callotrypa*) *macropora* Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 24, pl. xi, figs. 25-29; pl. xxiii, figs. 15-19.

Callotrypa macropora Simpson, 1897, 14th Ann. Rept. State Geol. N. Y. for the year 1894, pl. xviii, figs. 12-14.

Description.—Zoarium of solid, ramose, frequently bifurcating branches, varying from 1 to 2 mm. in diameter. Zoœcial apertures polygonal, rather thick-walled, 5 to 6 in 2 mm. Mesopores small and irregularly distributed.

The only specimens of this species which have been seen are silicified, and these do not show the internal structure. It is possible that when thin sections are made of calcareous specimens *C. macropora* may be found to be a species of either Eridotrypa or Batostomella.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. North foot of Moore Knob.

Collection.—U. S. National Museum.

Genus ERIDOTRYPA Ulrich

ERIDOTRYPA PARVULIPORA n. sp.

Plate XLIII, Figs. 5-8; Plate XLIV, Figs. 7, 8

Description.—Zoarium consisting of slender, cylindrical ramulets, generally about 2.5 mm. in diameter, increasing to 3 mm. just before bifurcation which occurs at intervals of from 10 to 20 mm. Surface even, the maculæ of larger cells, which are usually quite inconspicuous, generally including from one to three open interspaces. Zoœcial apertures oblique and rather regularly arranged longitudinally in young examples, becoming more direct and polygonal with age, thin walled, 8 to 9 in 2 mm. Acanthopores small, usually seen only in sections and on well-preserved surfaces; irregularly distributed, wanting, apparently, over considerable spaces; when most abundant, three or four surround a zoœcium. Mesopores few, almost restricted to the maculæ, always inconspicuous externally, generally discernible in thin sections only.

In thin sections the vertical sections show that the zoœcial tubes are thin-walled in the axial region, becoming moderately thickened in the short peripheral zone. The diaphragms, one to three, usually two in each tube, are developed only in the bend from the axial to the peripheral regions. None have been observed in the mesopores. The minutely stippled structure of the walls characterizing species of this and related genera is but obscurely shown in tangential sections—probably because of defective preservation.

This form has all of the characters of the long-lived genus Eridotrypa and is rather closely related to the Trenton types. The zoœcia, however, are smaller and the longitudinal arrangement of their apertures more pronounced than in any other species having equally large zoaria.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser (types), Cherry Run, West Virginia; Cumberland, Maryland.

Collection.—U. S. National Museum.

ERIDOTRYPA CORTICOSA (Hall)

Plate L, Figs. 11, 12

Trematopora (Chætetes) corticosa Hall, 1883, Rept. State Geol. N. Y. for the year 1882, pl. x, figs. 1-10; pl. xiii, fig. 4.

Trematopora ? (Trematella ?) corticosa Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 15, pl. x, figs. 1-10; pl. xiii, fig. 4; pl. xxiii, fig. 20.

Description.—Zoarium solid, ramose, frequently branching, sometimes at an angle of 90°; diameter from 4 to 5 mm. Zoœcia thick-walled, polygonal, 6 to 7 in 2 mm. At the surface the walls are strongly elevated and sometimes coalesce, forming an irregular ridge. Mesopores few or wanting entirely.

The polygonal zoœcia with their thick walls, will distinguish this from other of the small associated ramose bryozoa.

Abundant in the New Scotland limestone near Clarksville, New York.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. North foot of Moore Knob, Washington County, Corriganville.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus LIOCLEMA Ulrich

LIOCLEMA SUBRAMOSUM n. sp.

Plate XLIII, Figs. 1-4; Plate XLIV, Fig. 5

Description.—Zoarium subramose or irregularly ramose, the branches sometimes intertwining to form thick clumps; the largest mass of this kind seen, although incomplete, being 90 mm. in length and 50 mm. wide. The free branches vary from 10 to 15 mm. in diameter. Surface smooth, the maculæ, composed of slightly larger zoœcia and mesopores, never rising into tubercles or nodes, and being, on the whole, inconspicuous. Zoœcia 6 to 7 in 2 mm., more or less polygonal, usually about two-thirds separated by large, angular mesopores. The number of mesopores varies, the surface of the same specimen sometimes showing them to be few and again so numerous as to isolate the zoœcia. Acanthopores numerous, small, noticeable only on exceptionally well-preserved surfaces.

In tangential sections showing the fully matured condition, each zoœcium has from 2 to 4, commonly 3, of the small acanthopores in its walls. The latter are of medium thickness for the genus, and about twice as thick as walls separating adjoining mesopores. The zoœcial tubes in vertical sections are seen to be without diaphragms in the axial region and to have, according to the size of the specimen sectioned, from 1 to 3 in the peripheral. The mesopores, on the contrary, have numerous diaphragms, these being distant from each other their own diameter or less.

This species is closely related to *L. wilmingtonensis* Ulrich on the one hand, and *L. occidens* (Hall and Whitfield) on the other, differing from the first, which is from the Richmond of Illinois, in having the diaphragms less crowded in the mesopores, and from the latter, a common species in the Upper Devonian of Iowa and Missouri, in having these structures more numerous. *L. subramosum* differs from both the species mentioned in having much fewer mesopores, while its acanthopores are both more numerous and stronger.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Cash Valley, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

LIOCLEMA PULCHELLUM n. sp.

Plate XLIII, Figs. 9-12

Description.—Zoarium incrusting foreign objects and varying from .5 to 1.0 mm. in thickness; surface even, the clusters of large cells or mesopores being scarcely discernible. Zoœcia subcircular to slightly petaloid, 5 to 6 in the space of 2 mm., separated from each other by from one to three rows of rather small, angular mesopores, the latter open at the surface. Acanthopores small, as usual increasing in size with age; in the matured region, 2 to 4 surround a zoœcium and slightly indent its walls so as to give the petaloid appearance. Vertical sections show that while the zoœcial tubes are without diaphragms, the mesopores are rather closely tabulated, the partitions being usually about two-thirds of their diameter apart or about 7 in 5 mm. The appearance of some of these partitions in thin sections seems to indicate that they were centrally perforated.

Compared with other incrusting species of *Lioclema,* this pretty form is distinguished by its comparatively large zoœcia and unusually numerous small mesopores. As figured,[1] *L.* (*Fistulipora*) *parasiticum* Hall from the New Scotland beds of New York, has a similar method of growth but its zoœcia are smaller, its mesopores larger and more numerous, and its acanthopores apparently quite inconspicuous.

Occurrence.—HELDERBERG FORMATION. KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

Genus STENOPORA Lonsdale

STENOPORA (?) INCRUSTANS n. sp.

Plate XLII, Figs. 11-16; Plate XLIV, Fig. 6

Description.—Zoarium a thin crust, 1 mm. or less in thickness, generally growing on corals; composed, so far as seen, of but a single layer. Surface even, with distinct groups of much larger zoœcia distributed at intervals of about 4 mm., measuring from center to center. Zoœcia polygonal, thin-walled, angular, counting from the center of a macula, 7 to 8 in 2 mm. Well-preserved examples sometimes show small acanthopore-like elevations at the angles and occasionally between them.

Tangential sections present various appearances according to the maturity of the specimen sectioned. Specimens usually found show small acanthopores at the angles of the walls, the latter being thin with their boundaries well marked and the intervening space either clear or faintly dotted. In a fully matured zoarium, the walls are rather thick, the angles of junction occupied by acanthopore-like dark spots and the inner half of the wall by smaller dots arranged either irregularly or in a manner transverse to the wall, in the latter case appearing as dark transverse lines.

Vertical sections show that the bend from the immature region to the mature is not abrupt and that in the latter region a few apparently

[1] Nat. Hist. N. Y., Pal., vol. vi, 1887, pl. xxiii, fig. 4.

curved diaphragms are developed, several of the tubes, however, showing 3 or 4 very thin diaphragms in each, scarcely a half-tube diameter apart.

This abundant species is difficult to classify. The writers are thoroughly satisfied that it has no close relations to any of the known Ordovician genera, and equally well convinced that its natural affinities are with Stenopora and allied genera. Still it can find no permanent place in that genus, but will doubtless go with several other Silurian and Devonian species which will eventually be grouped together as a new genus. Specifically *S. ? incrustans* is clearly distinct, and there is no associated species with which any careful observer could possibly confound it.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley, Pinto.

Collections.—Maryland Geological Survey, U. S. National Museum.

DIPLOSTENOPORA n. gen.

This new genus is instituted for a very abundant and characteristic bryozoan of the Keyser limestone which agrees with Stenopora in the tabulation of its zoœcia but differs in being bifoliate and in lacking the characteristic periodic swelling of the zoœcial walls. Externally it resembles members of the Cryptostomata, but thin sections show it to have indubitable affinities with the Trepostomatous family Batostomellidæ. The following diagnosis gives the supposed generic characters.

Zoarium of comparatively narrow, bifoliate branches with the two layers of zoœcia arising from a distinct mesial lamina which is duplex as usual. Zoœcia angular, thick walled, with rounded apertures set in areas sloping inward from the sharp crest of the walls. Wall structure as in Stenopora, amalgamated. Mesopores few, acanthopores small and few. Diaphragms centrally perforated. Zoœcial walls merely thickened in the peripheral zone, but not "beaded" as in Stenopora.

Type *Escharopora siluriana* Weller.

In its general aspect and structure the type suggests Petalotrypa to which the writers were at first inclined to refer it. However, on closer investigation by means of thin sections, it proved that the noted resemblance was merely fortuitous and superficial and not truly genetic.

Petalotrypa has the wall structure of the Integrata,[1] whereas the proposed Diplostenopora is, like the rest of the Batostomellidæ to which family it is referred, distinctly a representative of the Amalgamata. Furthermore, Petalotrypa has straight and complete diaphragms while those found in *Diplostenopora siluriana* are centrally perforated.

DIPLOSTENOPORA SILURIANA (Weller)

Plate XLV, Figs. 3-6; Plate XLVIII, Figs. 1-3; Plate LII, Figs. 3, 4

Escharopora siluriana Weller, 1903, Paleont. N. J., vol. iii, p. 225, pl. xviii, figs. 6, 7; pl. xix, figs. 8, 9.

Description.—Zoarium of flattened fronds, which have subparallel edges, are bifoliate and branch dichotomously at rather regular intervals of about 1.5 cm.; angle of bifurcation about 75°. The largest specimen seen is fragmentary but branches twice and has a height of 4.5 cm. and average width of 7 mm. Edges of branches thin and sharp in growing examples but somewhat rounded in more mature specimens, apparently never developing a nonporiferous border. Surface usually smooth, but occasionally, in young specimens especially, having the cluster of larger cells raised into low rounded monticules.

Zoœcial apertures rounded, enclosed by fairly thick walls which rise ridge-like so that the crest forms a polygonal outline about the apertural slope. Mesopores few and confined almost entirely to the maculæ. Acanthopores not observed at the surface. In thin sections they are few and small, a single one being occasionally found in the angle between several adjoining zoœcia. Eight zoœcia in 2 mm.

The internal structure is shown clearly on pl. xlv, and it is therefore thought unnecessary to describe it in further detail. Figs. 5 and 6 show the most important of the specific as well as generic characters, namely, the bifoliate structure of the zoarium, the perforated diaphragms and the absence of constrictions in the zoœcial walls characterizing the otherwise similar stenoporoids.

[1] The Trepostomata have been classified by the present writers in two large divisions, the *Integrata* in which the walls of adjoining zoœcia are distinct and separated by a dark divisional line and the *Amalgamata* with adjoining walls fused.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley and other localities near Cumberland. Abundant.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family TREMATOPORIDAE

Genus MONOTRYPA Nicholson

MONOTRYPA SPHÆRICA (Hall)

Plate LII, Figs. 5-8

Favosites sphericus Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. vii, figs. 1-12.

Favosites sphæricus Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 9, pl. vii, figs. 1-12; pl. viii, fig. 8.

Description.—Specimens from the New Scotland beds at Dawson, Maryland, were found upon a close examination to have all the characters of this rather abundant form described by Hall as a species of Favosites.

As shown on the accompanying plate, the zoarium is massive and is made up of polygonal zoœcia whose diameter range from .25 to .35 mm. The surface exhibits well-marked maculæ, .5 mm. in diameter, composed of zoœcia larger than usual. Mesopores wanting. Diaphragms rather numerous in the successive mature regions.

Although a single series of mural pores was described by Hall as occurring on each face of the cell tubes, this error was corrected in the description of the plates by the same author. The Maryland specimens before us are silicified and the minute internal structure has not yet been studied. However, the species probably belongs to Monotrypa as indicated above.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Dawson.

Collections.—Maryland Geological Survey, U. S. National Museum.

MONOTRYPA TABULATA (Hall)

Plate L, Figs. 1-4

Chætetes ? tabulatus Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. ix, figs. 12-15.

Chætetes (Ptychonema) tabulatus Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 14, pl. ix, figs. 12-15.

Description.—Zoarium rounded or in hemispheric masses, 40 or more mm. in diameter. Zoœcia polygonal, 4 to 5 in 2 mm.; walls thin, strongly and regularly corrugated, with about 15 corrugations in the space of 5 mm. Diaphragms wanting.

Polygonal zoœcia with thin and strongly corrugated walls and the absence of diaphragms are characteristics of this species which readily separate it from other massive bryozoa.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Southwest slope of Elbow Ridge, Washington County; Dawson.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus STROMATOTRYPA Ulrich

STROMATOTRYPA GLOBULARIS n. sp.

Plate XLII, Figs. 1-4; Plate XLVI, Figs. 8, 9

Description.—Zoarium usually forming globular masses 25 mm. or more in diameter, becoming more or less irregular with age, the largest specimen seen measuring about 170 mm. in its greatest dimension. Zoœcial tubes radiating from the base which is usually small and sometimes covered with a wrinkled epitheca. Celluliferous surface even, but exhibiting at regular intervals rather inconspicuous maculæ composed of slightly larger zoœcia. Zoœcial apertures circular or polygonal, their shape depending upon the relative development of the mesopores. In younger stages the mesopores are large and apparently never in more than one series between neighboring zoœcia, becoming smaller with age, and in the fully matured condition wedging out, the zoœcia at the same time becoming correspondingly larger and assuming the angular shape incident to contiguity. Five zoœcia may be counted in the space of 2 mm. and because of the relation between the sizes of the zoœcia and mesopores mentioned above, the estimate holds, whatever the condition of the latter. Acanthopores about as numerous as the zoœcia, rather well developed as seen in tangential sections, but, especially in the rather unfavorable preservation of the surface characters prevailing among the specimens seen, not a conspicuous external feature. In thin sections the acanthopores prove to be thin-walled, the lucid spot, as is demanded by the genus Stromatotrypa, being relatively much larger than in the more common types of acanthopores. The diaphragms occur at infrequent and irregular intervals in the zoœcial tubes, the space intervening between successive diaphragms varying from one to four or five tube diameters; in the mesopores they recur at much more frequent and regular intervals, averaging about 6 in 1 mm.

This common and rather striking species seems to possess all the essential characters of Stromatotrypa, which was founded upon a single species from the Black River and Trenton formations of Minnesota. Since that time, five other Ordovician species have been determined by the writers and await opportunity for publication. The species here described is rather closely related to a lamellate new species occurring in the Sevier shales of East Tennessee, but its globular mode of growth distinguishes it from not only this, but all the other species. As far as known, there is no associated form with which it can be confounded.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Cash Valley, Pinto, and other localities near Cumberland, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Order CRYPTOSTOMATA

Family FENESTELLIDAE

Genus FENESTELLA Lonsdale

FENESTELLA CUMBERLANDICA n. sp.

Plate XLVII, Figs. 1, 2

Description.—Among the collections from the Keyser limestone are specimens of a species of Fenestella agreeing in general shape and size of fenestrules with *F. philia* Hall[1] of the New Scotland beds of New York, but differing (1) in the more knotty aspect of the reverse side of its branches, and (2) in the larger number of zoœcial openings in a given space. In Hall's figures of *F. philia,* the zoœcial apertures are represented quite regularly spaced with an average of three in the length of a

[1] Rept. State Geol. N. Y. for 1882, pl. xx, figs. 9-11.

fenestrule, while in the present species an average of four is counted in the same space.

The preservation of the material at hand is not satisfactory as to finer details of structure. It is believed, however, that better specimens may show other differences between *F. philia* and *F. cumberlandica* besides those indicated above.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley, Devil's Backbone.

Collections.—Maryland Geological Survey, U. S. National Museum.

FENESTELLA PHILIA Hall

Plate LI, Figs. 6-8

Fenestella Philia **Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. xx, figs. 9-11.**
Fenestella Philia **Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 50, pl. xx, figs. 9-11.**

Description.—Zoarium of slender, rounded, smooth branches, from 12 to 16 in the space of 5 mm. Dissepiments slender, with 9 in 5 mm. Fenestrules quadrangular. Branches angular and marked by a line of nodes along the center on the celluliferous face. Zoœcial apertures small, circular and in two ranges, with three in the space of one fenestrule.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. North foot of Moore Knob, Washington County.

Collection.—U. S. National Museum.

FENESTELLA ? IDALIA Hall

Plate LII, Figs. 9-11

Fenestella idalia **Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. xxi, figs. 6-9.**
Fenestella idalia **Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 52, pl. xxi, figs. 6-9.**

Description.—In Maryland only the non-celluliferous side of this species has been noted, but this portion of the zoarium, however, is easily distinguished by the rounded, compactly arranged, rather broad branches, marked by 3 to 5 striations and by the subquadrangular fenestrules. The dissepiments are very slender, with 6 to 9 in the space of 5 mm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone, Corriganville.

Collections.—Maryland Geological Survey, U. S. National Museum.

FENESTELLA (CYCLOPORINA) ALTIDORSATA n. sp.

Plate XLV, Fig. 15; Plate XLIX, Figs. 1-3

Description.—Zoarium apparently not infundibuliform, but growing from small attachments into large flabellate expansions, 2 inches or more in diameter. Judging from material in hand these expansions on continued growth become irregular in outline and perhaps folded so that the fossilized network, which sometimes covers the space of a man's hand, was matted together with the branches of overlying parts oriented in varying directions. Aside from this largely fortuitous irregularity, the branches impress one as fairly rigid. Their number in a given space varies from the fact that two or more adjacent branches will bifurcate almost simultaneously. One of the fragments on the slab shown in fig. 2 of pl. xlix shows five branches thus simultaneously divided, another three. However, a fair average would be 13 or 14 in 10 mm., with extremes ranging from 12 to 16. The fenestrules vary in width for the same reason, but measured longitudinally their number in 10 mm. is constantly 6 or 7. Of zoœcial apertures 22 or 23 are counted on each side of a branch in 5.0 mm. Not only the branches, but the dissepiments also are carinated. The branches and carinæ grow stronger with age, the latter being very prominent on the older portions of the colonies. A striking feature of the species is that the carinæ are developed on both the obverse and the reverse sides, though usually not so sharp on the back as on the front of the branches and dissepiments. The development of carinæ on both sides of the zoarium, coupled with the fact that the branches appear nearly as rigid on the reverse as on the obverse side, is likely to cause some difficulty in distinguishing the two sides, especially when the specimen is sufficiently imbedded in the matrix to obscure the zoœcial apertures. An occasional feature, retained, however, only by the most perfect examples, is the presence of relatively large semicircular caps which project laterally from the sides of the carinæ over a fenestrule or on a dissepiment. These probably represent a peculiar kind of ovicell.

The presence of semicircular ovicells (?) on the sides of the carinæ suggests the advisability of referring this fine species to the otherwise Middle Devonian genus *Cycloporina* Simpson.[1] Undoubtedly *F. altidorsata* is a true progenitor of the type of Cycloporina, but it is also true that it is readily distinguished from that species by characters which in a future and already much needed revision of the Fenestellidæ might be deemed of generic and not merely specific importance. Pending such investigation the relationship of this early Devonian species seems to be sufficiently indicated by the form of the name adopted above. No Helderberg species is likely to be confused with it.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone. Abundant.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus POLYPORA McCoy

POLYPORA DICTYOTA n. sp.

Plate XLVII, Fig. 3

Description.—Zoarium an undulating or flat, fan-shaped expansion, the largest specimen seen although fragmentary measuring 4.5 cm. in height. Branches slender, about 11 in 1 cm. and varying slightly in width; surface minutely granulose, the granules showing best in thin sections. Dissepiments short, depressed, varying from about one-half the width of the branch in the lower portion of the zoarium to the entire width in the upper and less crowded parts. Fenestrules varying from subrhomboidal to quadrate. Zoœcia arranged in two or three ranges, the latter number predominating. Zoœcial apertures 10 in 2 mm., 4 to a branch. Reverse of both branches and dissepiments rounded and faintly granulose.

[1] Simpson, Handbook Genera North America, Pal. Bry. in 14th Rept. State Geol. N. Y. for 1894, p. 504, 1895.

This is the only species of Polypora so far discovered in the Helderberg rocks of Maryland, and therefore need not be compared with other forms. Several Helderberg species from other states seem to be related, but none of these appear to have the same measurements.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland. Common.

Collections.—Maryland Geological Survey, U. S. National Museum.

POLYPORA COMPACTA (Hall)

Plate LI, Figs. 9-11

Fenestella compacta Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. xviii, figs. 1-3.

Fenestella (*Polypora*) *compacta* Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 63, pl. xviii, figs. 1-3; pl. xxii, figs. 4, 5.

Fenestella (*Hemitrypa*) *Nervia* Hall, 1883 (in part), Rept. State Geol. N. Y. for 1882, pl. xxii, figs. 1-3.

Description.—" Bryozoum infundibuliform, compact. Branches on the non-celluliferous side moderately strong, rounded, marked by obscure, granulose striations. Bifurcations occurring at intervals of from 3 to 7 mm.; width of the interstices usually less than the narrower portion of the branches. Dissepiments strong, rounded, on a plane with the branches, seven or eight in the space of 5 mm. Fenestrules oval, width from one-half to three-fourths the length. On the celluliferous face the branches are rounded, and the dissepiments angular, while the fenestrules appear much narrower than on the opposite face, the branches being, sometimes, nearly in contact. Cell apertures minute, circular, in two and three ranges, opening directly outward, from fifteen to seventeen in the space of 5 mm., separated by less than the diameter of an aperture: margins distinctly elevated, those of the lateral ranges indenting the borders of the fenestrules.

" Width of branches .33 mm., increasing to .66 mm.; width of dissepiments from .25 mm. to .33 mm.; length of fenestrules from .25 mm. to .33 mm." Hall and Simpson, 1887.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville.

Collection.—Maryland Geological Survey.

Genus SEMICOSCINIUM Prout

SEMICOSCINIUM PLANUM n. sp.

Plate XLV, Fig. 7; Plate XLIX, Fig. 4

Description.—Form of entire zoarium unknown but probably infundibuliform, the type and only specimen seen being a fragment showing the reverse and consisting of a fan-shaped slightly undulated expansion about 3.5 cm. both in height and width. Branches strong on the non-celluliferous side, varying slightly in width, flattened and sometimes even slightly concave, about 8 in 1 cm. Dissepiments rather short, on the same plane with the branches; fenestrules elongate, oval. Celluliferous side known only from thin sections which show that the zoœcia are in two rows, open directly upward, have well-marked peristomes, and are separated by an elevated carina slightly flexuous and considerably expanded at the top; zoœcial apertures circular about two-thirds their diameter apart, 8 in 2 mm. and 4 to a branch.

The rather large, elongate fenestrules, plane, flat, reverse and expanded carina with its concave surface distinguish this species from associated forms of the Fenestellidæ.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Hyndman, Pennsylvania.

Collection.—U. S. National Museum.

SEMICOSCINIUM CORONIS (Hall)

Plate LI, Figs. 3-5

Fenestella Coronis Hall, 1883, Thirty-second Ann. Rept. N. Y. State Mus., p. 171 (reprint, 1880, p. 33).

Fenestella Coronis Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 51, pl. xxi, figs. 10-13.

Description.—A detailed description of this fine species has been given by Hall and Simpson. The prominent expanded carinæ on the celluliferous face and the quadrangular form of the fenestrules on the reverse are the most noticeable features of the species.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. North foot of Moore Knob, Washington County.

Collection.—U. S. National Museum.

Genus THAMNISCUS King

THAMNISCUS REGULARIS n. sp.[1]

Plate XLVII, Figs. 4-6

Description.—In the striation of the reverse and the general aspect of the obverse or celluliferous face of the branches this species resembles the three New Scotland species from New York cited for comparison. However, the resemblances are of generic rather than of specific import. In *T. nysa* and *T. variolata* the growth of the zoarium, especially as regards branching, is more rapid and more irregular, giving a bushy aspect rather than the gracefully erect habit marking the Maryland species before us. *T. fruticella* seems to be nearer than the other two New Scotland species, but unfortunately only the reverse side of this species is known. So far as the visible features permit forming an opinion *T. regularis* differs in its less frequent and more regularly dichotomous branching, and less crowded branches.

On the obverse side the zoœcial apertures are rounded, with peristome, and arranged in fairly regular diagonal rows, four or five in each row. Minute granules cover the peristomes and are arranged in regular series over the depressed intervening spaces. Larger nodes occasionally interspersed between the zoœcial apertures. The reverse side is closely but distinctly striated longitudinally in young examples and at the growing ends of older specimens. Toward the basal part of the latter the striæ are obscured and finally obliterated by nearly smooth secondary deposit.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family RHABDOMESONTIDAE

Genus ORTHOPORA Hall

ORTHOPORA RHOMBIFERA (Hall) ?

Plate XLV, Figs. 12-14; Plate XLVIII, Fig. 6; Plate LI, Fig. 18

Trematopora rhombifera Hall, 1874, Twenty-sixth Ann. Rept. N. Y. State Mus., p. 103.

[1] Cf. *Thamniscus ? nysa* Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. xxii, figs. 31, 32, 47, 48. Also *T. fruticella* and *T. variolata* of the same author, work, and plate, figs. 33-46.

Trematopora rhombifera Hall, 1879, Thirty-second Ann. Rept. N. Y. State Mus., p. 152 (reprint, 1880, p. 14).

Trematopora rhombifera Hall, 1883, Rept. State Geologist N. Y. for 1882-1883, pl. xi, figs. 15-20 (not pl. xxiv, figs. 3, 4).

Trematopora (*Orthopora*) *rhombifera* Hall and Simpson, 1887, Nat. Hist. N. Y., Pal., vol. vi, p. 18, pl. xi, figs. 15, 17-20; pl. xxiii, figs. 11, 12 (not pl. xxv, fig. 29; pl. xxvi, figs. 3, 4).

Description.—Zoarium ramose, apparently dividing at rather frequent intervals; branches .7 to 1.0 mm. in thickness. Zoœcial apertures oval, set into rhomboidal or hexagonal sloping vestibular areas, arranged in diagonally intersecting lines, measuring lengthwise 6 to 7 in 2 mm. and diagonally about 6 in 1 mm. Interapertural spaces ridge-shaped, granulose when perfect; a depression occasionally between the ends of the zoœcia bordered on each side by two or three small acanthopores.

In tangential sections taken just beneath the surface, the zoœcia are regularly ovate, enclosed by a dark line and separated by a distance quite as great as their longer diameter; the interspaces are occupied by strong acanthopores, about four to each zoœcium. In a deeper tangential section, the zoœcia are comparatively thin-walled and angular, while the walls show no trace of acanthopores.

In a vertical section, the zoœcial tubes appear to rise from a median line from which they curve outward in all directions. Just before passing into the thick-walled peripheral region in which the acanthopores show distinctly, two large hemisepta are developed.

The specimens above described agree very well in their internal appearance with *O. rhombifera* Hall of the New Scotland beds of New York, but their reference to that species must be considered only provisional since the internal characters of Hall's species are not yet known.

Occurrence.—Helderberg Formation, Coeymans Member. Cash Valley, Maryland; Keyser, West Virginia.

Collection.—U. S. National Museum.

Orthopora regularis (Hall)

Plate LI, Figs. 15-17

Trematopora regularis Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. xi, figs. 1-8; pl. xiii, figs. 1-3 (in part).

Trematopora (*Orthopora*) *regularis* Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 16, pl. xi, figs. 1-8; pl. xxiii, fig. 1.

Description.—This species is closely allied to the associated *O. rhombifera* but differs in having a considerably smaller zoarium with the zoœcial apertures arranged in well-marked, longitudinal rows. The apertures are elongate, oval, .15 to .18 mm. in length, with 15 in the space of 5 mm.; 10 to 12 rows occur on a branch, separated by prominent ridges, which in old specimens are frequently wider than the cell apertures and often obscure them.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville.

Collections.—Maryland Geological Survey, U. S. National Museum.

ORTHOPORA OVATIPORA (Hall)

Plate L, Figs. 16-18

Trematopora ? ovatipora Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. xi, figs. 9-11.

Trematopora (Orthopora) ovatipora Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 17, pl. xi, figs. 9-11; pl. xxiii, fig. 5.

Description.—Zoarium solid, ramose, very slender, branches seldom exceeding .15 mm. in diameter. Zoœcial apertures arranged in longitudinal, parallel rows. Margins of apertures slightly elevated and granulose, with a minute spine at each posterior margin. 4 to 5 apertures in 2 mm. measuring longitudinally.

This neat little form may be distinguished from the associated *O. regularis* by its larger ovate apertures and the smaller number of rows to a branch.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. North foot of Moore Knob, Washington County.

Collection.—U. S. National Museum.

Family PTILODICTYONIDAE

Genus PTILODICTYA Lonsdale

PTILODICTYA TENELLA n. sp.

Plate XLII, Fig. 10; Plate XLVIII, Figs. 7, 8

Description.—Zoarium a simple, unbranched, straight, narrow, bifoliate frond without monticles, 20 mm. or more in length and about 2 mm.

wide, tapering at the lower end to a pointed base. Entire zoarium consists, as in all simple species of the genus, of narrow, oblong, quadrate zoœcia arranged in a longitudinal series. Counting longitudinally, 8 zoœcia in 2 mm. and transversely about 12 rows of zoœcia in a frond of 2 mm. width, a single zoœcium thus being about .25 mm. in length and .17 mm. wide, or the length and width being to each other as 3 is to 2.

The simple narrow zoarium and the shape of the zoœcia will distinguish this form from described species. *Ptilodictya angusta* (Hall)[1] has a similar method of growth, but the measurements given indicate that it has much larger zoœcia and it may indeed not be a Ptilodictya. *Ptilodictya gladiola* Billings[2] from Anticosti is probably a close relative, but the zoarium of that species is usually curved and the zoœcia are more elongated, their length being twice their width.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family STICTOPORELLIDAE

Genus STICTOPORA Hall

STICTOPORA ? PAPILLOSA Hall

Plate LI, Figs. 12-14

Stictopora papillosa Hall, 1883, Rept. State Geol. N. Y. for 1882, pl. xiii, figs. 12 and 13.

Stictopora papillosa Hall and Simpson, 1887, Pal. N. Y., vol. vi, p. 37, pl. xiii, figs. 12 and 13; pl. xxiii*a*, fig. 16.

Description.—A single specimen from the New Scotland limestone at Kreigbaum, Maryland, exhibits all of the characters of this neat little species as figured by Hall. On account of the preservation, the internal characters of the species have not been studied yet, so that it must still be referred to as above. Its external features are sufficient for its easy recognition.

[1] *Escharopora (Ptilodictya) angusta* Hall, 1883, Trans. Albany Institute, vol. x, p. 621 (Abstract, 1879, p. 6).

[2] *Ptilodictya gladiola* Billings, 1866, Catal. Sil. Foss. Anticosti, p. 10.

The zoarium is ramose and bifoliate, consisting of frequently bifurcating branches varying in width from 2 to 2½ mm. Zoœcial apertures are circular with well-marked peristomes about .25 mm. in diameter, arranged in indistinct, longitudinal rows.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Kreigbaum.

Collection.—Maryland Geological Survey.

CLASS BRACHIOPODA[1]

Order NEOTREMATA

Superfamily DISCINACEA

Family DISCINIDAE

Genus ORBICULOIDEA d'Orbigny

ORBICULOIDEA ROEDERI n. sp.

Plate LIII, Figs. 1, 2

Description.—Shell large and nearly circular in outline. Dorsal valve tumid, with the obtuse apex situated from one-third to one-fourth the length of the shell from the posterior region; surface uniformly convex except back of the apex, where it is steep and slightly convex or concave. Ventral valve somewhat convex except in front of the apex, where it is more or less concave; pedicle sinus large, deep, and long, beginning a little in front of the center and extending to near the posterior margin.

Surface of both valves marked by sharply elevated, high, flattened concentric ridges separated by concave spaces about three times as wide as the ridges. About six ridges in 3 mm. near the posterior edge of the ventral valve.

The relations of this species are with *O. ampla,* the only other large form of the Oriskany. The latter, however, is larger, with the dorsal apex subcentral, and with much stronger and more distant concentric

[1] This section is by Charles Schuchert except where other contributors are indicated.

raised ridges. The species is named for Mr. George M. Roeder, who first collected it, in recognition of his enthusiastic and careful collecting of the fossils about Cumberland.

Length 3.4 cm., width 3.5 cm.

Orbiculoidea jervensis Barrett[1] is another Oriskany species of the higher zones. It is readily distinguished by having a broadly suboval or nearly elliptical outline, depressed ventral valve, and fine concentric lines of growth, instead of the widely placed, high, narrow ridges of *O. ampla* and *O. roederi.*

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cash Valley.

Collection.—George M. Roeder.

ORBICULOIDEA AMPLA (Hall)

Plate LIII, Figs. 3-5

Discina grandis emend. *ampla* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 406, pl. xcii, fig. 1, 1861.

Description.—"Shell suborbicular or very broadly oval. Dorsal valve very convex, the convexity equalling about one-third of the width; apex subcentral. Ventral valve nearly flat: apex somewhat eccentric, very slightly elevated in front of the foramen, and the space between this and the anterior margin slightly concave; foramen oblong, narrow oval, the depression on the exterior of the shell extending from the apex to near the posterior edge. Surface marked by strong elevated concentric lamellose striæ, and, on the interior of the shell, by radiating vascular impressions." Hall, 1859.

Diameter about 5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. In loose blocks at Miller's Spring, Ridgely, West Virginia; sections along the North Branch in Washington County, Maryland.

Collection.—Maryland Geological Survey.

[1] See Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 343, pl. xlv, figs. 7, 8.

ORBICULOIDEA SCHUCHERTI n. sp.

Plate LIII, Figs. 6, 7

Description.—Shell subcircular, concavo-convex. Dorsal valve convex, apex slightly excentric, posterior slope slightly concave. Ventral valve nearly flat, its surface undulating a little. Foramen large, its anterior end a little back of center of valve. Surface ornamented by concentric lamellæ and intermediate finer striæ.

Diameter 10 to 15 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Dawson.

Collection.—Maryland Geological Survey.

[Swartz.]

ORBICULOIDEA sp.

Description.—Fragments of a species of Orbiculoidea have been found in the New Scotland member which appear distinct from the other described species. They are too poor to permit specific determination.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone.

Collection.—Maryland Geological Survey.

[Swartz.]

Family TREMATIDAE

Genus SCHIZOCRANIA Hall and Whitfield

SCHIZOCRANIA sp.

Description.—A single much crushed dorsal valve of a large species of Schizocrania has been found in the New Scotland. Its length is about 25 mm. and the width about 20 mm. It is marked by fine radial striæ of which there are thirteen in 5 mm. near the anterior margin, and these are crossed by exceedingly delicate concentric lines, causing them to be very finely nodose on the upper edge. There are also concentric rugosities.

The species seems to be nearest to *S. superincreta* Barrett, but it has a finer and more strongly nodose ornamentation. The latter is from the

Lower Oriskany of New Jersey, and has recently been redescribed and refigured by Weller.[1]

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone, uppermost beds.

Collection.—George M. Roeder.

Superfamily CRANIACEA

Family CRANIIDAE

Genus PHOLIDOPS Hall[2]

PHOLIDOPS MULTILAMELLOSA n. sp.

Plate LIII, Figs. 8, 9

Description.—Shell large, broadly and regularly oval in outline or slightly shouldered posteriorly. Valves depressed convex; dorsal beak acute, small, and situated just a little back of the center, with about fifteen lamellæ of growth; ventral scar of attachment fairly large, smooth, and flat, outside of which are about ten well-developed lamellæ. The length of the largest specimen is 8 mm., and 6 mm. in width.

This species differs from associated Oriskany Pholidops in its large size, combined with the subcentral beaks and the great number of lamellæ.

Length about 1.2 cm., width about 1 cm.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. Cash Valley, 21st Bridge.

Collection.—U. S. National Museum.

[1] Geol. Survey N. J., Pal., vol. iii, 1903, p. 323, pl. xli, fig. 4.

[2] For a good generic definition, see Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 155. The writer no longer has any doubt in regard to the fact that *Pholidops* was cemented to foreign objects by a small part of the ventral beak. The cicatrix has been seen in *P. ovata*, *P. multilamellosa*, *P. tumida*, and *P. implicata*, the last being from Gotland. In all these cases the scar is flat or concave and devoid of lamellæ, and in the same species the lamellæ continue in the dorsal valve quite close to the protegulum.

PHOLIDOPS OVATA Hall

Plate LIII, Figs. 10-12

Pholidops ovatus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 490, pl. ciii*b*, fig. 7.

Pholidops ovatus Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 226, pl. xx, figs. 27-29, p. 300.

Description.—"Shell ovate: apex excentric. Surface marked by fine concentric lamellæ of growth, which are wider on the posterior part of the shell. Very minute radiating striæ are sometimes visible." Hall, 1859.

The valves in this species are nearly flat and the ventral valve outside of the scar of attachment has from 5 to 8 concentric lamellæ. The cementation scar is quite large, is easily recognized in being devoid of lamellæ, and is usually flat, but may be slightly concave. This is an abundant species in the Bryozoa beds near the base of the Keyser.

Diameter 10 to 15 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Tonoloway, Maryland.

Collection.—U. S. National Museum.

PHOLIDOPS TUMIDA n. sp.

Plate LIII, Fig. 17

Description.—Shell above the average in size for the genus, elongate-oval in outline, with the posterior end somewhat truncated. Valves quite convex, with the highest point near the posterior end; beaks nearly marginal and abruptly elevated above the posterior margin; lamellæ distinctly imbricating, from fifteen to eighteen on each valve. Ventral cementation scar small, but readily discernible.

This species differs from *P. multilamellosa* in its elongate oval shape, tumid valves, and the nearly marginal beaks; from other Lower Devonian species in the greater number of lamellæ and the nearly marginal beaks.

Length about 14 mm.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. Winchester Road, near Cumberland.

Collection.—Maryland Geological Survey.

Genus LINGULAPHOLIS n. gen.

Description.—Pholidops-like brachiopods, but uncemented, with terminal beaks which are separated from one another by a lamellose thickening of the posterior region of the valves, thus producing a false area on each. Valves apparently slightly gaping posteriorly. The solid beaks are unequally developed, the ventral (?) extended a little beyond the other. Growth lines as in Lingulella or Obolus, *i. e.,* they pass behind the beak and across the false area. Interior as in Pholidops.

Type *Pholidops terminalis* Hall.

The oboloid exterior, with terminal beaks and false areas, and the uncemented valves distinguish Lingulapholis from Pholidops. To this genus are referred *P. terminalis* and *P. linguloides* Hall.[1] The latter species the writer has in his private collection, represented by excellent material etched out of rock from Canandaigua Lake, New York, by Beecher. Another species is *P. calceola* Hall and Clarke, of the Onondaga; probably also *P. infrasilurica* Huene of the Lower Silurian of Russia.

The systematic position of Lingulapholis and Pholidops is uncertain, but most students of Brachiopoda refer the latter to the Craniidae. Lingulapholis, however, was not a cemented species like Crania, but had a functional pedicle throughout life, which apparently came from between the slightly gaping valves, as in Lingula. The valves of Pholidops are closely appressed, without false cardinal areas, and do not appear to gape posteriorly. On the other hand, there is unmistakable evidence that the excentric ventral beak of Pholidops was cemented to foreign objects, in which event there would be no use for a pedicle, as is the case in other genera of the Craniidae. On the other hand Huene[2] points out that the

[1] *Lingulapholis linguloides* (Hall). *Pholidops oblata* Hall, 1867, Nat. Hist. N. Y., Pal., vol. iv, p. 414, pl. iii, fig. 10 (based on a cast of the interior; therefore not expressive of the species; the next name has been selected for the species).

Pholidops ? linguloides and *P. ? lamellosa* Hall, *ibidem*, p. 414, pl. iii, fig. 11 (the latter name is a lapsus for *P. linguloides*).

Pholidops linguloides and *P. oblata* Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. 1, p. 157, pl. xli, figs. 35, 36.

Occurrence.—Hamilton, Aurora, and Canandaigua Lake, New York.

[2] Verh. d. k. russischen min. Gesell. St. Petersb., sec. ser., vol. xxxvi, 1899, pp. 331-337.

interior characters are rather those of Lingula than Crania. It must be admitted that Pholidops and Lingulapholis have characters that more strongly suggest the Atremata than the Neotremata, but until the early shell stages of living Crania are known it does not seem that a satisfactory phyletic disposition can be made of them.

LINGULAPHOLIS TERMINALIS (Hall)

Plate LIII, Figs. 14-19

Pholidops terminalis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 490, pl. ciii*b*, figs. 8*a*-8*d*, 1861.
Pholidops arenaria Hall, 1867, Nat. Hist. N. Y., Pal., vol. iv, pp. 32, 413, pl. iii, fig. 3 (fide Clarke).
Pholidops terminalis Hall and Clarke, 1892, *ibidem*, vol. viii, pt. 1, p. 157.
Pholidops terminalis Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 59, pl. viii, figs. 23-25.

Description.—"Shell subelliptical, broader behind, and narrowing to the apex: apex terminal. Surface marked by strong squamiform lamellæ: a flattened subtriangular space beneath the apex; the inner margins of the shell somewhat flattened. The muscular impression is double, and situated on each side of a mesial ridge, which becomes thickened and expanded towards the apex." Hall, 1859.

To the above description may be added that both beaks are terminal, protruding nearly equally, and are separated from one another by an intervening lamellose thickening of the valves. The growth lines are as in Lingula and not as in most species of Pholidops, where the beak is situated near the middle of the shell with the lines regularly disposed around it, as in the dorsal valve of Orbiculoidea.

Casts of the interior, especially of small specimens, are difficult to distinguish from associated species of Pholidops, unless the cast is very good and shows the posterior lamellose false area.

Length 8 mm. to 20 mm.; width 5 mm. to 16 mm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, North Branch, Maryland; Warren Point, Pennsylvania.

Collection.—Yale University.

Order PROTREMATA

Superfamily ORTHACEA

Family ORTHIDAE

Genus ORTHOSTROPHIA Hall[1]

ORTHOSTROPHIA STROPHOMENOIDES (Hall)

Plate LIII, Figs. 20-23

Orthis strophomenoides Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 46.

Orthis strophomenoides Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 177, pl. xiv, fig. 2.

Description.—"Shell transverse, somewhat semioval: ventral valve flattened convex, with a distinct narrow mesial elevation passing from beak to base; beak scarcely distinct from hinge-line, straight: dorsal valve more convex than the opposite, most elevated between the middle and the beak, from which a distinct narrow depression extends towards the front; beak more prominent than the opposite, obtuse, incurved: hinge-line straight, nearly equalling the greatest width of the shell; area large, plane; foramen apparently closed. Surface marked by coarse radiating striæ, which increase by implantation and bifurcation: several of those on the mesial elevation of the ventral valve appear to coalesce along the center, before reaching the beak. In well-preserved specimens, strong concentric striæ are visible in the depressions between the radiating striæ. Shell marked by a few strong concentric undulations of growth." Hall, 1857.

Length about 1.6 cm.; width about 3.3 cm.

This species, like *Spirifer macropleurus,* is a conspicuous Silurian straggler.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, near Cumberland, Dawson.

Collection.—Maryland Geological Survey.

[1] See Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, pp. 199, 223, 253.

Genus DALMANELLA Hall and Clarke[1]

DALMANELLA PLANICONVEXA (Hall)

Plate LIV, Figs. 1-6

Orthis planoconvexa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 168, pl. xii, figs. 1-6, 1861.

Description.—" Shell plano-convex; outline somewhat circular or transversely oval: length and breadth about as ten to twelve. Dorsal valve nearly flat, slightly prominent near the beak on either side of the faint central depression, and quite flat towards the margins. Ventral valve convex, sometimes scarcely subangular towards the beak; greatest convexity a little above the middle of the shell, and thence sloping uniformly to the lateral and basal margins: beak small, acute, incurved. Area linear, its length greater than half the width of the shell. Striæ fasciculate, much curved upwards towards the cardinal and lateral margins." Hall, 1859.

In Maryland this species seems to take the place of *D. subcarinata* of New York. The latter is very rare, if present at all, in Maryland, and the few dorsal valves seen that may pass as that species are about one-third the size of the New York form. On the other hand *D. planiconvexa* is common in the South and rare in New York. In the Ridgely member of the Oriskany the species is very common and, as a rule, is a little longer on the hinge than New Scotland specimens; occasionally there is one as extreme as any in the Becraft. Specimens from near Cumberland occur infrequently in which the dorsal valve is depressed convex instead of flat or very slightly concave. In these the cardinal process is thick and very high.

Length about 1.6 cm.; width about 1.5 cm. to 2.5 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Miller's Spring, 21st Bridge, Maryland; Keyser, West Virginia. BECRAFT MEMBER. Cherry Run, West Virginia. ORISKANY FORMATION, RIDGELY MEMBER. Knobly, Williams Road near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

[1] This group of orthoids has a punctate shell structure and is readily distinguished from Rhipidomella by the smaller and narrower muscular scars, and the small and inconspicuous cardinal areas.

DALMANELLA PERELEGANS (Hall)

Plate LIV, Figs. 14-23

Orthis perelegans Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 44, fig. 1.

Orthis perelegans Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 171, pl. xiii, figs. 4-12, 1861.

Description.—" Shell transversely oval: valves nearly equally convex. Dorsal valve subventricose, more or less depressed along the middle from near the beak to the front: beak small, little elevated above the hinge-line. Ventral valve elevated along the middle from the beak towards the front, and sloping laterally: beak small, pointed, incurved, extending beyond that of the opposite valve. Cardinal margin generally sloping a little from the beaks, and rounding imperceptibly into the lateral margins. Area narrow, nearly half as long as the width of the shell. Foramen broad triangular, extending nearly to the apex of the beak. Surface marked by fine irregular bifurcating longitudinal striæ, crossed by concentric lines of growth." Hall, 1859.

Length 1.7 cm. to 2.5 cm.; width 1.7 cm. to 3.0 cm.

In Maryland this well-known and characteristic New Scotland fossil never attains the large size of New York examples, but otherwise the specimens are indistinguishable. *D. concinna* of the Keyser member is a more obese shell, with more pronounced dorsal sinus and ventral median ridge, and the radial striæ are finer and equal in size.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Devil's Backbone, Corriganville. NEW SCOTLAND MEMBER. Keyser, West Virginia; Dawson, Corriganville, Maryland.

Collection.—Maryland Geological Survey.

DALMANELLA EMINENS (Hall)

Plate LIV, Figs. 24-26

Orthis eminens Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 42, text figs. 1, 2.

Orthis eminens Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 167, pl. xi, figs. 7-14, 1861.

Rhipidomella eminens Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, pp. 210, 225.

Rhipidomella eminens Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 304, pl. xxxiv, fig. 9.

Description.—"Shell circularly subquadrate, wider than high. Dorsal valve convex in the middle, and depressed almost equally towards the margins: beak rising but slightly above the hinge-line, with a central depression which is lost before reaching the middle of the valve. Ventral valve very convex near the beak, flattened or depressed towards the base: beak very prominent, projecting much beyond the opposite valve, pointed and slightly incurved. Hinge-line less than the width of the shell. Area large, extending nearly two-thirds the entire width of the shell: foramen large and high. Surface finely striated, with frequent bifurcations; the striæ curving upwards to the hinge margin." Hall, 1859.

Length 2.2 cm.; width 2.5 cm. to 3.0 cm.

This species, never common in Maryland, is readily distinguished from the associated orthoids by the long and high ventral cardinal area and the regularly convex valves, both of which are equally deep. The interior structure is that of Dalmanella. Mr. Roeder has a ventral valve that is 41 mm. long and 46 mm. wide, therefore larger than New York individuals.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, near Cumberland, 21st Bridge, Maryland; near Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

DALMANELLA CLARKI n. sp.

Plate LIV, Figs. 7-10

Description.—Subcircular to transversely subelliptical in outline, wider than long, hinge-line shorter than the greatest width of the shell. Pedicle valve very convex, very gibbous to ventricose, beak pointed and strongly incurved and arched over the cardinal area. Brachial valve depressed convex with a well-defined mesial sinus, which extends from the beak to the front, narrow at the beak and becoming gradually wider towards the front; beak small, pointed, incurved, extending only slightly above the hinge-line. The surface of both valves marked by fine radiating striæ, which are prominent and well defined. They increase toward the margin by implantation. The striæ may be alternately coarse and fine, or there may be several fine striæ between the coarser ones. Internally the ventral valve is not usually well preserved. The vascular area is small and not usually well defined. The teeth which diverge from the beak, are prominent, rounded, and become thicker towards their extremities. In the dorsal valve the cardinal process is prominent and on both sides of it are strong divergent dental lamellæ which are produced forward and extend to at least the middle of the valve, converging toward the central prominent ridge which extends from beneath the beak to the base, and circumscribes a suboval muscular area. Dimensions of an average specimen: Length 6.5 mm.; width 8 mm.

Dalmanella clarki may be distinguished from *Dalmanella postelegantula* of the Decker Ferry in being smaller while the sinus of the brachial valve extends from the beak to the front. It differs from *Dalmanella elegantula* of the Clinton and Niagara in being wider than long, while the brachial valve is more convex and the mesial sinus more conspicuous. It differs from *Dalmanella subcarinata* in having the brachial valve more convex, but not subcarinate.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collection.—Maryland Geological Survey.

[Maynard.]

DALMANELLA CONCINNA (Hall)

Plate LIV, Figs. 11-13

Orthis concinna **Hall, 1859, Pal. N. Y., vol. iii, p. 172, pl. x*a*, figs. 1-3, 1861.**
Dalmanella concinna **Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. 1, pp. 207, 224.**

Description.—"Shell longitudinally semielliptical: valves unequally convex: hinge-line straight, with the extremities subangular. Dorsal valve convex, with a depression from beak to base, on each side of which the shell is more convex, and thence sloping somewhat abruptly to the sides: beak very small and scarcely incurved. Ventral valve very convex, gibbous, and almost subcarinate in the middle: beak prominent, much elevated above the hinge-line, and neatly incurved over the area. Area comparatively large, the length greater than half the width of the shell.

Surface very finely and evenly striated. This species bears some resemblance to *O.* [*Dalmanella*] *elegantula* of the Niagara group; but it is more finely and beautifully striated, the dorsal valve is more gibbous, ... and the beak less arched." Hall, 1859.

Certain individuals referred to this species are much more circular in outline than the forms described by Hall, the cardinal angles being less extended and the valves less elongate.

Concerning this species Schuchert remarks that it "is easily confounded with *Dalmanella perelegans,* but it is always smaller, more obese, and with finer striæ. Hall states that these specimens are from the "shaly limestone of Cumberland, but is in error, since all those now found are from the Keyser member, and none have been seen in the New Scotland member."

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Cash Valley, Devil's Backbone, Market Street Bridge, Cumberland, section southwest of Rawlings, Pinto, Viaduct Cumberland, Tonoloway, Maryland; Pleasant Valley, Bedford County, and Hyndman, Pennsylvania.

Collection.—Maryland Geological Survey.

[Maynard.]

Genus RHIPIDOMELLA Œhlert[1]

RHIPIDOMELLA EMARGINATA (Hall)

Plate LV, Figs. 1-8

Orthis oblata var. *emarginata* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 164, pl. x*a*, figs. 4-6, 1861.

Description.—"Among the collections from the Lower Helderberg rocks of Cumberland, Maryland, there are numerous specimens of an *Orthis,* having the same general characters as *O. oblata,* but proportionally narrower and the beak more extended. The dorsal valve is very convex, and the ventral valve is marked by an undefined depression, which, beginning below the beak, gradually becomes wider and deeper, producing a deep sinuosity or emargination in front.

[1] See Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 209.

"The vascular area of the ventral valve occupies a comparatively greater space than in shells of *O. oblata* from the Helderberg, and it is more elongated or triangular in form. In the dorsal valve, the double imprints of the adductor muscles are well preserved." Hall, 1859.

The forms collected in Maryland by the writer differ from those figured by Hall in having the lateral margins well rounded; giving to the shell a much more circular appearance than the somewhat subtriangular outline of those figured by Hall.

Rhipidomella emarginata resembles somewhat *Dalmanella quadrans* and *Dalmanella concinna* but seldom assumes the subquadrate shape which characterizes both these species.

Length of average specimen about 1.5 cm.; width about 1.7 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, near Bloomfield, West Virginia; Cash Valley, Cumberland, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Maynard.]

RHIPIDOMELLA OBLATA (Hall)

Plate LV, Figs. 9-16

Orthis oblata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 41, figs. 1-5.

Orthis oblata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 162, pl. x, figs. 1-22, 1861.

Rhipidomella oblata Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, pp. 210, 225, pl. via, figs. 3, 4.

Description.—"Shell [in the young state] longitudinally subovate, and varying from circular to transversely oval in its stages of growth, resupinate: ventral valve convex at the beak, flattened in the middle, and concave towards the front; dorsal valve very convex in the middle and towards the beak; beaks of the two valves nearly equally elevated, that of the ventral valve pointed; area very small; foramen large. Surface finely striated; striæ frequently bifurcating and curving towards the lateral and cardinal margins, concentrically marked by finer striæ and stronger lines of growth, which are numerous in the older shell."

"Internally the ventral valve is marked by a large foliate vascular impression: impressions of the adductor muscles rarely well preserved, except in the casts. Teeth prominent, and, when entire, rounded and thickened at their extremities. Dorsal valve with prominent cardinal process and divergent brachial lamellæ: a central ridge, more or less prominent, extends from beneath the beak to near the base." Hall, 1859.

Length of average specimen about 2 cm.; width about 2.5 cm.

This well-known and widely distributed Helderberg orthoid is abundantly present in Maryland, where it rarely attains the large size of the New York examples, but otherwise is identical.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Dawson. NEW SCOTLAND MEMBER. 21st Bridge (shale zone), Dawson, Miller's Spring, Devil's Backbone, Corriganville, near Cumberland, Ernstville, Maryland; Cherry Run, West Virginia.

Collection.—Maryland Geological Survey.

RHIPIDOMELLA ASSIMILIS (Hall)

Plate LV, Figs. 17-19

Orthis assimilis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 175, pl. xv, figs. 1*a*-1*e*, 1861.

Rhipidomella assimilis Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, p. 224.

Description.—"Shell suborbicular, sometimes a little longer than wide: valves nearly equally convex above the middle. Dorsal valve most convex in the middle, and sloping to the front and sides. Ventral valve most convex towards the beak, depressed and broadly sinuate below: beak prominent, acute, incurved, and extending beyond the opposite valve. Area longer than half the width of the shell; the height equal to one-third the length. Foramen large.

"Surface finely and somewhat evenly striated. Vascular impressions of the ventral valve foliate, occupying a broad ovate space, limited on the sides by a continuation of the brachial lamellæ." Hall, 1859.

Length about 2.7 cm.; width about 3 cm.

With *R. oblata* occur individuals less oblate and more elongate. These approach *R. assimilis* and it appears that the latter developed from that species. The New Scotland variety, however, does not attain the size of the Becraft species, nor has it the obesity, the great shallow ventral sinus, and other characters marking *R. assimilis.*

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Cherry Run, abundant in the Baltimore and Ohio Railroad cut through North Mountain near its eastern end, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

RHIPIDOMELLA MUSCULOSA (Hall)

Plate LV, Fig. 20; Plate LVI, Figs. 1-4

Orthis musculosa Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 46.

Orthis musculosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 409, pl. xci, figs. 1-3; pl. xcv, figs. 1-7, 1861.

Rhipidomella musculosa Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, pp. 190, 210, 225, pl. via, fig. 5.

Description.—"Shell suborbicular, the length about nine-tenths as great as the width: ventral valve depressed convex, sometimes slightly concave near the front; beak prominent, equalling or extending a little beyond that of the opposite valve, pointed and slightly incurved: dorsal valve regularly and distinctly convex, most elevated in the central region, sometimes a little depressed towards the front; beak prominent, triangular, pointed and incurved; cardinal teeth and process strong; hinge extremely short; area triangular, scarcely extending beyond the foramen; foramen large, partly occupied by the prominent cardinal process of the other valve, visceral impression large, fan-shaped, and strong. Surface marked by fine, distinct, radiating striæ, those nearest the cardinal margin being curved outwards from the beak; concentrically marked by obscure lines of growth." Hall, 1857.

Length 3 cm.; width 3.6 cm.

Fine examples of this species show them to be large and massive *R. assimilis,* with the muscular scars relatively larger. Hall compared this form with *R. oblata,* and under *R. assimilis* the writer stated that the latter probably developed from the more elongate variety of *R. oblata.* This seems to be the line of development, beginning in small specimens and terminating with the largest growth in the Upper Oriskany in *R. musculosa.*

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly, Williams Road, and Collier's Run, near Cumberland, Maryland; Pendleton County, West Virginia.

Collection.—Maryland Geological Survey.

RHIPIDOMELLA MUSCULOSA VAR. ARCTISINUATA n. var.

Plate LV, Figs. 21, 22

Description.—Associated with *R. musculosa* are a number of small individuals with a narrow ventral sinus, stronger medially elevated dorsal valve, and an emarginate anterior edge. In many ways these shells recall *R. emarginata* of older formations, but are more coarsely striate, thicker shelled, and more strongly biconvex. They can hardly be regarded as direct descendants of *R. emarginata,* since the Oriskany material grades into *R. musculosa.* However, the Lower Devonian Rhipidomellas are closely related forms, and it may be that *R. musculosa* var. *arctisinuata* is reversional or atavistic in its expression.

A very large specimen apparently of this species in Mr. Roeder's collection measures 35 mm. in length and 40 mm. in width. The average specimen is 15 mm. by 18 mm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—U. S. National Museum.

RHIPIDOMELLA MARYLANDICA n. sp.

Plate LV, Fig. 23

Description.—This species has the external expression of *R. assimilis* or half-grown individuals of *R. musculosa,* with which it has been confounded. It differs from all Lower Devonian Rhipidomellas in the narrow ventral muscle area and the nearly complete absence of the raised lateral and anterior margins usually seen in this area in other species. The ventral valve is depressed convex as in *R. musculosa,* but has not the broad shallow sinus of this species. Dorsal valve unknown.

Length 2.5 cm.; width 2.5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Williams Road near Cumberland.

Collection.—Maryland Geologieal Survey.

Genus SCHIZOPHORIA King[1]

SCHIZOPHORIA MULTISTRIATA (Hall)

Plate LVI, Figs. 5-8

Orthis multistriata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 45, figs. 1, 2.

Orthis multistriata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 176, pl. xv, figs. 2*a*-2*f*, 1861.

Schizophoria multistriata Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, pp. 212, 226, pl. via, fig. 25.

Description.—" Shell circular or transversely suboval: ventral valve most convex near the beak, depressed so as to form a broad shallow undefined sinus, which sometimes gives to the front a subemarginate aspect; beak a little more prominent than the opposite, slightly ineurved: dorsal valve more elevated, most convex between the middle and the beak; beak rising above the hinge, obtuse and ineurved; hinge-line straight, about half the width of the shell; area small; foramen narrow, extending nearly to the apex. Surface marked by fine, erowded, nearly equal striæ, whieh inerease chiefly by implantation, and are erossed by a few faint coneentrie lines of growth." Hall, 1857.

Length 1.9 cm.; width 2.1 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Baekbone.

Collection.—George M. Roeder.

SCHIZOPHORIA ORISKANIA n. sp.

Plate LVI, Figs. 9-12

Description.—This speeies is most elosely related to *S. propinqua* of the Onondaga limestone, but has a less pronouneed ventral sinus and ventral eardinal area, while the museular sears and vaseular sinuses are far less

[1] See Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 211.

marked than in the latter. The surface ornamentation is not well preserved, but the number of striæ appear to be about as abundant as in *S. propinqua.*

This species is distinguished from *S. multistriata* in being smaller, less gibbous, and with coarser striæ. One example referred with doubt to this species has a slight ventral fold and a narrow dorsal sinus, conditions just the reverse of that in the other specimen regarded as the type of *S. oriskania;* otherwise the expression is that of Schizophoria.

Length 1.8 cm.; width 2 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (Knobly).

Collection.—George M. Roeder.

Superfamily STROPHOMENACEA

Family STROPHOMENIDAE

Genus LEPTÆNA Dalman

LEPTÆNA RHOMBOIDALIS (Wilckens)

Plate LVI, Figs. 13-17

Conchita rhomboidalis Wilckens, 1769, Nachricht von selten Versteinerungen, p. 77, pl. viii, figs. 43, 44.
Leptæna depressa Hall, 1852, Pal. N. Y., vol. ii, p. 257, pl. liii, figs. 6*a*-6*l*.
Strophomena rugosa Hall, 1859, Pal. N. Y., vol. iii, p. 195, pl. xix, fig. 1.
Leptæna rhomboidalis Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, 1892, p. 279; pl. viii, figs. 17-31; pl. xv*a*, figs. 40-42; pl. xx, figs. 21-24.

Description.—"Shell semioval or semicircular; hinge-line equal to or extending beyond the width of the shell; dorsal valve having the upper part nearly flat, slightly convex or even concave, with strong concentric undulations, towards the margin abruptly inflected; ventral valve parallel to the dorsal valve, presenting a deep concavity. Surface marked by prominent radiating striæ. The cardinal area is narrow and extended to the extremities of the hinge-line; the foramen is broad and spreading, but filled by a callosity of the ventral valve, which has a narrow groove at its summit for the protrusion of the pedicle; the apex of the dorsal valve is often, and perhaps always, perforated. The flatter portions of both valves are strongly marked by concentric undulations, which are crossed by fine striæ. On the deflected portions there are no undulations, the striæ alone marking the surface. Sometimes the shell is nearly flat, the deflected portion being either very narrow, or not at all conspicuous. The undulations are variable in number, even in shells of the same size, and are not to be relied upon as characteristic; and in very old shells they are not so strong as in younger ones, or those of medium size. The striæ crossing the undulations are likewise variously prominent in different individuals, frequently bifurcating, and in well-preserved surfaces are crossed by fine concentric striæ. The interior structure is always peculiar and sufficiently characteristic, though the exterior characters are very closely simulated by a different shell in the shaly limestone of the Helderberg.

"This species has a wide range, occurring in the Clinton group and ranging to the Upper Helderberg limestones." Hall, 1852.

This species is found also in the Clinton and Oriskany of Maryland.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Corriganville, Cash Valley, Pinto, Tonoloway, Maryland; Hyndman, Pennsylvania. COEYMANS MEMBER. Dawson, Corriganville, Devil's Backbone. NEW SCOTLAND MEMBER. 21st Bridge, Dawson, Corriganville, Miller's Spring, Ernstville, Maryland; Cherry Run, West Virginia. BECRAFT MEMBER. Warren Point, Pennsylvania. ORISKANY FORMATION, RIDGELY MEMBER. Miller's Spring, near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Maynard.]

LEPTÆNA RHOMBOIDALIS VAR. VENTRICOSA (Hall)

Plate LVI, Fig. 18; Plate LVII, Fig. 1

Strophomena depressa var. *ventricosa* Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 55.

Strophomena rugosa var. *ventricosa* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 417, pl. xciv, figs. 2*e*, 2*f*, 3.

Leptæna rhomboidalis var. *ventricosa* Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, pl. xv*a*, fig. 43.

Description.—"Shell transversely oblong, subsemicircular; length and breadth sometimes nearly equal; front often straight in the middle, and parallel to the hinge-line; ventral valve extremely ventricose, scarcely geniculate in front: dorsal valve forming an inclined plane from the hinge towards the front, near which it is abruptly deflected, giving the valve a deep concavity: hinge-line equal to the greatest width of the shell; lateral margins contracted, so as to leave small auricular extensions at the extremities of the cardinal border; area sublinear, longitudinally striate: interior distinctly granulose; muscular attachments strongly marked." Hall, 1857.

Length 3.5 cm.; width along hinge 5.6 cm.

This is the Oriskany form of *L. rhomboidalis,* with strongly marked muscular scars.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Maryland; Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

Genus LEPTÆNISCA Beecher

LEPTÆNISCA CONCAVA (Hall)

Plate LVII, Figs. 2-5

Leptæna concava Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 47.

Leptæna concava Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 197, pl. xviii, fig. 2, 1861.

Leptænisca concava Beecher, 1890, Amer. Jour. Sci. (3), vol. xl, p. 238, pl. ix, figs. 1-5.

Description.—" Shell concavo-convex, hemispherical: ventral valve regularly convex; umbonal region prominent; cardinal margin rounding from the beak towards the lateral extremities: dorsal valve deeply concave; hinge-line less than the greatest width of the shell; area of ventral valve broad, that of dorsal valve linear; foramen triangular, nearly closed by a thick callosity. Surface marked by very fine, close, radiating striæ, each fifth or sixth one a little more prominent than those between; crossed by fine regular concentric wrinkles, producing a beautiful subcancellate appearance." Hall, 1857.

Length 1.5 cm. to 3 cm.; width 1.7 cm. to 3.3 cm.

This interesting brachiopod is common in a very restricted zone near the base of the New Scotland in Albany County, New York. Occasionally a single specimen is found higher in the same horizon.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Dawson. NEW SCOTLAND MEMBER. Miller's Spring near Cumberland, Devil's Backbone.

Collection.—Maryland Geological Survey.

Genus STROPHEODONTA Hall[1]

The Lower Devonian species of Stropheodonta are readily divided into two groups on the basis of the ventral muscle areas. In Stropheodonta proper the shells are always concavo-convex and sometimes strongly so, while in Leptostrophia they are nearly always plano-convex (except *L. magniventra,* which is strongly concavo-convex). In the latter group the ventral muscle scars are bounded laterally by two strongly pustulose diverging ridges, while anteriorly the scars are not strongly limited. In Stropheodonta proper there are no lateral diverging ridges and the muscle scars are well defined all around by a raised rim which is more or less scalloped.

The cardinal areas in all the Devonian forms of Stropheodonta are strongly marked by transverse lines terminating on the hinge-line by a series of fine teeth. In the Silurian species the degree of development of these teeth is, upon the whole, progressive, beginning in the Clinton with a few teeth on each side of the deltidium and increasing in number through the Niagara into the Manlius. For these early forms of Stropheodonta Hall and Clarke have used Brachyprion Shaler.

STROPHEODONTA ARATA (Hall)

Plate LVII, Figs. 7-10

Strophodonta varistriata var. *arata* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 183, pl. xviii, figs. 1*a*-1*t*, 1861.

Description.—" Shell semielliptical, with the cardinal extremities more or less salient: hinge crenulate. Dorsal valve more or less concave. Ventral valve varying from moderately convex to very gibbous, and sometimes

[1] For an extended description of this genus and its subdivisions, see Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, pp. 284-289.

geniculate towards the front. Area narrow. Foramen none, or a narrow elevation or callosity in place of it.

"Surface marked by very prominent sharp angular ridges and intermediate fine undulating striæ, which cover also the slopes of the ridges. Sometimes a few short wrinkles mark the spaces between the ridges, along the cardinal margin towards the hinge extremities." Hall, 1859.

Length about 1.5 cm.; width about 2.4 cm.

A very convex variety is here illustrated. Other specimens are more depressed, but both forms have the sharp angular plications covered with finer striæ.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Dawson, Devil's Backbone. NEW SCOTLAND MEMBER. Dawson, Devil's Backbone.

Collections.—Maryland Geological Survey, American Museum of Natural History.

STROPHEODONTA VARISTRIATA (Conrad)

Plate LIX, Figs. 1, 2

Strophomena varistriata Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 255, pl. xiv, fig. 6.

Strophodonta varistriata Hall, 1859, Pal. N. Y., vol. iii, p. 180, pl. viii, figs. 1-16; pl. xvi, figs. 1-8, 1861.

Stropheodonta varistriata Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 427.

Description.—"Shell semioval, varying in form from length and width equal to length greater or less than the width: hinge-line equal to or greater than the width of the shell below; extremities rounded or salient. Dorsal valve flat, or more or less concave according to the convexity of the ventral valve, but not conforming entirely to the curvature of the latter. Ventral valve varying from slightly convex to gibbous, and sometimes abruptly arching towards the front; umbonal region more or less prominent; beak usually a little elevated. Area narrow, almost linear. Foramen linear or none.

"Surface often finely and evenly marked with straight or slightly undulating striæ; more often with prominent sharp striæ at more or less equal distances from each other, and the intermediate spaces by minute equal striæ; and again in other specimens by alternating larger and smaller striæ, of which there are frequently three regular gradations in size. Radiating striæ crossed by fine concentric elevated lines, and often by undulations or indentations which are more conspicuous on those shells where the striæ are in fascicles of finer between stronger ones. Vascular impressions of the ventral valve circumscribed by lamellæ, more or less distinctly flabellate: impressions of adductor muscles elongate-oval." Hall, 1859.

Length 1.1 cm. to 1.9 cm.; width 1.5 cm. to 2.5 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley, Maryland; Hyndman, Pennsylvania.

Collection.—Maryland Geological Survey.

[Maynard.]

STROPHEODONTA COEYMANENSIS n. sp.

Plate LVII, Fig. 6

Description.—Shell medium size, subsemioval; concavo-convex, hinge-line of specimen observed shorter than width, transverse ventral valve very convex, greatest convexity anterior to middle. Area not seen. Dorsal valve not observed. Surface of ventral valve ornamented by plications of unequal strength distant about 1 mm. near margin. Interior of ventral valve showing large distinct flabelliform muscle scars.

Length 2.7 cm.; width 3.3 cm.

This species resembles *S. inæquiradiata* Hall of the Onondaga, but differs in its much larger muscular scars.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Devil's Backbone.

Collection.—Maryland Geological Survey.

[Swartz.]

STROPHEODONTA DEMISSA (Conrad)

Plate LVII, Fig. 11

Strophomena demissa Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 258, pl. xiv, fig. 14.

Strophodonta demissa Hall, 1867, Nat. Hist. N. Y., Pal., vol. iv, pp. 81, 101, pl. xi, figs. 14-17; pl. xii, figs. 1-5.

Description.—"Length and width nearly equal; inferior valve ventricose; superior valve deeply concave; radii sharp, prominent, subtuberculated, much more prominent on the upper than on the lower half of the valves, where they greatly bifurcate and become fine and very numerous; umbo convex, the summit slightly elevated; hinge angles slightly salient." Conrad, 1842.

Length 2.6 cm.; width 3.2 cm.

This well-known species has heretofore been reported from the Schoharie grit, Onondaga, Hamilton, and Chemung formations, and now its range is extended downward into the Upper Oriskany. The four ventral interiors cannot be distinguished from Hamilton specimens, but as yet no dorsal valves have been seen in the Oriskany. The species nearest related to *S. demissa* in the Lower Oriskany is *S. schuchertanum,* but its striæ are finer and somewhat bundled and the valves are decidedly more arched.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. North fork of south branch of the Potomac River, Pendleton County, West Virginia.

Collection.—U. S. National Museum.

STROPHEODONTA (LEPTOSTROPHIA) BECKII (Hall)

Plate LVII, Figs. 12, 13

Strophodonta beckii Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 191, pl. xxii, figs. 1*a*-1*f*, 1861.

Stropheodonta (*Leptostrophia*) *becki* Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, p. 288, pl. xiii, figs. 23, 24.

Description.—"Shell semielliptical or subquadrate: length sometimes equal to the width (though usually from two-thirds to three-fourths as great). Ventral valve very depressed convex: beak very small. Dorsal valve flat or a little concave near the hinge, slightly convex near the front. Hinge-line crenulated, generally equal to the greatest width of the shell, but sometimes less. Area linear, confined to the ventral valve. Foramen small, linear, usually closed.

"Surface marked with strong, regular, closely arranged, bifurcating, radiating striæ, crossed by fine obscure concentric lines, and more or less regular concentric wrinkles which curve outwards on approaching the hinge. Interior of shells striato-punctate, the hinge-line crenulated almost to its extremities. The muscular area of the ventral valve flabelliform, more or less strongly defined at its margins." Hall, 1859.

Length 4 cm.; width 4.5 cm.

Mr. Roeder collected a single small specimen on Knobly Mountain in the Upper Oriskany, which may belong to this species. It has fewer concentric corrugations, and these are restricted to an area in the posterior region smaller than in the Helderberg specimens, and there are fewer undulating striæ. In Helderberg individuals there are about seventeen of these in 10 mm., while in that from the Oriskany there are fifteen in the same space.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cedar Cliff, West Virginia; 21st Bridge, Maryland; Warren Point, Pennsylvania. ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain, near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

STROPHEODONTA (LEPTOSTROPHIA) PLANULATA (Hall)

Plate LVII, Figs. 14-16

Strophodonta planulata **Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 184, pl. xvi, figs. 9-12, 1861.**

Description.—" Shell semielliptical, width nearly one-half the length, plano-convex: hinge-line greater than the width of the shell below; the cardinal extremities often salient. Dorsal valve flat. Ventral valve uniformly and very slightly convex, sometimes flattened towards the margins: beak scarcely elevated above the hinge-line. Area linear. Foramen unknown. Surface finely and evenly striated: striæ of the dorsal valve often flattened. Radiating striæ crossed by fine closely arranged concentric striæ, and somctimes with a few inconspicuous laminæ of growth, and towards the cardinal extremities by a few wrinkles or undulations." Hall, 1859.

Length about 3 cm.; width about 4 cm.

This species is readily separated from *S. beckii* by its finer and equal rounded radial striæ, while the concentric corrugations, if present at all, are very faint.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Dawson, Corriganville. NEW SCOTLAND MEMBER. Dawson, Devil's Backbone, Corriganville. BECRAFT MEMBER. Washington County, Maryland. Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

STROPHEODONTA (LEPTOSTROPHIA) BIPARTITA (Hall)

Plate LVII, Figs. 17, 18

Leptæna bipartita Hall, 1858, Pal. N. Y., vol. ii, p. 326, pl. lxxiv, figs. 4, 5.
Stropheodonta nearpassi Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 427.
Stropheodonta textilis Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 427.
Strophomena (?) *bipartita* Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 429.
Stropheodonta bipartita Weller, 1903, Pal. N. J., vol. iii, p. 226, pl. xx, figs. 1-5.

Description.—"Shell with thin, nearly flat brachial valve and slightly convex pedicle valve, longitudinally subsemielliptical in outline, the hinge-line produced beyond the body of the shell into mucronate extensions, hinge-line crenulate.

"Surface of both valves marked by fine, irregularly alternating, angular, raised striæ, which are not continuous over the umbo to the beak, and which curve outward on the sides of the shell in passing to the margin, the curvature becoming stronger on approaching the hinge-line. The surface is also marked by much finer, crowded, concentric lines, which continue to the beak. Oblique wrinkles along the cardinal margin are present in many specimens. The interior of the valves, more especially the pedicle, is covered with fine, closely crowded papillæ, which gives to the surface of internal casts a finely pitted or punctate appearance. These internal papillæ may frequently be detected through the thin shell substance as dark spots, giving it a punctate appearance, but there are apparently no perforations. The muscular impressions of the pedicle valve are rather large and divergent and are free from impressions of papillæ. In the interior of the brachial valve a low median ridge reaches more than half way to the front of the shell.

"The dimensions of a medium-sized specimen are: Length, 28 mm.; breadth, 30 mm." Weller, 1903.

This species is the same as *Stropheodonta bipartita* which Weller describes from the Decker Ferry of New Jersey and which he considers the same as the three shells described by Hall in Volume II of the Paleontology of New York under the names *Leptæna* sp., *Leptæna bipartita*, and *Stropheodonta textilis*, all from the Coralline limestone of Schoharie, New York. It differs from the three forms described by Hall in having the striæ curve outwards on the sides of the shell in approaching the margins, the curvature increasing towards the posterior portion of the shell. This curvature is not mentioned in Hall's description and on examining the type material the striæ do not curve but radiate from the beak straight. While this form is the same as that described by Weller it may prove to be a distinct species from Hall's.

It is distinguished from *S. planulata* of the Lower Helderberg by the curvature of the alternating angular striæ, while the striæ of *S. planulata* are fine and even.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Hancock, Cookerly, 1¾ miles northeast of Flintstone, Pinto, Maryland; Hyndman, Pennsylvania.

Collection.—Maryland Geological Survey.

[Maynard.]

STROPHEODONTA (LEPTOSTROPHIA) ARCTIMUSCULA n. sp.

Plate LVIII, Fig. 1

Description.—This is a very flat species of Stropheodonta, with the ventral muscle area very much narrower and more excavated than in other forms from the Oriskany. The striæ are somewhat coarser than in *S. magnifica*, there being about twelve in 5 mm., while in the latter there are from fifteen to twenty in the same space in Cumberland specimens. *L. oriskania* Clarke,[1] with which it was at first identified, is a somewhat smaller species,

[1] Mem. N. Y. State Mus., vol. iv, No. 3, 1900, p. 53, pl. vii, figs. 29-35.

with finer striæ, concentric corrugations, and a more triangular ventral muscle pit. Dorsal valve unknown.

Length about 3 cm.; width about 4 cm.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge, North Branch near Cumberland, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

STROPHEODONTA (LEPTOSTROPHIA) MAGNIFICA (Hall)

Plate LVIII, Figs. 2-5

Strophodonta magnifica Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 54.

Strophodonta magnifica Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, pp. 414, 482, pl. xciii, fig. 4; pl. xciv, figs. *2a-2d*; pl. xcv, fig. 8; pl. xcv*a*, figs. 15-19.

Strophodonta vascularia Hall, 1859, *ibidem*, vol. iii, p. 412, pl. xcii, fig. 4; pl. xcv, fig. 10 (not pl. xciii, figs. 2*b*, 2*c* = ? *S. magniventra*), 1861.

Strophomena magnifica Billings, 1861, Can. Jour. Sci. Arts, vol. vi, p. 348.

Strophomena magnifica Billings, 1863, Geol. Canada, p. 961, fig. 468.

Strophodonta magnifica Hall, 1883, Second Ann. Rept. N. Y. State Geol., pl. xliv, figs. 27, 28.

Stropheodonta (Leptostrophia) magnifica Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 288, pl. xiii, figs. 27, 28.

Leptostrophia magnifica Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 53, pl. vii, fig. 36.

Description.—" Shell very large, transversely suboval, somewhat semicircular, more or less rounded at the extremities of the hinge; length and breadth sometimes equal: ventral valve depressed convex in the middle and umbonal regions, flattened near the lateral extremities; cardinal margin sloping slightly from the beak: dorsal valve slightly concave; hinge-line crenulated, usually a little less than the width of the shell; area broad, distinctly and regularly marked with transverse striæ produced by the prolongations of the hinge crenulations; foramen very narrow, not closed. Surface marked by somewhat faint radiating striæ, which bifurcate regularly about two or three times at uniform distances from the beak." Hall, 1857.

The large size, somewhat thicker shell, lower ventral cardinal area, and especially the equally fine radial striæ of both valves distinguish this species from *S. magniventra*. The character pointed out by Hall for *S.*

vascularia, i. e., the narrower muscular impressions of the dorsal valve, has no particular significance, since that grades into the wider muscular area of *S. magnifica. S. lincklæni* is a smaller species with a flatter dorsal valve and a septum separating the posterior pair of adductor muscles.

Length about 5 cm.; width about 6 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain, Miller's Spring near Cumberland, Devil's Backbone, Martin Mountain, Collier's Run, Maryland; Warren Point, Pennsylvania; Pendleton County, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

STROPHEODONTA (LEPTOSTROPHIA) MAGNIVENTRA Hall

Plate LVIII, Figs. 6-8

Strophodonta magniventra Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 54.

Strophodonta magniventra Hall, 1859, Nat. Hist. N. Y. Pal., vol. iii, p. 411, pl. xcii, figs. 2*a*-2*c*, 3; pl. xcv, fig. 9, 1861.

? *Strophodonta lincklæni* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, pl. xciii, fig. 2*a* (not figs. 3*a*, 3*b* = *S. lincklæni*).

Strophodonta vascularia Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, pl. xciii, figs. 2*b*, 2*c* (not pl. xcii, fig. 4; pl. xcv, fig. 10 = *S. magnifica*), 1861.

Strophomena magniventra Billings, 1861, Can. Jour. Sci. Arts, vol. vi, p. 349.

Strophomena magniventra Billings, 1863, Geol. Canada, p. 961, fig. 469.

Strophomena magniventra Billings, 1874, Pal. Foss., vol. ii, p. 22, figs. 10-12, pl. ii, figs. 2, 2*a*.

Stropheodonta (Leptostrophia) magniventra Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 288, pl. xiii, figs. 25, 26.

? *Stropheodonta lincklæni* Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 52, pl. vii, fig. 37.

Description.—" Shell subsemicircular varying to longitudinally suboval, variable; length usually two-thirds the breadth, sometimes equal or greater: ventral valve convex in the central and umbonal regions, flattened towards the extremities; beak slightly incurved; cardinal border sloping from the umbo: dorsal valve unknown, probably concave: hinge-line crenulated, equal to the greatest width of the shell, sometimes extended into mucronate points beyond the lateral margins of the shell; area of ventral valve very broad, slightly curved, distinctly marked by vertical striæ produced by the prolongation of the crenulations of the hinge; foramen large, triangular, apparently mostly closed. Surface marked by regular, rounded, slightly elevated, radiating striæ: interior scarcely granulose, strongly marked with a plicated flabelliform muscular impression, covering nearly two-thirds of its extent." Hall, 1857.

Length 2.5 cm. to 4 cm.; width about 4 cm.

This has been a very perplexing species, owing to the fact that the valves are found separated, are very thin and frail, and usually broken before deposition. This is shown in the ventral valves figured by Hall, no two of which are alike, and one of which has the anterior margin passing through the muscular scars (see fig. 2*b*, Hall), an impossible condition for a living brachiopod. The mature shells attained a size nearly as large as *S. magnifica,* are usually thin and quite convex. It is more often these convex valves that have so much of the anterior region broken away, though preserving the characteristic posterior portion with its very high ventral cardinal area. The writer has before him twelve half-grown, not very convex examples, seven of which have both valves united. The latter show that the shells are very thin and that the ornamentation of the two valves is very dissimilar. On the ventral valve the striæ are low, obscure, and separated by wide flat interspaces, there being rarely seven and more commonly from nine to twelve of these in 5 mm. This valve appears nearly smooth. The dorsal valve is marked by exceedingly fine, closely adjoining thread-like striæ, there being not less than thirty-two in 5 mm. In New York it is usually this valve that is found in large examples, with the anterior margin perfect, and is nearly always labeled *S. lincklæni.* However, this is now known to be the companion valve to *S. magniventra,* which was based on ventral shells. The interior of this species is practically the same as in *S. magnifica.*

S. magniventra is easily distinguished from all associated Stropheodontæ by its external ornamentation, *i. e.,* by the few widely separated obscure striæ on the ventral valve and by the very delicate and exceedingly numerous striæ of the dorsal valve. Another feature is the very high ventral cardinal area.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland. South end of Martin Mountain, Miller's Spring near Cumberland.

Collection.—Maryland Geological Survey.

STROPHEODONTA sp.

Description.—A large Stropheodonta measuring 4 cm. in length by about 4.5 cm. in width was found in the Keyser member of the section at Pinto. The individual observed is too poorly preserved for specific identification, and it has not been figured. It resembles *S. beckii* or an unusually large individual of *S. bipartita.*

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Pinto.

Collection.—Maryland Geological Survey.

[Swartz.]

Genus STROPHONELLA Hall[1]

STROPHONELLA GENICULATA (Hall)

Plate LIX, Figs. 3-5

Strophodonta geniculata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 483, pl. xxiii, figs. 6*a*, 6*b*, 6*c*, 1861.

Description.—" Shell somewhat semicircular, abruptly geniculate towards the base. Dorsal valve flat for two-thirds the length of the shell, when it is abruptly inflected. Ventral valve with a narrow area, the beak projecting a little beyond the opposite, slightly convex from the beak towards the middle, becoming flattened and concave, and the last third abruptly deflected, corresponding with the opposite valve. Surface at and near the beaks marked by strong radiating striæ, which bifurcate, and are increased by interstitial additions towards the base of the shell. Tubular openings are noticed at intervals on the summits of the stronger striæ, and round or oval pores mark the interstitial spaces.

" In some specimens the center of the dorsal valve is marked by a strong sinus with a prominent elevation on each side, with a corresponding mesial elevation on the center of the opposite or concave valve, and a sinuosity on either side." Hall, 1859.

[1] This genus is readily distinguished from Stropheodonta in having the relative convexity of the valves reversed. In other words, Stropheodonta is plano-convex or concavo-convex, while in Strophonella a section along the middle from the beak to the anterior margin will be sigmoid in outline. Otherwise the two genera are essentially alike. See Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, pp. 290-293.

Some specimens from Tonoloway are larger than those described by Hall and have much coarser striæ. They are questionably referred to this species. It is cited by Hall as coming from the lower Helderberg rocks of Cumberland.

Length about 1 cm.; width 1.8 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Viaduct Cumberland, Cash Valley, Tonoloway, Maryland; Keyser, West Virginia.

Collection.—Maryland Geological Survey.

[Maynard.]

STROPHONELLA LEAVENWORTHANA (Hall)

Plate LIX, Figs. 6, 7

Strophomena (Strophodonta) leavenworthana Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 53.

Strophonella leavenworthana Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 292, pl. xii, figs. 6-9.

Description.—" Shell subsemicircular, about three-fourths as long as wide, contracted below the extremities of the hinge; cardinal border sloping slightly from the beak: ventral valve flattened in the middle and cardinal margins, so as to form a semicircular inclined plane ascending from the hinge to beyond the middle of the shell; the front and lateral margins abruptly inflected, giving a deep concavity to the whole valve: dorsal valve flattened or slightly concave in the umbonal and central regions, very convex towards the front and lateral margins: hinge-line equal to the greatest width of the shell, crenulated; area linear, vertically striated; foramen small, triangular, closed in full-grown individuals. Surface marked by fine, obscure, closely arranged, radiating striæ, crossed on the depressed part of the valves by small regular concentric wrinkles." Hall, 1857.

None attain the large size of New York examples, but otherwise are indistinguishable. The species is readily distinguished from *S. punctulifera* by the much finer radial striæ and the more decided concavo-convex curvature of the valves.

Length 3.5 cm.; width 4.5 cm.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Keyser, West Virginia; Dawson, Corriganville, Devil's Backbone, Maryland. NEW SCOTLAND MEMBER. Dawson, Corriganville, Devil's Backbone, Miller's Spring near Cumberland.

Collection.—Maryland Geological Survey.

STROPHONELLA PUNCTULIFERA (Conrad)

Plate LIX, Figs. 8-10

Leptæna punctulifera Conrad, 1838, Second Rept. N. Y. State Geol. Surv., p. 117.

Strophomena punctulifera Vanuxem, 1842, Geol. N. Y., Rept. Third Dist., p. 122, fig. 5.

Strophomena (Strophodonta) punctulifera Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 50, fig. 1.

Strophodonta cavumbona Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 51.

Strophomena punctulifera Rogers, 1858, Geol. Penn., vol. ii, pt. ii, p. 825, fig. 648.

Strophodonta punctulifera Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 188, pl. xxi, fig. 4; pl. xxiii, figs. 4-7.

Strophodonta cavumbona Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 187, pl. xxi, figs. 1-3, 1861.

Strophomena punctulifera Billings, 1863, Proc. Portland Soc. Nat. Hist., p. 108, pl. iii, fig. 2.

Strophomena punctulifera Billings, 1863, Geol. Canada, p. 957, fig. 448.

Strophomena punctulifera Billings, 1874, Pal. Foss., vol. ii, p. 31, pl. iii, fig. 2.

Strophonella punctulifera Hall, 1879, Twenty-eighth Rept. N. Y. State Mus. Nat. Hist., p. 154.

Strophonella punctulifera Hall, 1883, Second Ann. Rept. N. Y. State Geol., pl. xliii, figs. 10-12.

Strophodonta punctulifera Walcott, 1884, Mon. U. S. Geol. Surv., vol. viii, p. 121, pl. xiii, fig. 10.

Strophonella punctulifera Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 292, pl. xli, figs. 10-12.

Strophonella cavumbona Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, pp. 291-292.

Strophonella punctulifera Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 277, pl. xxvii, figs. 6-8; p. 301, pl. xxxiii, fig. 9.

Description.—"Shell with the upper valve deeply concave; radiating striæ very numerous, prominent, angulated, each with a series of very regular small elevated punctæ. Length, 2 inches. Locality, Helderberg Mountain." Conrad, 1838.

"Shell subsemicircular, about four-fifths as long as wide. Ventral valve concave: beak not projecting beyond the hinge. Dorsal valve concave near the umbo, very convex near the middle: beak not elevated above the cardinal margin; sides somewhat contracted below the extremities of the hinge. Hinge-line straight, nearly or quite equalling the greatest width of the shell, finely crenulated. Area narrow, linear, vertically striated. Foramen nearly closed, with a narrow prominent callosity along the center. Surface marked by strong sharp striæ, which increase by bifurcation and interstitial addition, becoming rapidly more numerous and finer towards the margins, and are distinctly punctate in the best preserved specimens." Hall, 1859.

Length about 3.25 cm.; width about 4.5 cm.

A careful comparison of Albany County, New York, material of *S. cavumbona* Hall reveals no characters not possessed by *S. punctulifera* Conrad as redefined by Hall. The *S. euglypha* Roemer[1] Fœrste told the writer was derived from the Louisville limestone zone, and does not belong to this species. *S. cavumbona* Meek and Worthen[2] may be regarded as a good variety under the name *rectilateraria* proposed in the same place. It should be written *S. punctulifera rectilateraria*. On account of these changes in the synonymy the complete bibliography of *S. punctulifera* has been given above.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Dawson, Corriganville, Devil's Backbone. NEW SCOTLAND MEMBER. Dawson, Devil's Backbone, Corriganville, Maryland; Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

STROPHONELLA KEYSERENSIS n. sp.

Plate LIX, Fig. 11

Description.—Shell subsemicircular, concavo-convex, resupinate; about four-fifths as long as wide. Dorsal valve more convex than ventral valve, concave near umbo. Hinge-line usually somewhat greater than width of

[1] Sil. Fauna d. w. Tenn., 1860, p. 66, pl. v, fig. 3.

[2] Geol. Surv. Ill., vol. iii, 1868, p. 374, pl. vii, fig. 10.

shell anteriorly. Ventral valve concave anteriorly, convex near umbo. Umbo small, area narrow, triangular. Surface with numerous fine striæ. Interior of valves pustulose. Muscular scars unknown.

Length 3 cm.; width 3.7 cm.

This species closely resembles *S. punctulifera* from which it differs chiefly in its finer striæ.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway.

Collection.—Maryland Geological Survey.

[Swartz.]

STROPHONELLA HEADLEYANA (Hall)

Plate LIX, Fig. 12

Strophodonta headleyana **Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 185, pl. xx, figs. 1-3, 1861.**

Description.—" Shell nearly semicircular, about three-fourths as long as broad. Ventral valve very concave especially near the front, sometimes depressed convex at the beak; beak scarcely elevated above the margins of the area. Dorsal valve depressed at the umbo, and very convex towards the front: beak not extending beyond the cardinal margin. Hinge-line equalling the greatest width of the shell, crenulated. Area somewhat wide, and marked by transverse striæ produced by the continuation of the crenulations from the hinge-line across the surface. Foramen narrow, closed.

" Surface marked by coarse sharply elevated striæ, which increase chiefly by implantation, and present a peculiar irregularly waved appearance." Hall, 1859.

A single ventral valve of this species has been collected from Maryland. It was found by Rowe at Corriganville, near Cumberland. There is no need to figure the species in this place, since it has the general expression of *S. punctulifera* and differs only in having the sharp striæ wavy in elevation (irregular in height) and more numerous.

Length 4.6 cm.; width 6.5 cm.

The writer has in his collection two artificial impressions made from specimens collected by Mr. Andrews in the Upper Oriskany, and now in the Hall collection, that cannot be distinguished from this species. Here, therefore, are forms transitional to *S. ampla* of the Onondaga. The exterior in these two specimens is not preserved, and no positive identification can be made, though they seem to be *S. headleyana.*

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville.

Collections.—Maryland Geological Survey, U. S. National Museum.

STROPHONELLA UNDAPLICATA n. sp.

Plate LIX, Figs. 13, 14

Description.—Shell large, concavo-convex, resupinate, semioval to subsemicircular; length two-thirds to three-fourths width, hinge-line equalling or slightly greater than greatest width, extremities slightly extended. Ventral valve convex anteriorly, umbo concave, area not observed. Dorsal valve concave anteriorly, umbo convex. Surface ornamented by coarse, irregular, sinuous plications which may unite again forming elliptical depressions between them. Plications increasing by bifurcation or intercalation, more numerous and finer towards margin. Interior not observed.

Length of large individual 4.5 cm.; width 5.2 cm. Other specimens are shorter proportionally.

This species closely resembles *S. headleyana* to which it was earlier referred. Its ornamentation is distinctive.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Dawson, Corriganville.

Collection.—Maryland Geological Survey.

[Swartz.]

Genus SCHUCHERTELLA Girty[1]

The specific characters of these shells are about as variable as is the generic name under which they have been grouped. For a long time they were referred to the genus Streptorhynchus. In 1884 Waagen showed that the interior generic characters were different, and thinking he had cor-

[1] Orthothetes of authors. For a diagnosis, see Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 253, and Girty, 1904, Proc. U. S. Nat. Mus., vol. xxvii, p. 734.

rectly made out the interior characters of the Russian Upper Carboniferous shell, the basis of Fischer de Waldheim's genus Orthothetes, all subsequent writers, until 1904, have followed him in his conclusions. In that year, however, Girty showed that the Russian type had the characters for which Waagen proposed the genus Derbya in 1884, and according to the law of priority in publication, all the so-called Derbyas must be referred to Orthothetes, which should be spelled Orthotetes. This reference left the brachiopods referred to the last-named genus by authors except Waldheim without a group name. For these Girty has proposed Schuchertella, with *Streptorhynchus lens* White as the type.

SCHUCHERTELLA PROLIFICA n. sp.

Plate LX, Figs. 1-3

Description.—This abundant and medium-sized shell for this genus has the general form of *Schuchertella woolworthana,* but differs from it in many ways. The valves are thinner and less convex, the ventral cardinal area narrower, and the striæ far more abundant. In *S. woolworthana* the striæ are abruptly elevated and there are from nine to thirteen in 5 mm., while in *S. prolifica* they are lower and have from thirteen to twenty in the same space. In the latter species the striæ are also crossed by exceedingly delicate concentric lines of growth, which are not so well preserved in the other form. In the interior of *S. prolifica* the muscle scars are not impressed and are therefore but rarely seen, while the cardinal process is less strongly developed than in *S. woolworthana.* There are transitional forms, however, which unite this species so closely with *S. woolworthana* of the Coeymans as to make their separation often difficult or even arbitrary.

Length about 2.6 cm.; width about 3.3 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Dawson, Devil's Backbone, Corriganville, Tonoloway, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

SCHUCHERTELLA WOOLWORTHANA (Hall)

Plate LX, Figs. 4-9

Strophomena woolworthana Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 48, figs. 1, 2.

Strophomena woolworthana Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 192, pl. xvii, figs. 1*a*-1*f*, 2*a*-2*c*, 1861.

Orthothetes woolworthanus Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, p. 255, pl. ix, figs. 25-31.

Description.—" Shell semielliptical, often extremely elongate. Ventral valve concave towards the front and flat on the lateral margins, depressed convex near the beak: beak small, and scarcely rising above the edge of the valve. Dorsal valve convex, most elevated near the front, and flattened towards the umbo: beak not projecting. Hinge-line straight, equal to the greatest width of the shell. Area linear, conspicuous, partly common to both valves. Foramen broadly triangular, partially or entirely closed.

" Surface finely striated. Striæ round, crowded, simple, increasing by interstitial addition, concentrically crossed by closely arranged striæ and a few distant lines of growth.

" Ventral valve marked interiorly by a broad flabellate vascular area, which is partially limited by the dental lamellæ: teeth strong, projecting more or less into the interior of the valve; in old shells, less conspicuous. Dorsal valve with vascular area strongly marked: cardinal process deeply bifid, and each division again trilobate upon the exterior side; lateral lamellæ curving as in *Orthis*." Hall, 1859.

This variable species occurs in large and small specimens, all apparently mature, as in New York.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Keyser, West Virginia; Dawson, Devil's Backbone, Corriganville, Maryland. NEW SCOTLAND MEMBER. Dawson, Miller's Spring near Cumberland, Corriganville, Devil's Backbone, Maryland; Cherry Run, Cedar Cliff, West Virginia. BECRAFT MEMBER. Shale zone at 21st Bridge, Maryland; Cherry Run, West Virginia; Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum

Schuchertella becraftensis (Clarke)

Plate LX, Figs. 10-12

Orthothetes becraftensis Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 51, pl. vii, figs. 15-28.

Description.—" Shell small, suborbicular or elongate in outline. Pedicle valve erect at the beak, umbonal region generally sloping directly or with low convexity to the peripheral margins; sometimes slightly depressed about the umbo. Brachial valve depressed at and about the beak, becoming convex over the median and anterior regions. Surface of both valves covered with strong, rounded striæ increasing by implantation, new striæ generally appearing in successive cycles. The surface also bears exceedingly fine, concentric lines which are visible in the interspaces but seldom cross the radial striæ. Concentric varices of growth are also frequent, especially near the margins.

" The cardinal area of the pedicle valve is triangular, broad and erect, seldom showing distortion. In but a single instance has attachment been observed. . . . . The deltidium is pronounced. On the interior the markings are those characteristic of the genus; the brachial valve bears an erect, continuous cardinal process, divided into two lobes, each grooved on its outer face. The lateral walls of this process are continued inward to form the strong dental sockets." Clarke, 1900.

Length 8 mm. to 17 mm.; width 12 mm. to 21 mm.

As Clarke states, this small Oriskany species has no close ally in the Devonian faunas and its nearest approach is found in the *O. arctostriata* of the Hamilton.

Occurrence.—Oriskany Formation, Shriver Member. North Branch. Ridgely Member. Williams Road near Cumberland.

Collection.—Maryland Geological Survey.

Schuchertella deckerensis (Weller)

Plate LX, Figs. 13-16

Orthothetes deckerensis Weller, 1903, Geol. Survey N. J., Pal., vol. iii, pp. 229-230, pl. xx, figs. 6-7.

Description.—" Shell subplano-convex, transversely subelliptical in outline, the hinge-line shorter than the greatest width of the shell, which is near the middle. Pedicle valve depressed, the umbonal region usually irregularly concave; the concave area, having been a facet of attachment to some external object, retains the reverse of the contour of the object to which the shell was attached. Between the umbonal concavity and the margin this valve is marked by one or more conspicuous, more or less irregular, concentric wrinkles, with less conspicuous intermediate ones. The cardinal area is unsymmetrical and variable because of the attachment of the shell, but it is always rather low; its margin is sometimes sharply defined, but it is often very poorly defined. The brachial valve is more or less regularly convex, the greatest convexity usually being posterior to the middle; it is never so strongly marked by concentric wrinkles as the opposite valve. Both valves marked by fine, more or less unequal, radiating ribs, of which three or four occupy a space of 1 mm. at the margin of the shell. The larger ribs extend the entire length of the shell, while the shorter ones are intercalated at various distances from the beak.

"The dimensions of a rather large pedicle valve are: Length 20.5 mm.; width 25.5 mm.; height of area at center 3 mm.; maximum depth of valve 4.5 mm. A brachial valve having the same length and breadth has a convexity of 9 mm.

"This species differs greatly from any other Silurian species of the genus, having a much closer resemblance to younger forms such as *O. chemungensis* of the Devonian and some Carboniferous species. It differs from any of these younger forms, however, in its much larger facet of attachment upon the umbo of the pedicle valve." Weller, 1903.

Most of the individuals referred to this species do not show the strong wrinkles observed in the individuals from New Jersey while the area is higher at times. They also attain a larger size, a large individual being 27 mm. long and 31 mm. wide, convexity of brachial valve 10 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Pinto, Devil's Backbone, Market Street Bridge Cumberland, Cookerly, Cash Valley, 1¼ miles east of Rush, Maryland.

Collection.—Maryland Geological Survey.

[Maynard.]

Schuchertella deformis (Hall)

Plate LXI, Figs. 1, 2

Orthis deformis Hall, 1857, Tenth Rept. N. Y. State Cab. Nat. Hist., p. 44.
Orthis deformis Hall, 1859, Pal. N. Y., vol. iii, p. 174, pl. x*a*, fig. 13; pl. xv, fig. 3, 1861.
Orthothetes deformis Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, pp. 296-297.

Description.—" Shell suborbicular, lenticular. Ventral valve more convex than the opposite, most elevated between the center and beak: beak straight, or often distorted in consequence of having been the point by which the shell was attached. Dorsal valve depressed convex, most elevated near the beak: beak not extending beyond the hinge-line. Hinge-line straight, equalling about three-fourths the width of the shell. Area broad, flat, sometimes nearly on a plane with the axis of the shell. Foramen closed above, and filled below by the strong cardinal process. Surface marked by prominent rounded striæ, which increase by implantation, and are crossed at intervals by distinct subimbricating concentric lines of growth. The striæ are distinctly tubular, with openings at the more conspicuous lines of growth. The fine concentric striæ are often scarcely visible in the silicified specimens." Hall, 1859.

Length about 4 cm.; width about the same.

Occurrence.—Helderberg Formation, Keyser Member. Devil's Backbone, Cash Valley.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Maynard.]

Schuchertella sinuata (Hall and Clarke)

Plate LXI, Figs. 3, 4

Orthothetes deformis var. *sinuatus* Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, pl. 20, figs. 8 and 9.

Description.—Two views of a specimen are figured but not described by Hall and Clarke, which show the distortion of the beak and the median sinus on the brachial valve. Hall says " Further examination will probably prove this form to be a distinct species." This fossil was collected at Cumberland, Maryland, by Hall and is cited from the rocks of the Lower Helderberg. The individual at hand consists only of the brachial valve.

Brachial valve transversely subelliptical in outline, wider than long, extremely convex, gibbous, greatest convexity about 3 mm., anterior to the beak, sloping somewhat abruptly to the lateral margins, there becoming plane to concave. Hinge-line straight and less than the greatest width of the shell. Lateral and front margins rounded; beak strongly incurved. A somewhat shallow sinus extends from the beak to the front, gradually becoming broader from the beak anteriorly. Surface marked by well-defined simple tubular ribs which increase by interstitial addition and implantation.

Dimensions: Length 17 mm.; width 22 mm.

This species differs from *Schuchertella deformis* in (1) having the dorsal valve extremely convex, (2) being transversely subelliptical in outline while *S. deformis* is suborbicular lenticular, (3) having a well-defined sinus in the dorsal valve.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone. Beneath the *Gypidula coeymanensis* var. *prognostica zone.*

Collections.—U. S. National Museum, American Museum of Natural History. [Maynard.]

SCHUCHERTELLA MARYLANDICA n. sp.

Plate LXI, Figs. 5-9

Description.—Shell plano-convex, subelliptical in outline. Length greater than the width. Lateral and anterior margins rounded. Hinge-line straight, about two-thirds the greatest width of the shell. Cardinal area high, triangular in outline. Pedicle valve convex, ventricose along the median portion and descending rather abruptly towards the lateral margins. Greatest convexity about 7 mm. anterior to the beak, beak only slightly incurved, prominent, and extending high above the beak of the dorsal valve.

Dorsal valve plano-convex to depressed convex; beak straight and extending to the hinge-line. A medial sinus extends from the beak to the base, which is narrow at the beak and gradually wider anteriorly and contains three or four radiating ribs. A slight emargination is produced where the dorsal sinus meets the ventricose portion of the ventral valve at the base of the shell. Surface of both shells marked by strong radiating simple rounded ribs which extend from the beaks to the base of the shell and increase by implantation and interstitial addition, and are crossed by faint concentric lines of growth.

This form is not easily confused with any other species.

Dimensions: Length 16.5 mm.; width 14 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland, Maryland; Keyser, West Virginia.

Collection.—U. S. National Museum.

[Maynard.]

Genus HIPPARIONYX Vanuxem[1]

HIPPARIONYX PROXIMUS Vanuxem

Plate LXI, Figs. 10-13

Hipparionyx proximus Vanuxem, 1842, Nat. Hist. N. Y., Rept. Third Dist., p. 124, fig. 29, No. 4.

Orthis hipparionyx Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 407, pl. lxxxix, figs. 1-4; pl. xc, figs. 1-7; pl. xci, figs. 4, 5; pl. xciv, fig. 4, 1861.

Orthis cumberlandia Hall, 1859, *ibidem*, p. 481, pl. xcva, figs. 20-21.

Strophodonta intermedia Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 482, pl. xcva, figs. 13, 14, 1861.

Hipparionyx proximus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 230 (cites other bibliography).

Orthis cumberlandia Whitfield and Hovey, 1900, Bull. Amer. Mus. Nat. Hist., vol. xi, p. 223 (=*H. proximus*).

Description.—" This truly remarkable impression [figured in woodcut No. 4] in no small degree resembles the under part of the hoof of a colt, and is often taken for such." Vanuxem, 1842.

" Shell large, subhemispherical. In youth the pedicle valve is very slightly convex, but at maturity it is depressed, or concave, over the pallial

[1] For a diagnosis, see Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 258.

region. The brachial valve is always very convex. Marginal outline of the valve subcircular. On the pedicle valve the hinge-line is straight but short, the cardinal area low, and the beak retrorse. The delthyrium is broad, and covered by an imperforate convex deltidium. The teeth are moderately large and are supported by lamellæ which extend to the bottom of the umbonal cavity, and are produced into strong ridges entirely surrounding the muscular area. This area is very large, having the structure of that in extreme examples of Rhipidomella, such as *Orthis musculosa,* and is composed of broad, flabellate diductors enclosing an elongate or cordate adductor impression. There is a low median septum in the umbonal cavity, separating the arms of the cardinal process of the opposite valve, but it is quite short, disappearing at the adductor scar, though sometimes reappearing in front of it.

"In the brachial valve there is no cardinal area. The cardinal process has essentially the same structure as in Orthothetes [=Schuchertella] and Derbya [=Orthotetes], but is very high, its two branches completely traversing the umbonal cavity of the opposite valve; it is supported by a short, median septum, and laterally by strong crural plates which extend for a short distance along the margins of the muscular impressions; these are usually quite faint and undefined, occupying a much smaller area than in the pedicle valve, and leaving arborescent markings as in some species of Stropheodonta. On the interior of both valves the margin is sharply pectinated, or crenulated, the crenulations on the brachial valve extending to the base of the cardinal process, and in the pedicle valve extending for a considerable distance on the cardinal area. Surface of both valves covered with fine sharp radiating striæ." Hall and Clarke, 1892.

Length about 3 cm.; width about 4 cm.

This well-known and widely distributed brachiopod is not common in the Upper Oriskany of Maryland, nor does it attain the large size of New York examples.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Devil's Backbone, Knobly Mountain near Cumberland, Maryland; Pendleton County, West Virginia.

Collection.—U. S. National Museum.

Family PRODUCTIDAE

Genus CHONETES Fischer de Waldheim[1]

Chonetes may be distinguished from other Lower Devonian brachiopods by the striate surface and the concavo-convex contour associated with a few tubular spines along the ventral cardinal edge. There are, however, other genera with spines along the posterior edge, and these may be distinguished from Chonetes as follows: Anoplia has a lamellose exterior and apparently no external tubular spines, though it has otherwise the general expression of Chonetes; Chonostrophia bears to Chonetes the same relation that Strophonella does to Stropheodonta, *i. e.,* the relative convexity of the valves is reversed and a section along the medial line would be sigmoid in Chonostrophia and concavo-convex in Chonetes.

CHONETES SUBACUTIRADIATUS n. sp.

Plate LXI, Fig. 16

Description.—Shell small, regularly hemispheric, semicircular in outline, but little wider than long. Greatest width along the hinge-line, which is 6.5 mm., while the length is 4 mm. Surface marked by well-defined rounded plications, which are usually simple, but here and there one bifurcates toward the anterior margin, while on the umbo increase in number takes place by implantation; from twenty-five to twenty-eight on each valve. In a New York example there are about forty plications. These are crossed by very fine, closely adjoining concentric lines of growth. Toward each extremity the ventral cardinal margin bears one stout, slightly laterally directed tubular spine and two smaller ones on each side of the beak. Dorsal valve and interior unknown.

The nearest relationship of this species appears to be *C. acutiradiatus* of the Onondaga. The latter, however, is a far larger and more winged species. In New York it occurs in the New Scotland member at Slingerlands and Indian Ladder, Albany County. The species is very rare in Maryland.

[1] For an extended description, see Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, pp. 303-309.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Miller's Spring near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

CHONETES ROWEI n. sp.

Plate LXI, Fig. 14

Description.—Shell very large for Chonetes, slightly concavo-convex, and quite transverse in outline; hinge-line a little shorter than the greatest width of the shell, with the cardinal angles slightly rounded; lateral and antero-lateral margins broadly rounded, front margin nearly parallel with the hinge-line or slightly concave, and especially so when the ventral valve has a shallow median sinus. Ventral cardinal margin with about six stout, nearly vertical tubular spines on each side of the beak. Cardinal areas very narrow. Surface finely striate, about twenty striæ in 5 mm. along the anterior margin. Width of largest example 37 mm., length 22 mm.

This shell has a general resemblance to *C. hudsonicus* in form and surface ornamentation, but its great size and flatness clearly distinguish the two. Compared with *C. canadensis,* the largest American Chonetes (50 mm. or more), it is more transverse, less convex, with smaller cardinal areas, and less abundant striæ.

Named for Richard Burton Rowe, Ph. D., assistant and fellow of Johns Hopkins University, who spent the summers of 1897-99 in the field, bringing together much of the material used in this report and in his thesis "The Paleodevonian formations of Maryland: a study of their stratigraphy and faunas." A victim of pulmonary troubles, he died before his work bore full fruitage.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. From loose blocks at Miller's Spring near Cumberland, Maryland, associated with *Spirifer arenosus* and *Rensselæria (Beachia) suessana;* north fork of South Branch of Potomac River, Pendleton County, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

CHONETES HUDSONICUS Clarke

Plate LXI, Fig. 15

Chonetes hudsonica Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 49, pl. vii, figs. 1-6.

Chonetes hudsonica Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 347, pl. xlvi, fig. 11.

Description.—" This is the only normally convex Chonetes found in this fauna. The shell is of medium or small size, transverse in outline; hinge-line marking the greatest width of the shell; lateral margins subparallel for a short distance and rounding rather abruptly to a nearly transverse anterior margin. Surface of the pedicle valve quite uniformly convex, with a faint median sinus seen only over the anterior portion of the valve. The surface striæ are fine, round and close together, with very narrow interspaces. They increase rapidly and irregularly by bifurcation and implantation. Very fine, concentric lines are sometimes visible with favorable preservation. The cardinal spines are two or three in number on each side of the beak and are directed outward.

" On the brachial valve a fold to correspond to the obscure median sinus of the pedicle valve is not always to be seen. So far as observed, the multiplication of the striæ of this valve seems to be wholly by bifurcation. With respect to their interior characters, both valves present normal structure with a considerable development of the median septum in the pedicle valve." Clarke, 1900.

Before Clarke described this species the writer identified it with *C. melonica* Billings. As the former points out, however, that species has a slightly different outline and a greater number of striæ. In *C. hudsonicus* there are about twenty striæ in 5 mm. and in *C. melonica* about twenty-five in the same space. Clarke's specimens also seem to be smaller than Billings's species, but the writer has an example from Beeraft Mountain 17 mm. in width; at Camden, Tennessee, it reached 21 mm. in width, and about Cumberland, 24 mm. In New York the species has from two to three cardinal spines on each side of the beak and in the southern material there are usually three.

Length 12 mm.; width 23 mm.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Ernstville. ORISKANY FORMATION, RIDGELY MEMBER. Cash Valley, Winchester Road near Cumberland, and North Branch, 21st Bridge. SHRIVER MEMBER. Williams Road near Cumberland, Monster Rock opposite Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

CHONETES JERSEYENSIS Weller

Plate LXI, Figs. 17-19

Chonetes jerseyensis Weller, 1900, Ann. Rept. Geol. N. J. for 1899, p. 8.
Chonetes jerseyensis Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 230, pl. xx, figs. 11-16.

Description.—" Shell concavo-convex or nearly plano-convex, length about two-thirds the breadth, hinge-line usually a little shorter than the greatest breadth, lateral and anterior margins regularly rounded. Pedicle valve depressed convex, the greatest convexity near the beak: beak small, not prominent; cardinal area low, with as many as seven slightly oblique marginal spines on each side of the beak upon the larger specimens. Brachial valve slightly concave or nearly flat. Both valves marked by rather coarse, radiating ribs, which increase by implantation and bifurcation, three or four of them occupying a space of 2 mm. at the front margin. On the younger shells the ribs are usually finer and more angular and the lateral ones often have a slight anterior curvature as they approach the margin. As the shells increase in size this peculiar curvature of the ribs becomes more and more conspicuous, and can always be detected to a greater or less degree in the adult individuals, and it is always more conspicuous in the brachial than in the pedicle valve. Just anterior to the beak in both valves there is a small area where the radiating ribs are obsolete. In addition to the radiating ribs, both valves are marked by exceedingly fine, concentric lines.

" The dimensions of a large individual are: Length 14 mm. and width 22 mm." Weller, 1903.

This species is an exceedingly variable one in form. The larger specimens may be recognized by the peculiar curvature of the radiating ribs, while in the smaller or younger specimens the ribs may be straight or in others have the peculiar curvature.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Dawson, Cookerly, Cash Valley, Devil's Backbone, Breakneck Hill, Flintstone, 1¼ miles east of Rush, Hancock, Tonoloway, Maryland; Keyser, West Virginia.

Collection.—Maryland Geological Survey.

[Maynard.]

CHONETES JERSEYENSIS VAR. SPINOSUS n. var.

Plate LXI, Fig. 20

Description.—This variety of *Chonetes jerseyensis* differs in being larger and having a greater number of marginal spines on each side of the beak. Pedicle valve slightly more convex. The radiating ribs are coarser and somewhat nodose.

Length 17 mm.; width 22 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Hancock.

Collection.—Maryland Geological Survey.

[Maynard.]

Genus ANOPLIA Hall and Clarke[1]

The shells referred to Anoplia are small, smooth or slightly lamellose chonetoids, with the muscular scars of the ventral valve not elongate and divided by a very short, high, and bluntly terminating median septum. In *A. helderbergiæ* the tubular canals in the thickened ventral cardinal area pass through the shelly matter and terminate in spines, as in Chonetes. In *A. nucleata* the spines have not been seen and it may be that we have here an atavistic tendency to a non-spinose condition. While the absence of spines was taken to be the chief distinguishing character separating Anoplia from Chonetes, still the genus is a good one and will embrace the early smooth or slightly lamellose, highly convex, small chonetoids with a ventral median septum. The smooth forms of Chonetes are not the descendants of Anoplia, but are derived from associated finely striated forms of the former genus.

[1] See Hall and Clarke, 1892, Nat. Hist. N. Y., Pal., vol. viii, pt. i, p. 309.

ANOPLIA HELDERBERGIÆ n. sp.

Plate LXI, Fig. 21

Description.—Shell smooth, moderately concavo-convex, semicircular in outline and wider than long. Hinge-line equal to or greater than the greatest width of the shell. Cardinal areas linear. The cardinal margin of the ventral valve bears three prominent laterally directed tubular spines on each side of the umbo. Interior of dorsal valve with an abundance of papillæ arranged in radiating lines as in Chonetes. The ventral valve has the two short muscular scars separated by the high, but very short, bluntly terminating septum so characteristic of Anoplia. Surface of both valves smooth; the exceedingly delicate concentric lines of growth hardly discernible. Specimens rarely exceed 6 mm. in width and 4.5 mm. in length.

Anoplia helderbergiæ differs from *A. nucleata,* which it most resembles, in being smaller, more transverse, less convex, but more particularly by the smooth instead of lamellose exterior and the presence of tubular spines; from the associated species of Chonetes, by the smooth exterior.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. 21st Bridge.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Rowe.]

ANOPLIA NUCLEATA (Hall)

Plate LXI, Figs. 22-24

Leptæna nucleata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 47.

Leptæna nucleata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 419, pl. xciv, figs. 1*a*-1*d*, 1861.

Anoplia nucleata Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, p. 309, pl. xv*a*, figs. 17, 18; pl. xx, figs. 14-17.

Anoplia nucleata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 325, pl. xli, fig. 9; p. 349, pl. xlvi, figs. 8-10.

Description.—"Shell semicircular: ventral valve extremely gibbous, abruptly depressed or flattened towards the lateral extremities; beak (internal cast) very abruptly incurved, and divided by a central groove (left by the mesial plate) which extends back nearly to the center of the valve:

dorsal valve unknown; hinge-line equal to the greatest width of the shell, terminating in minute triangular extensions; area sublinear, incurved beyond the plane of the valves. Surface unknown." Hall, 1857.

Length 10-12 mm.; width 14-20 mm.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. Devil's Backbone, Winchester Road near Cumberland, North Branch, 21st Bridge. RIDGELY MEMBER. Williams Road near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus CHONOSTROPHIA Hall and Clarke

CHONOSTROPHIA COMPLANATA (Hall)

Plate LXII, Figs. 1, 2

Chonetes complanata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 56.

Chonetes complanata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 418, pl. xciii, fig. 1, 1861.

Chonostrophia complanata Hall and Clarke, 1892, *ibidem*, vol. viii, pt. i, p. 311, pl. xvi, figs. 13, 29.

Chonostrophia complanata Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 50, pl. vii, figs. 1-13.

Chonostrophia complanata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 348, pl. xlvi, fig. 12.

Description.—"Shell nearly semicircular, compressed? about two-thirds as long as wide: ventral valve flat or concave: dorsal valve unknown; tubular spines of the cardinal margin directed obliquely outwards. Surface marked by fine, closely arranged (bifurcating?) striæ, which appear to have been crenulated by closely arranged concentric striæ. Some of the specimens show distant imbricating concentric lines of growth: interior finely granulose; viscera impression large, uniform, not strongly marked." Hall, 1857.

Length about 1.7 cm.; width about 2.8 cm.

While this species has great geographic distribution, it seems never to be a common shell.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Miller's Spring, Devil's Backbone, Maryland; Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

CHONOSTROPHIA HELDERBERGIA Hall and Clarke

Plate LXII, Fig. 3

Chonostrophia helderbergia Hall and Clarke, 1892, Pal. N. Y., vol. viii, pt. i, p. 353, pl. xv*b*, fig. 14.

Description.—Shell large, semicircular, very slightly concavo-convex, being nearly flat, slightly resupinate, greatest width at hinge-line. Ventral valve slightly convex, umbo scarcely concave, concave towards cardinal extremities. Area low. Dorsal valve slightly concave, umbo scarcely convex. Surface ornamented by fine equal thread-like striæ and crossed by fine concentric lines. A single very strong elevated rib extends from umbo nearly to front of valve. Cardinal margin bearing about 7 spines directed obliquely outward, spines near umbo very small, becoming stronger towards extremities.

Length 1.7 cm.; width 2.8 cm.

This fine and striking shell is distinguished from all other species of the fauna by its strong median rib. It becomes abundant locally at the base of the New Scotland limestone.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Dawson, Devil's Backbone.

Collection.—Maryland Geological Survey.

[Swartz.]

Superfamily PENTAMERACEA

Family PENTAMERIDÆ

Genus GYPIDULA Hall

GYPIDULA (SIEBERELLA) COEYMANENSIS n. name

Plate LXII, Figs. 4-7

Atrypa galeata Vanuxem, 1842 (not Dalman), Geol. N. Y., Rept. Third Dist., p. 117, fig. 1.

Atrypa galeata Castelnau, 1843, Essai Syst. Sil. l'Amér. Septent., p. 39, pl. xiv, fig. 4.

Pentamerus galeatus Hall, 1857 (not Dalman), Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 105, figs. 1-3.

Pentamerus galeatus Rogers, 1858, Geol. Penn., vol. ii, pt. ii, p. 825, fig. 646.

Pentamerus galeatus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 257, pl. xlvi, fig. 1; pl. xlvii, fig. 1, 1861.
Sieberella galeatus Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 246, fig. 175, pl. lxxii, figs. 7-13.
Gypidula galeata Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 226.
Gypidula galeata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 279.

Description.—" Shell varying from ovoid to subglobose and transversely elliptical. Ventral valve gibbous, becoming in old shells very ventricose in the umbonal region; a strong mesial fold along the center of the lower half of the valve: beak ventricose, arched, and strongly incurved over that of the opposite valve. Dorsal valve often nearly circular or transversely elliptical, gibbous above; area with or without a defined mesial sinus towards the lower margin: beak incurved, and filling the triangular foramen beneath the beak of the ventral valve.

" Surface, in extremely young shells, smooth, or marked only by concentric lines of growth; in older forms, having longitudinal plications more or less developed, or rarely with none. Old shells variously plicated; the plications simple or bifurcating, and crossed by fine concentric striæ of growth, which sometimes become stronger imbricating laminæ towards the margin of the shell.

" Internally the dental lamellæ are developed into a long spoon-shaped cavity or chamber, which forms a continuation from the triangular foramen or pit beneath the beak of the ventral valve. A central septum extends from the beak of the ventral valve, half the length of the shell, and, in its upper part, is united to the conjoined dental lamellæ or V-shaped chamber of this valve. In the dorsal valve the two septa extending from either side of the beak are attached to the shell for about half the distance to the base, below which point they become free." Hall, 1859.

Length about 3 cm.; width about 2.6 cm.

These shells have been invariably identified as Dalman's *Atrypa galeatus,* but as the American specimens differ in many minor characters from the Silurian specimens of Gotland, it seems advisable to recognize this difference by a distinct name. The adult specimens from near the top of the Coeymans formation attain a far larger size and are wider anterior to the mid-length than the full-grown individuals from Gotland. In the latter specimens the dorsal valve is devoid of plications in the posterior half and the ventral in the posterior third; the number of plications varies from 8 to 17. Dalman's type has from 12 to 15 plications. In the Coeymans, the medial plications in nearly all the individuals attain the apex of both valves, are more prominent, and in full-grown specimens vary in number between fifteen and twenty. There is, therefore, a progressive development from the Wenlock to the Coeymans, not only in larger growth, but in acquiring more plications, and these appear earlier in the growth of the individuals.

The Wenlock specimens from Dudley, England, usually attain a larger growth than Gotland individuals, while both retain the same general youthful expression, except that in the English material the medial plications appear earlier in life than in the Swedish, yet not quite so early as in the Coeymans specimens. The English material, however, must be separated from Dalman's species because the growth lines are farther apart, become progressively stronger and finally wavy, giving the greater portion of the valves a reticulated sculpture. These specimens are here named *Gypidula (Sieberella) dudleyensis.*[1]

This is the most diagnostic species of the Coeymans, occurring in great numbers wherever that member is exposed.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Keyser, West Virginia; Dawson, Corriganville, Devil's Backbone, Tonoloway, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

GYPIDULA (SIEBERELLA) COEYMANENSIS VAR. PROGNOSTICA n. var.

Plate LXII, Figs. 9-11

Description.—Shell subovoid to longitudinally subglobose, length greater than the breadth. Ventral valve convex, quite gibbous to subventricose; beak pointed, arched and strongly incurved, but not closely incurved over that of the opposite valve. Dorsal valve convex, subcircular to transversely elliptical, slightly gibbous in the umbonal region; beak incurved, extending to that of the opposite valve and beneath it. Surface marked by rather indistinct plications which are more conspicuous from

[1] *Pentamerus galeatus* Davidson, 1867, Mon. British Foss. Brach., Silur., p. 145, pl. xv, figs. 13-22 (not Dalman).

the center towards the anterior. From the center to the beak the shell is smooth except in the very large individuals where plications extend beyond the center becoming less conspicuous posteriorly. Very faint concentric lines of growth mark both valves. There is no distinct fold or sinus on either valve. Internally the dental lamellæ converge to form a triangular-shaped cavity which forms a continuation from the triangular delthyrium beneath the beak of the ventral valve. A central septum extends from the beak of the ventral valve more than two-thirds the length of the shell almost to the front. In its posterior portion the central septum is united to the converging dental lamellæ beneath the triangular aperture, formed by the delthyrium and the dental lamellæ. The dorsal interior not seen. Dimensions vary from small individuals 11 mm. long and 10 mm. wide to individuals 26 mm. long and 25 mm. wide.

Mature individuals of this variety are distinguished from those of *Gypidula coeymanensis* by the truncated anterior margin, less inflated beak of the ventral valve which is only slightly incurved over the beak of the brachial valve, by the feebly developed sinus and fold, rather indistinct plications and small size. The adult forms of this variety resemble more or less closely some of the immature shells of *G. coeymanensis*. This variety abounds in a zone a few feet thick near the middle of the Keyser member at most localities at which its horizon is exposed. It is hence one of the most valuable faunal subzones of that member for the correlation of the various sections of the State.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Pinto, Devil's Backbone, Corriganville, Cash Valley, Market Street Bridge Cumberland, Breakneck Hill, 1¾ miles northeast of Flintstone, Flintstone, Hancock, Hazen, Maryland; Keyser, West Virginia; Hyndman, Pennsylvania.

Collection.—Maryland Geological Survey.

[Maynard.]

GYPIDULA (LIEBERELLA) COEYMANENSIS VAR. CORRIGANENSIS n. var.

Plate LXII, Figs. 12-18

Description.—Shell somewhat transversely subelliptical in outline, wider than long. Ventral valve convex, gibbous, greatest convexity about two-thirds the distance from the front to the beak; beak incurved over that of the opposite valve. The median portion of the valve is elevated in some individuals to form a fairly well-defined fold which extends from a short distance anterior to the umbo to the front, and contains several inconspicuous plications, while in other individuals the fold is very faint. On each side of the median fold there are two to three simple plications which are most prominent at the front and become obsolete from the center of the shell to the beak, leaving this portion of the shell smooth. Dorsal valve transversely subelliptical in outline, convex, greatest convexity just anterior to the umbo; much less convex than the ventral valve. It possesses a more or less depressed mesial sinus which never extends posterior to the center of the shell, and which is bounded by two rounded plications. One or two plications occur on each side of the sinus. Both valves are marked by inconspicuous concentric lines of growth. Dimensions: 17 mm. long and 19 mm. wide.

This species closely resembles *Gypidula angulata* Weller from the Coeymans of New Jersey from which it differs as follows: The median portion of the shell is elevated into a fold which is rarely sharply defined and seldom extends farther than the center of the shell. The plications on the fold are rounded, never subangular. More than one plication occurs on each side of the fold and sinus.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Maryland; Keyser, West Virginia.

Collection.—U. S. National Museum.

[Maynard.]

GYPIDULA SUBGLOBOSA n. sp.

Plate LXII, Figs. 20-22

Description.—Shell subglobose, both valves of almost equal convexity; length and breadth about equal. Ventral valve convex, gibbous, becoming ventricose in the umbonal region; beak prominent, slightly incurved opposite the beak of the dorsal valve. Dorsal valve of almost equal convexity with the ventral valve, gibbous in the umbonal region but not ventricose; beak slightly incurved and opposite the beak of the ventral valve. Two simple rounded plications form an undefined fold in the ventral valve which is only conspicuous from the center of the valve to the front, and a single plication on the brachial valve marks the center of an undefined sinus, bordered by two inconspicuous plications near the front. The shell is smooth on both valves from the center posteriorly. The slope from the umbonal regions is abrupt towards the posterior and the posterior region becomes concave; the lateral margins rounded. The shell is marked by faint concentric lines of growth. Dimensions of an average individual: Length 12 mm.; width 13 mm.

This species is distinguished from *Gypidula corriganensis* by its somewhat more globose character, the almost equal convexity of the valves, and by the prominent beaks which are almost equal and directly opposite each other, and by the abrupt slope from the umbonal region to the posterior.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collection.—U. S. National Museum.

[Maynard.]

Order TELOTREMATA

Superfamily RHYNCHONELLACEA

Family RHYNCHONELLIDÆ

Genus RHYNCHOTRETA Hall[1]

RHYNCHOTRETA CUMBERLANDICA n. sp.

Plate LXII, Figs. 23, 24

Description.—Shell trigonal or subpentagonal with the posterior sides angulated and nearly vertical; width somewhat greater than the length. Ventral valve flatter than the dorsal, with a shallower sinus having two or more often three plications; beak nearly erect, but not greatly elevated. Dorsal valve deeper than the ventral, but not gibbous, with a depressed flat fold having usually four plications. On each side of the fold and sinus there are commonly four, sometimes five, plications. All the plications are sharply elevated, with subangulated crests. Interior unknown, and also the finer surface markings.

[1] For generic description, see Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 185.

Dimensions of the largest specimen are: Length 15 mm.; width 18 mm. Of a smaller specimen: Length 12 mm.; width 13 mm.

In general this species much reminds one of *Rhynchotreta cuneata* of the Silurian, and is apparently related to it. It is true that the ventral beak is not so erect nor high, nor is the shallow sinus in the posterior region of the dorsal valve so well developed as in the Silurian species, yet the general characters of this Devonian shell are so similar that for the present *R. cumberlandica* is best referred to Rhynchotreta. In young specimens the *R. cuneata* aspect is most marked. In the Konieprussian of Bohemia undoubted Rhynchotreta occurs in *R. nympha* Barrande.

The rectangular posterior margins of *R. cumberlandica* distinguish it from all associated rhynchonelloids.

Weller has recently described a form of this genus as *R. transversa*[1] from the higher Coeymans zone of New Jersey. This form is readily distinguished from *R. cumberlandica* by its much smaller size, fewer plications, and especially because the dorsal fold has but two plications, while in the Maryland species there are always three or four.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland, Maryland; Queen's Point, opposite Keyser, West Virginia; Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Rowe.]

Genus STENOCHISMA Conrad[2]

This genus as now understood differs from *Camarotœchia* in that "the septum of the dorsal valve is represented only by an exceedingly obscure median thickening, being in fact virtually wanting." In other words, there is no subcardinal cavity as in *Camarotœchia,* "but the hinge-plate is divided by a fissure which extends to the bottom of the shell, and contains a slender longitudinal cardinal process."

[1] Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 286, pl. xxix, figs. 32-39.

[2] For generic description, see Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 187.

STENOCHISMA FORMOSA (Hall)

Plate LXII, Figs. 25-29

Rhynchonella formosa Hall, 1859, 10th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 76, figs. 1-5.

Rhynchonella formosa Hall, 1859, Pal. N. Y., vol. iii, p. 236, pl. xxxv, figs. 6*a-y*, 1861.

Rhynchotrema formosum Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 369.

Description.—" Shell subtriangular or transversely oval; lateral margins forming an angle at the beak of about 90° to 110°. Ventral valve somewhat more depressed than the opposite: beak prominent, arched, not strongly incurved. Dorsal valve larger, declining with a gentle curve towards the margins: beak incurved. Surface marked by twenty to twenty-four simple angular plications on each valve, from two to four of which in the middle are coarser and depressed in the ventral valve, having a corresponding number abruptly elevated upon the dorsal valve; concentrically marked by fine closely arranged striæ." Hall, 1859.

The specimens referred to this species differ but little from those referred to *S. deckerensis,* the chief distinguishing feature being the more transverse form of the latter species.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Miller's Spring, Viaduct and Market Street Bridge Cumberland, Cash Valley, 1¾ miles northeast of Flintstone, Pinto, Flintstone, Maryland; Hyndman, Pennsylvania.

Collection.—Maryland Geological Survey.

[Maynard.]

STENOCHISMA DECKERENSIS (Weller)

Plate LXIII, Figs. 1-4

Rhynchonella deckerensis Weller, 1903, Geol. Survey, N. J., Pal., vol. iii, p. 234, pl. xxi, figs. 1-4.

Description.—" Shell subtriangular, wider than long, the postero-lateral margins sloping from the beak, where they form an angle of from 95°-115°, in nearly straight lines to a point a little posterior to the middle of the shell; the lateral and front margins regularly rounded. The pedicle valve usually a little less convex than the opposite one; its beak prominent, arched, but not strongly incurved; the sinus is rather abrupt, not reaching quite to the beak. The surface of the brachial valve curves gently to the margins, except toward the front, where the mesial fold is rather abruptly elevated. The surface of each valve is marked by from 20-24 simple, angular plications, of which two or three, somewhat coarser than the remainder, are depressed in the medial sinus, with a corresponding number elevated in the fold of the brachial valve.

"The dimensions of a rather large specimen are: Length 15 mm.; width 19.5 mm.; thickness 10 mm.

"This shell is a rather common one in the lower beds of the Decker Ferry formation. It resembles *Stenochisma formosa* Hall, from the higher portion of the Helderbergian series, but may be distinguished from that species by its coarser plications, its greater proportional width and by its less strongly convex valves, which gives to members of this species a less thickness of shell." Weller, 1903.

This species differs but little from *S. formosa* of which it may be considered a variety.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley, National Road east side of Warrior Mountain, Devil's Backbone, Corriganville, Maryland; Keyser, West Virginia; Hyndman, Pennsylvania.

Collection.—Maryland Geological Survey.

[Maynard.]

Genus CAMAROTŒCHIA Hall and Clarke[1]

This rhynchonelloid genus is characterized internally by the fact that the median septum of the brachial valve is divided posteriorly in such a manner as to form an elongate cavity, which does not extend to the bottom of the valve. Each branch of the septum supports one of the lateral divisions of the hinge-plate, to which are attached the curved crural processes.

[1] Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 189.

CAMAROTŒCHIA (?) ALTIPLICATA (Hall)

Plate LXIII, Figs. 5, 6

Rhynchonella altiplicata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 72, figs. 1-4.

Rhynchonella altiplicata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 231, pl. xxxiii, figs. 2*a*-2*k*.

Rhynchonella altiplicata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 282, pl. xxix, figs. 24-27.

Description.—" Shell subtrigonal, more or less gibbous: ventral valve depressed convex; beak pointed, arched or nearly straight: dorsal valve the larger, most elevated in the middle, declining with a curved outline towards the beak and margins; beak incurved; foramen triangular, extending to the apex of the beak. Surface marked by from ten to about nineteen simple, strongly elevated, sharply angular plications on each valve; two to four of which are elevated on the dorsal valve into a more or less distinct mesial prominence extending nearly to the beak, and from one to three depressed on the middle of the ventral valve into a distinct sinus, which widens regularly and somewhat rapidly from near the beak to the front, where it is prolonged into a short projection, filling a corresponding sinus in the front of the opposite valve: shell traversed by fine concentric lines of growth." Hall, 1857.

The southern specimens never attain the large growth seen in New York examples. Weller states that it is found only in the Coeymans in New Jersey, the individuals always being smaller and with but a single plication in the sinus.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Devil's Backbone, Ernstville, Maryland; Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

CAMAROTŒCHIA ORISKANIA n. sp.

Plate LXIII, Figs. 7, 8

Description.—This small rhynchonelloid has the essential characters of *C. altiplicata,* except that the dorsal fold has but two plications and the ventral sinus but one. Further, there are from twelve to fifteen plications on a valve against from ten to nineteen in the latter species.

Length 11 mm.; width 13 mm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland.

Collection.—U. S. National Museum.

[Rowe.]

CAMAROTŒCHIA (?) LAMELLATA (Hall)

Plate LXIII, Figs. 9, 10

Atrypa lamellata Hall, 1852, Nat. Hist. N. Y., Pal., vol. ii, p. 329, pl. lxxiv, figs. 11*a-h*.

Rhynchonella (?) *lamellata* Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, p. 359.

Description.—"Subrhomboidal, the ventral valve more convex; beak of the dorsal valve incurved, small, acute and prominent; surface marked by six or seven plications on each side of the mesial lobe and sinus, which are simple from their origin; mesial sinus marked by two plications, with three corresponding ones on the opposite valve (rarely three plications in the sinus, and four on the corresponding elevation); plications crossed by strong imbricating lamellæ, which are deeply arched, giving the surface a rugose aspect. This species bears a close resemblance to *Atrypa rugosa;* but all the specimens examined are nearly uniform in size, and not so large as the larger ones of that species. The plications are also simple from their origin, though marked by imbricating lamellæ much in the same manner." Hall, 1852.

The shell is often subcircular in outline. In nearly all individuals seen in Maryland the mesial elevation is formed by two plications which coalesce towards the beak, one plication is found in the mesial sinus and three to four plications on each side of the sinus and fold. It has been established that no spirals occur in these shells, hence Schuchert removes this species from among the Atrypas. Its generic position is not assured. This species is abundant in the Tonoloway of Maryland.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Pinto, Market Street Bridge and Viaduct Cumberland, Cash Valley.

Collection.—Maryland Geological Survey. [Maynard.]

CAMAROTŒCHIA LITCHFIELDENSIS (Schuchert)

Plate LXIII, Figs. 11-14

Atrypa sp. Hall, 1852, Nat. Hist. N. Y., Pal., vol. ii, p. 330, pl. lxxiv, figs. 3 and 12.

Rhynchonella agglomerata Weller, 1903, Geol. Survey N. J., Pal., vol. iii, pp. 234-235, pl. xxi, figs. 5-11.

Rhynchonella (?) *litchfieldensis* Schuchert, 1903, Amer. Geol., vol. xxi, p. 167, figs.

Description.—" Shell subtriangular, usually a little wider than long, the valves subequally convex, the postero-lateral margins tapering to the beak, where they form an angle of about 90°; the lateral and anterior margins rounded. Pedicle valve most prominent near the umbo, the beak sharply pointed, arched over that of the opposite valve; mesial sinus rather shallow, rounded in the bottom, not extending back to the center of the valve. Brachial valve most prominent at and in front of the middle; mesial fold not conspicuous, except near the front margin. Each valve marked by from eighteen to twenty-two simple, angular plications, three of which are usually included in the sinus of the pedicle valve. The finer markings of the shell, if they were present, have been obliterated by exfoliation. The dimensions of an average adult specimen are: Length 9 mm.; width 9.5 mm., and thickness 5.5 mm." Weller, 1903.

This small shell is very abundant in the *Chonetes jerseyensis zone* of the Keyser member. It is distinguished from *Rhynchonella transversa* of the Helderberg by its smaller size, and by the fact that the fold and sinus are not so broad except in the larger specimens.[1] It is also more gibbous and less transverse. *Camarotœchia litchfieldensis* also resembles *Rhynchonella neglecta* from the Clinton and Niagara faunas. It differs from *R. neglecta* in having more plications with the fold and sinus narrower only in the small individuals, the sinus and fold broadening in the larger forms. This form, which has been found in the Cobleskill of New York, has been identified as *R. neglecta,* so closely does it resemble it.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. At all exposures of the *Chonetes jerseyensis zone.*

Collection.—Maryland Geological Survey. [Maynard.]

[1] The individual figured by Schuchert in American Geologist, vol. xxi, p. 167, 1903. is much enlarged, although no mention is made of that fact.

CAMAROTŒCHIA GIGANTEA n. sp.

Plate LXIII, Figs. 15, 16

Description.—Shell subtriangular in outline. Width greater than the length. Pedicle valve convex, greatest convexity in the umbonal region, anterior to this somewhat depressed convex, beak closely incurved over that of the dorsal valve. Sinus shallow and undefined posteriorly, becoming deeper and with more definite limits towards the front. Dorsal valve larger than the ventral valve, extremely gibbous, greatest convexity two-thirds the distance from the beak to the anterior, sloping gradually to the beak and abruptly to the anterior and lateral margins. No well-developed mesial fold; beak strongly incurved under that of the ventral valve. Surface marked by simple, well-defined, round, radiating plications, which are more elevated and prominent towards the anterior and though not becoming obsolete they are not so prominent in the umbonal region. About 18 to 20 plications on each valve, five of which may occupy the sinus on the ventral valve. The dorsal margins are abruptly deflected posteriorly and become rounded towards the front.

This form resembles most closely *Camarotœchia stricklandi* (Sowerby) of the Niagara. It is of about the same size, but differs in having the plications of equal size upon the sides and in the mesial sinus. Sinus narrower, no prominent mesial fold. The reference of this species to the genus Camarotœchia is not assured as the interior of the shell has not been observed.

Length about 2.5 cm.; width about 3 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Cash Valley.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Maynard.]

Subgenus PLETHORHYNCHA Hall and Clarke

CAMAROTŒCHIA (PLETHORHYNCHA) CAMPBELLANA (Hall)

Plate LXIII, Figs. 17-19

Rynchonella campbellana **Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 79.**

Rhynchonella campbellana Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 239, pl. xliii, fig. 2.

Uncinulus campbellanus Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 458.

Description.—"Shell longitudinally oval, ovate or oblong, laterally compressed, two-thirds as broad as long, length and height about equal: dorsal valve the larger, elevated near the front into a broad undefined mesial fold, declining near the beak and curving down abruptly at the sides; beak incurved: ventral valve compressed, abruptly deflected towards the opposite valve at the lateral margins, depressed into a broad rounded sinus which occupies almost the entire breadth of the narrow front; front margin curving upward, and extended into a triangular prolongation. Surface marked by twenty-two or twenty-four simple rounded subangular plications, five or six of which are elevated on the mesial fold, and four or five occupy the sinus of the ventral valve. Fine zigzag lines of growth are seen on the front of the shell, near the junction of the valves." Hall, 1857.

Length 2.5 cm.; width 2.3 cm.

Specimens of this easily recognized rhynchonelloid were collected by Rowe at Warren Point, and agree very well with those from New York. The dorsal apex of one of the southern specimens was ground down and showed the large and strong solid median septum so characteristic of Plethorhyncha. This is, therefore, the earliest or oldest species of this subgenus and it leads directly into *C. præspeciosa,* which is as large again and has from ten to twelve more plications on each valve than *C. campbellana.*

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

CAMAROTŒCHIA (PLETHORHYNCHA) PRÆSPECIOSA n. sp.

Plate LXIII, Figs. 20, 21

Description.—In the Maryland collections, this shell has heretofore been confounded with *Uncinulus nobilis* (Hall). It differs, however, in being more elongated, has more abrupt flattened sides, the ventral sinus narrower and far broader, and its lingual anterior extension far less inflected, while the plications on the lateral portions of the dorsal valve are more sharply angular. In other words, the characters of this species are those of *C. speciosa,* and it is undoubtedly the transitional form between *C. campbellana* and the characteristic Oriskany Plethorhyncha. It differs from *C. speciosa* in never attaining more than one-half its size, the ventral sinus is more pronounced, being broad and more or less undefined, and the plications are more constant in number, there being from thirty-two to thirty-six in each valve in the Covington, Virginia, specimens. In addition *C. præspeciosa* is found at a lower horizon, *i. e.,* in the Becraft zone, while *C. campbellana* occurs in the New Scotland zone of the Helderberg formation. Two dorsal interiors found by Rowe show the internal characters of Plethorhyncha.

Length 3.5 cm.; width about 3 cm.

The writer has many specimens of *Uncinulus nobilis* from the Becraft of Schoharie County, New York, none of which approach *C. præspeciosa,* but curiously a single specimen apparently from the Becraft zone of Becraft Mountain (Jones's Quarry), near Hudson, New York, is of this species. It has the flat and very broad ventral sinus and sharply angulated sides of the Maryland forms.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Ernstville, Maryland; two miles "below" (probably northeast, along the railroad) Covington, Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

CAMAROTŒCHIA (PLETHORHYNCHA) SPECIOSA (Hall)

Plate LXIII, Figs. 22-27

Rynchonella speciosa Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 81.

Rhynchonella speciosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 444, pl. ciiia, figs. 1-6, 1861.

Plethorhyncha speciosa Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 191, pl. lviii, figs. 29-37.

Description.—" Shell longitudinally ovoid, vertically flattened on the sides, higher than wide, abruptly rounded or subtruncate in front; sides nearly parallel; no sinus in either valve [there is a shallow more or less undefined sinus]: dorsal valve extremely elevated, abruptly deflected on each side towards the opposite valve; beak incurved; cardinal margin on each side of the beak profoundly sinuate, for the reception of the prominent rounded dental laminæ of the opposite valve; anterior and lateral margins uniting by sharp prominent interlocking notches: ventral valve flattened or much the less convex, forming a regular elliptical arch from beak to front, and abruptly deflected upwards at the sides so as to form distinct angles along the lateral margins, the whole front forming a broad truncated projection; beak somewhat obtuse, incurved. Surface marked by strongly elevated, subangular plications, each of which on the front and sides of the shell has a fine depressed line along the center, crossed by fine regular concentric zigzag lines of growth." Hall, 1857.

As the preservation of this species is not always good and very often the posterior region is absent or the entire shell crushed, *C. speciosa* appears to be a very variable species. In fact it is very variable in some characters and particularly in the amount of incurvation of the dorsal and more rarely of the ventral anterior margin, in the length (some specimens being considerably longer than wide and others as long as wide), and in the presence or absence of a ventral sinus. Usually neither valve has a sinus, but there are specimens with a very broad and shallow one, and occasionally there may even be a small low elevation down the center of the ventral valve. The number of plications varies from twenty-two to thirty-eight. Sometimes the thickness considerably exceeds the width.

Length about 4.5 cm.; width about 4 cm.

C. speciosa appears to be the southern representative of the northern *C. barrandii,* which is rare in Maryland, and is separated from the latter mainly by its smaller size.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain, Miller's Spring, and Williams Road near Cumberland, Collier's Run, Maryland; Pendleton County, West Virginia.

Collection.—Maryland Geological Survey.

CAMAROTŒCHIA (PLETHORHYNCHA) SPECIOSA VAR. RAMSAYI (Hall)

Plate LXIV, Fig. 1

Rhynchonella ramsayi **Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 446, pl. cia, figs. 7, 8*a*, 8*b*, 1861.**

Description.—"Shell longitudinally ovate, valves equally convex, gibbous towards the umbones and declining towards the front and sides, symmetrically rounded in front, with moderate sinus and elevation below the middle. Ventral valve convex in the middle and gradually tapering to the beak, which is small and neatly incurved over the umbo of the opposite valve, the truncated extremity being on a plane with the axis of the shell; the margins on each side, below the beak, slightly auriculate. Dorsal valve most convex at the first third from the beak: margins on each side, below the beak, moderately sinuous.

"Surface marked by thirty-six to forty or more slender rounded plications on each valve, about fourteen of which, in the center and near the front, become a little larger and more prominent than the others on the dorsal valve, while an equal number on the ventral valve are just perceptibly depressed. The cast shows a defined longitudinally oval muscular impression on the ventral side; while the dorsal side shows the mark of the median septum, and the cavities made by the slender crural processes." Hall, 1859.

Length about 3 cm.; width about 2.7 cm.

These shells appear to be very rare and are abnormal or reversional developments of *C. speciosa* since they have no incurved flat lateral sides. They also differ from the typical form in having a greater number of plications, and it is these more abundantly plicate forms of *C. speciosa* that vary in the length of the valves, some being nearly as wide as long. That the brachiopods with strongly incurved lateral margins vary considerably in this feature is also shown in *Rensselæria marylandica* and is an indication of obesity or old age.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collections.—U. S. National Museum, American Museum of Natural History.

CAMAROTŒCHIA (PLETHORHYNCHA) BARRANDII (Hall)

Plate LXIV, Figs. 2, 3

Rhynchonella barrandi Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 82, figs. 1-3; p. 84, fig. 4.
Rhynchonella barrandi Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 442, pl. ciii, figs. 3-8, 1861.
Rhynchonella septata Hall, 1859, *ibidem*, p. 443, pl. ciii, fig. 2, 1861.
Plethorhyncha barrandi Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 191.

Description.—"Shell very large, ovoid or subglobose; full-grown specimens higher than wide, vertically flattened on the sides: dorsal valve very convex, often extremely elevated; beak incurved; cardinal border on each side of the beak profoundly sinuate, for the reception of the thick, strongly projecting laminæ of the opposite valve: ventral valve much the smaller, strongly arcuate longitudinally, having a broad shallow rounded sinus towards the front, abruptly deflected upwards at the lateral margins which are distinctly angular, prolonged in front into a subtriangular vertical projection. Surface marked by forty to forty-six simple (rarely bifurcating) strongly elevated (angular?) plications on each valve." Hall, 1857.

In Maryland this species is not always readily separated from *C. speciosa* unless the specimens are very large, wider, and have a very large but shallow sinus. Mr. Gordon has an internal cast of the ventral valve having a length of 60 mm., which is larger than the usual New York material.

Rhynchonella septata Hall is based on the dorsal valve of *C. barrandii*. *R. fitchana* Hall holds the same relation to *C. barrandii* that *R. ramsayi* does to *C. speciosa*. Both are but variations without the incurved margins.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland, more common at Hancock, in the glass sand quarries; Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

CAMAROTŒCHIA (PLETHORHYNCHA) BARRANDII VAR. FITCHANA (Hall)

Plate LXIV, Figs. 4, 5

Rynchonella fitchana Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 85.
Rynchonella fitchana Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 441, pl. ciii, figs. 1*a*, 1*b*, 1861.

Description.—"Shell longitudinally oval or ovate: dorsal valve convex; beak slightly incurved; cardinal margin excavated on each side of the beak for the reception of the broad dental laminæ of the other valve: ventral valve depressed convex, most elevated in the umbonal region, flattened towards the lateral margins and depressed in front, forming a faint broad and undefined sinus. Surface ornamented by about seventy-five angular plications, which occasionally bifurcate." Hall, 1857.

Hall considered this form related to *C. pleiopleura*, but it clearly holds the same relation to *C. barrandii* that *C. ramsayi* does to *C. speciosa*. Both are variations in which the lateral margins are not incurved angularly and make plane sides. The only difference noticeable between *C. fitchana* and *C. ramsayi* is that the latter is only half the size of the former, but as no intergrading specimens have been seen, both names are for the present retained.

Length about 5 cm.; width about 6 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collections.—U. S. National Museum, American Museum of Natural History.

CAMAROTŒCHIA (PLETHORHYNCHA) PLEIOPLEURA (Conrad)

Plate LXIV, Fig. 6.

Atrypa pleiopleura Conrad, 1841, Fifth Ann. Rept. Geol. Surv. N. Y., p. 55.

Rhynchonella pleiopleura Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 86, figs. 1-4.

Rhynchonella oblata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 86.

Rhynchonella multistriata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 85.

Rhynchonella pleiopleura Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 440, pl. cii, figs. 3*a*-3*c*, 4*a*-4*c*, 1861.

Rhynchonella oblata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 439, pl. cii, figs. 1, 2*a*-2*d*, 1861.

Rhynchonella multistriata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 440, pl. cii, fig. 3 (? pl. cvi, fig. 3).

Plethorhyncha pliopleura Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 191.

Camarotœchia oblata Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 41, pl. v, fig. 22.

Description.—" Subtriangular, elevated in the middle of the lesser valve, and profoundly depressed towards the base of the larger; surface with about 50 rounded costæ; about 17 of which in mature specimens are on the elevated portion of the upper valve; sides dilated and rounded on their margins." Conrad, 1841.

" Shell transversely oval. Dorsal valve the larger, somewhat gibbous, having a round undefined mesial fold: beak incurved; cardinal border excavated in deep fossets on each side of the beak, for the reception of the dental lamellæ of the opposite valve. Ventral valve nearly flat, most elevated near the beak, having a somewhat deep broad rounded sinus near the front margin, which is prolonged into a rounded or subtriangular projection." Hall, 1859.

Length 5 cm.; width 6 cm.

A study of New York material of these large, abundantly plicated, strongly sinuate rhynchonelloids convinces the writer that there is but one species represented. As a rule rhynchonelloids are variable shells and the degree of development of the fold and sinus and plications represents changeable features. The number of plications on these shells varies between sixty and eighty-five, while those on the fold vary from twelve to twenty-five. The merging of Hall's species was also noticed by Clarke, since he says that " the distinction between *C. oblata* and *C. pleiopleura* Conrad is not well marked."

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Shriver Ridge Hill, Cumberland, Collier's Run.

Collection.—Maryland Geological Survey.

Genus UNCINULUS Bayle

Hall and Clarke[1] characterize this genus as follows: " There are large numbers of paleozoic rhynchonellas which are characterized by a full subcuboidal or subpentahedral contour, a fold and sinus not sharply developed except at the anterior margin, an abrupt anterior slope, sharply serrated lateral margins of contact, and low surface plications, each of which, on the front of both valves, is marked by a fine median line." Internally

[1] Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 197.

there is a well-developed bidentate cardinal process, or the two parts may be coalesced into a simple process.

UNCINULUS VELLICATUS (Hall)

Plate LXIV, Figs. 7-10

Rhynchonella vellicata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., pp. 69, 71, figs. 2, 3.

Rhynchonella vellicata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 230, pl. xxxiii, figs. 1*a*-1*p*, 1861.

Uncinulus vellicata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 199.

Description.—" Shell varying from transversely oval to subtriangular: ventral valve depressed convex; beak somewhat prominent, depressed, closely incurved over the opposite: dorsal valve more gibbous; beak incurved, not prominent. Surface marked by twenty-four to thirty-six plications, six to eight of which are elevated in front of the dorsal valve so as to form a rather distinct mesial prominence, rarely extending beyond the middle of the valve. On the ventral valve, five to seven of the plications are depressed, towards the front, into a more or less distinctly defined sinus, and prolonged, forming a mesial projection, which is more or less elevated in the front of the other valve. Near the junction of the valves in front, very fine closely arranged lines of growth are visible." Hall, 1857.

As this is not one of the common rhynchonelloids which as a rule are inconstant in their characters, it is not possible to point out the variations between the southern and northern stocks. On the other hand, *U. vellicatus* is closely related to *U. abruptus,* a fact that did not escape Hall, for he states that " there are, indeed, some forms which it is difficult to distinguish " from one another. The difference, however, that will distinguish *U. abruptus* from *U. vellicatus* is that the former is more transverse, the plications on each side of the dorsal fold are more sharply angular, and their crests are at one side of the center, nearer the median fold. Then, too, *U. abruptus* attains a larger growth. It must be admitted that these differences are not of great importance, and it may be that larger collections will show that both represent one species or that the two forms hold different horizons, in which case both names should stand. Both species, but especially *U. abruptus,* resemble species of Eatonia of the *E. sinuata* type to such an extent that for a time the writer referred specimens to this genus. The ventral muscular area, however, has the character of Uncinulus.

Length 19 mm.; width 21 mm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone, Corriganville, 21st Bridge, Maryland; Keyser, West Virginia. BECRAFT MEMBER. Ernstville, North Mountain, Maryland; Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

UNCINULUS ABRUPTUS (Hall)

Plate LXIV, Figs. 11, 12

Rhynchonella abrupta Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 68, fig. 1.

Rhynchonella abrupta Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 228, pl. xxxi, fig. 3.

Uncinulus abruptus Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 199, pl. lviii, figs. 15-21.

Description.—"Shell transversely oval, subpentagonal: ventral valve depressed convex, very abruptly deflected towards the opposite valve on the lateral margins; beak small, depressed on the outside and subangular along its lateral slopes, closely incurved over that of the opposite valve: dorsal valve much the larger, very prominent in front, obliquely declining towards the beak; beak depressed, incurved. Surface ornamented by from twenty-five to thirty-three simple subangular plications, seven or eight of which are elevated towards the front of the dorsal valve into a somewhat distinct mesial prominence; and from six to eight of those on the middle of the ventral valve are depressed so as to form a broad undefined sinus, which scarcely extends beyond the center of the valve towards the beak, but is prolonged in front, and abruptly bent upwards nearly at right angles to the dorsal valve into a distinct linguiform extension. The plications are marked in front by the usual longitudinal depressed line along the center of each, and extremely fine regular zigzag lines corresponding to the sharp interlocking edges of the front and lateral margins of the valves. These fine striæ doubtless represent lines of growth, which have become wholly obsolete on other parts of the shell." Hall, 1857.

Length 2 cm.; width 2.4 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone, Maryland; Cedar Cliff, West Virginia. BECRAFT MEMBER. North Mountain.

Collections.—Maryland Geological Survey, U. S. National Museum.

UNCINULUS GLOBULUS n. sp.

Plate LXIV, Figs. 13-15

Rhynchonella nucleolata Hall 1857 (in part), Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 68.

Rhynchonella nucleolata Hall, 1859 (in part), Nat. Hist. N. Y., Pal., vol. iii, p. 227, pl. xxxi, figs. 1*a*-1*c* (not the many other figures which are *U. nucleolatus*).

Description.—Hall in describing *R. nucleolata* the second time figured many specimens, a few of which do not pertain to the species intended to bear this name. In regard to these he wrote: "It is possible that the figs. 1*a, b, c* of pl. xxxi are distinct from those which follow." It is this globular form that is found in Maryland and none of the larger subtriangular (in section) shells are associated. This fact has led the writer to take out of *U. nucleolatus* these rotund forms and apply to them the name *globulus*.

Length and width about 10 mm.

This rhynchonelloid is easily distinguished from all associated species by its globular form and the shallow, narrow, thrice plicated ventral sinus; from *U. mutabilis,* to which it is most closely related, by the globular form and the less abundant plications. Thus far no undoubted specimens of the latter species have been seen from Maryland.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Devil's Backbone.

Collection.—Maryland Geological Survey.

UNCINULUS NUCLEOLATUS (Hall)

Plate LXIV, Figs. 16, 17

Rhynchonella nucleolata Hall, 1857 (in part), Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 68.

Rhynchonella nucleolata Hall, 1859 (in part), Nat. Hist. N. Y., Pal., vol. iii, p. 227, pl. xxxi, figs. *2f*-*2y* (not figs. *1a*-*1c* = *U. globulus*, *1d*-*1f* and *2a*-*2e* = ? *U. globulus*).

Uncinulus nucleolata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 199.

Description.—" Shell varying from spherical to spheroid-pentagonal [this refers to the forms here taken out and named *U. globulus*] or sub-pentagonal: ventral valve convex or depressed convex, abruptly deflected towards the margins; beak small, depressed, closely incurved over that of the opposite valve, often subangular on its lateral margins: dorsal valve larger, sometimes very gibbous, often a little depressed towards the beak; beak never prominent. Surface marked by fifteen to twenty-three [usual number eighteen] simple rounded plications, about four or five of which are slightly elevated towards the front of the dorsal valve into a mesial prominence, and three to five depressed on the ventral valve, so as to form a more or less distinct sinus, which never extends beyond the middle of the shell. These depressions are prolonged in front into a more distinct linguiform extension fitting into a corresponding sinus in the front of the opposite valve, and sometimes curved inwards beyond the plane of a right angle with the back of the valve." Hall, 1859.

This species, as illustrated by Hall, embraced at least two forms, but his description and the greater number of illustrations are here accepted as the author intended to apply this name to Helderberg rhynchonelloids. The smaller globular forms are here taken out of *U. nucleolatus* and distinguished under the name *U. globulus*. This leaves the larger and more triangular (in section or side view) shells under the name *U. nucleolatus*. As thus restricted, the species approaches closely to *U. pyramidatus* of the same geological horizon, but the latter can be distinguished by their fewer plications. It may prove that this difference has no greater value than a varietal one, but in that event the name will be useful. This coarsely plicated form does not occur in Maryland, and it is not yet established that *U. nucleolatus* occurs in the New Scotland zone about Cumberland.

In the Keyser member, especially in the ballast quarries near Keyser, are found shells that are best referred to *U. nucleolatus.* These are always smaller than the New Scotland individuals of New York, have somewhat fewer plications (eighteen to twenty against eighteen to twenty-three in northern specimens), and are never so inflated or strongly triangular in section. These differences are not considered of enough importance for distinction under another name, and the shells are here referred to *U. nucleolatus* (see also the remarks on *U. keyserensis*). The geologic range is therefore extended from the Keyser well up in the New Scotland, being abundant and restricted to the former horizon in the South, but attaining the climax of development in variation and number in the New Scotland of the Helderberg Mountains.

Length and width about 1.5 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia. COEYMANS MEMBER. Corriganville, Devil's Backbone, Tonoloway.

Collection.—U. S. National Museum.

UNCINULUS NUCLEOLATUS VAR. ANGULATUS n. var.

Plate LXIV, Figs. 18-20

Description.—Shell subpentagonal in outline, width more than two-thirds the length. Ventral valve convex, not at all gibbous, approaching more to plano-convex; beak sharp, pointed, but slightly incurved and extending beyond that of the dorsal valve. Dorsal valve convex, larger than the ventral valve; beak slightly incurved beneath that of the ventral valve, lateral margins abruptly deflected. Both valves have about equal convexity and are slightly deflected toward the lateral margins, the dorsal valve being more convex is more abruptly deflected toward the lateral margins; both valves gently curved in front. Surface marked by 23 well-developed simple plications in addition to which there are several indistinct plications near the lateral margins. The plications are very prominent from the center towards the front, becoming obsolete towards the beak. Four plications form a slight elevation on the dorsal valve and three occupy a shallow sinus on the ventral valve. The sinus is produced in front to form a slight linguiform extension. Dimensions: Length 12.5 mm.; width 9.5 mm.

This species closely resembles *Uncinulus nucleolatus* (Hall) from which it differs in having more angular plications which are more prominent towards the front and become obsolete toward the beak. The valves are also less convex than those of that species.

This form is in the material collected by Rowe and referred by him to the Helderberg.

Occurrence.—Helderberg Formation? Keyser Member? Cumberland.

Collection.—Maryland Geological Survey.

[Maynard.]

Uncinulus gordoni n. sp.

Plate LXV, Figs. 1-6

Description.—Shell subpentagonal, length and breadth about equal. Ventral valve convex, sometimes slightly depressed convex; beak small, extending beyond and usually slightly incurved over that of the opposite valve. Dorsal valve convex, larger than the ventral valve, at times gibbous. Beak small, incurved under the beak of the ventral valve, more incurved in the more gibbous individuals. Surface marked by simple subangular plications, varying in number from 19 to 26, which extend to the beak; more prominent in front, becoming less conspicuous towards the beak. In some individuals three or four plications form a slight mesial elevation at the anterior portion of the dorsal valve, while two or three plications occupy a shallow sinus in the ventral valve. The sinus and fold become almost obsolete in some individuals at the anterior margin. The lateral margins are deflected somewhat abruptly posteriorly. Dimensions of a small individual: Length 8 mm.; width 7.5 mm. Large individual: Length 12.5 mm.; width 12 mm.

This form approaches most closely *Uncinulus nucleolatus* (Hall) and Professor Schuchert has suggested that it may be a young form of that species. It differs from *Uncinulus nucleolatus* in being smaller, the beak of the ventral valve is straighter and not so closely incurved over that of the dorsal valve. It has in some individuals more plications and the plications are more angular than in *Uncinulus nucleolatus*. In the anterior portion the sinus and fold when present are less distinct and the fold is not prolonged anteriorly to form the linguiform extension seen in *Uncinulus nucleolatus*.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collection.—U. S. National Museum.

[Maynard.]

UNCINULUS KEYSERENSIS n. sp.

Plate LXV, Figs. 7, 8

Description.—Associated with the Lower Coeymans form of *U. nucleolatus* are other individuals in greater abundance, distinguished by fewer plications, all of which are decidedly angular and never depressed and rounded as in that species. *U. keyserensis* usually has four plications on the fold, but there may be an additional one, while the sinus has either three or four. The number of plications on a valve varies in different individuals between twelve and seventeen, while the associated specimens of *U. nucleolatus* have from eighteen to twenty. As in *U. nucleolatus*, this species also has the sharp linear depression along the center of the lateral plications near their anterior terminations. This Uncinulus character, however, has a tendency to be less developed and even lost in the angularly plicated *U. keyserensis*. The specimen illustrated is one of average size, but individuals nearly twice as large occur rarely.

Length 14 mm.; width 15 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Miller's Spring and Mullen's Quarry, Cumberland, Dawson, Tonoloway, Maryland; Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

UNCINULUS CONVEXORUS n. sp.

Plate LXV, Figs. 9-14

Description.—Shell trigonal or somewhat pentagonal, width at least two-thirds the length. Ventral valve convex, abruptly deflected in front.

Beak prominent, pointed, in some forms straight, but in most forms slightly incurved over that of the dorsal valve. Dorsal valve much more convex than the ventral valve, abruptly deflected in front and towards the lateral margins; beak incurved beneath that of the ventral valve. Surface marked by thirty or more low, simple, rounded plications, which become indistinct and are almost obsolete near the beak and are faint near the lateral margins. The lateral margins are slightly inflected so that the sides become distinctly concave. Fold and sinus very faint or absent entirely. The anterior portion is rounded. The plications and depressions interlock to produce sharply serrated lateral and front margins of contact. Dimensions of an average individual: 18 mm. long, and 15.5 mm. wide.

This form most closely resembles *Uncinulus campbellanus* of the Helderberg. In the latter species the dorsal valve is elevated near the front into a broad undefined mesial fold, the ventral valve is compressed and a broad sinus occupies the entire width of the narrow front, the front margin curves upward and extends into a subtriangular prolongation.

In *Uncinulus convexorus* the dorsal valve is not elevated near the front and there is no distinct mesial fold; the ventral valve is plano-convex. There is an undefined sinus in some individuals while most individuals have no sinus, and the front margin is rounded and sharply serrated. On account of the characteristic rounded margins the name *Uncinulus convexorus* has been applied to it.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway, Cash Valley, Viaduct Cumberland, Cookerly, Pinto, Maryland; near Cherry Run, Keyser, West Virginia; Hyndman, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Maynard.]

Genus WILSONIA Kayser

WILSONIA GLOBOSA Weller

Plate LXV, Figs. 15-17

Wilsonia globosa Weller, 1903, Geol. Survey N. J., Pal., vol. iii, p. 235, pl. xxi, figs. 12-22.

Description.—"Shell subglobose, a little longer than wide. Pedicle valve less convex than the brachial, its beak suberect or slightly arched, acutely pointed, umbo smooth and convex, mesial sinus shallow, beginning

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near the middle of the valve and produced as a lingual extension in front, at nearly a right angle to the plane of the valve. Brachial valve strongly convex or gibbous, smooth posteriorly, anterior margin deeply sinuate, mesial fold slightly elevated, originating near the middle of the valve. The surface of each valve is marked by sixteen or eighteen simple, low, rounded plications, sometimes slightly grooved anteriorly and becoming nearly or quite obsolete posteriorly, leaving that portion of both valves smooth. From two to five plications are included within the sinus, the more common number being four, with a corresponding number in the fold of the opposite valve. The dimensions of a rather large globose individual are: Length 12 mm.; width 11 mm.; thickness 10 mm. Those of another less globose specimen are: Length 11.25 mm.; width 10.5 mm.; thickness 7.5 mm.

"In some of its characters this species resembles the Helderbergian forms *Uncinulus mutabilis* Hall and *U. nucleolatus* Hall. It differs from both of them, however, in its smaller size, and in the obsolescence of its plications on the posterior portions of the shell. Internally there are conspicuous differences which are of even generic value. In *Wilsonia globosa* the cardinal process is absent, the hinge-plate is divided and is supported by a strong median septum. These characters, when associated with its external form, place it in the genus *Wilsonia,* while the two Helderbergian species mentioned possess well-developed cardinal processes and the other characters which distinguish the genus *Uncinulus.*" Weller, 1903.

It occurs in the upper Decker Ferry of New Jersey.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland, Cash Valley.

Collection.—U. S. National Museum.

[Maynard.]

WILSONIA CF. GLOBOSA Weller

Plate LXV, Figs. 18-20

Description.—Shell transversely subelliptical to subpentagonal in outline, broader than long. Ventral valve convex, plano-convex to depressed convex; beak extending beyond that of the brachial valve and slightly incurved over it. Dorsal valve convex, more gibbous and consequently more convex than the ventral valve, greatest convexity near the middle, beak incurved under the beak of the ventral valve. Surface of each valve contains indistinct, low, rounded, simple radiating plications, which can only be seen from the center anteriorly and become more conspicuous towards the front. From the center of the shell to the beak the surface is smooth save for indistinct concentric lines of growth. Anterior slope abrupt; lateral margins abruptly deflected posteriorly and rounded towards the anterior margin. Fold and sinus scarcely if at all developed.

Dimensions, 11 mm. long and 13.5 mm. wide.

A single somewhat imperfect individual has been observed which has been described above. It may be compared with *W. globosa* from which it differs in a number of respects.

Occurrence.—HELDERBERG FORMATION? KEYSER MEMBER? Tonoloway.

Collection.—Maryland Geological Survey.

[Maynard.]

Genus EATONIA Hall

EATONIA SINGULARIS (Vanuxem)

Plate LXV, Figs. 21, 22

Atrypa singularia Vanuxem, 1842, Geol. N. Y., Rept. Third Dist., p. 120, text fig. 3.

Eatonia singularia Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 243, pl. xxxviii, figs. 14-20, 1861.

Description.—Valves "very unequal; the upper one is flat, and forms with the end opposite to the beak, nearly a right angle; the lower valve curves, from the beak to the straight line on the opposite side. The middle or mesial part is very much depressed." Vanuxem, 1842.

"Shell wider than long, varying in form from ovate to transversely elliptical or rhomboidal: hinge-line very slightly declining from the beaks. Ventral valve depressed convex in the middle towards the beak, and concave between the center and the deflected margins; and below the middle, extended into a deep broad sinus, which is prolonged and turned upwards in front at right angles to the longitudinal direction of the shell:

beak small, closely incurved. Dorsal valve convex, sometimes gibbous, and sloping abruptly to the margins; having a strong mesial fold beginning above the center, and produced in a broad flattened and greatly elevated extension. Surface marked by fine radiating striæ, which, in well-preserved specimens, are crossed by much finer concentric striæ: a single central one, and sometimes two or three of the striæ upon the mesial sinus, are much stronger than the others; and there is sometimes an impressed line down the center of the dorsal valve." Hall, 1859.

Length 13 mm.; width 14 mm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Maryland; Keyser, Cherry Run, West Virginia. BECRAFT MEMBER. Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

EATONIA PECULIARIS (Conrad)

Plate LXV, Figs. 23-28

Atrypa peculiaris Conrad, 1841, Fifth Ann. Rept. N. Y. Geol. Surv., p. 56.
Eatonia peculiaris Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 244, pl. xxxviii, figs. 21-26; p. 436, pl. ci, figs. 2*a*-2*g*; pl. cia, figs. 1*a*-1*h*, 1861.

Description.—" Subtriangular, with obsolete, fine, radiating lines; inferior valve flat, concave at base, with a linguiform projection; superior valve with a convex, mesial elevation at base, where the margins of the valves meet above the basal margin, and are notched or serrate; submargin of the sides of the flat valve serrated." Conrad, 1841.

" Shell longitudinally ovate, the proportion of length and breadth variable: cardinal margins sloping abruptly from the beaks. Ventral valve depressed convex in the middle towards the beak, and flattened towards the margins, which are abruptly inflected along the cardinal slopes; below the middle, extended in a broad, not strongly defined mesial depression, which is prolonged in front into a linguiform extension: beak moderately elevated, perforate. Dorsal valve convex in the middle, and sloping abruptly to the lateral margins; the central part below the middle elevated into a rounded mesial fold, which becomes very prominent in front: margins of the valves denticulate. Surface marked by fine radiating bifurcating striæ; a stronger elevated one along the center of the mesial sinus, and a narrow longitudinal depression down the center of the dorsal valve, the mesial elevation of which is sometimes obtusely subplicate near the margin." Hall, 1859.

Length about 17 mm.; width 15 mm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Miller's Spring near Cumberland, 21st Bridge, Maryland; Cherry Run, West Virginia. BECRAFT MEMBER. North Mountain, Maryland; Warren Point, Pennsylvania. ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (Knobly), Collier's Run, Hancock, Maryland; Keyser, West, Virginia.

Collection.—Maryland Geological Survey.

EATONIA WHITFIELDI Hall

Plate LXV, Figs. 29, 30

Eatonia whitfieldi Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 437, pl. cia, figs. 2*a*, 2*b*, 1861.

Description.—"Shell longitudinally suboval, wider below than above. Ventral valve depressed convex near the beak, flat in the middle, and broadly depressed towards the front. Surface radiatingly plicated: plications rounded, about eight or nine on each side of the mesial one, which is a little stronger than the others. Muscular impression of the ventral valve broad, and not strongly defined: crural processes short." Hall, 1859.

Length 19 mm.; width 22 mm.

When the sinus is deeply impressed there is usually but one plication in it, as described by Hall, but when broad and undefined there are always three. On the lateral portion of the valve there are usually six to seven plications. The small size and few plications will readily distinguish this species from the other plicate Eatonias. The Maryland specimens, however, are always more acuminate than New York individuals, and the plications are better defined.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland.

Collections.—U. S. National Museum, George M. Roeder (figured forms).

EATONIA MEDIALIS (Vanuxem).

Plate LXV, Figs. 31-35

Atrypa medialis Vanuxem, 1842, Geol. N. Y., Rept. Third Dist., p. 120, text fig. 4, p. 122.

Eatonia medialis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 241, pl. xxxvii, figs. 1*a*-1*y*, 1861.

Description.—Vanuxem did not describe the species, but gave good figures of it and named it the "Medial atrypa (*A. medialis*)" because he regarded it "as the type or characteristic of the division" Atrypa.

"Shell transversely oval, suborbicular or subquadrate: hinge-line nearly straight, and forming a very obtuse angle at the beaks. Dorsal valve much large than the ventral, greatly elevated in the middle (especially near the front), declining with a gentle curve towards the hinge and very abruptly towards the sides. Ventral valve flat or concave, depressed in front so as to form a broad and profound mesial sinus: beak very small, pointed but not prominent, incurved, perforate at the extremity.

"Surface marked by from twelve to sixteen broad, rounded, rarely bifurcating plications, four of which usually occupy the summit of the mesial fold of the ventral valve, and about three the bottom of the sinus in the dorsal valve: entire surface (in well-preserved specimens) marked by fine radiating striæ, and rarely by a few imbricating lines of growth. The muscular impression in the ventral valve moderately large, ovate, very distinctly defined by a prominent border, and marked by longitudinal slightly radiating plications: near its center is the small cordiform longitudinally striate impression of the adductor muscle." Hall, 1859.

The writer has not seen the radiating striæ described by Hall, which when preserved must be very fine. In *E. sinuata* the radiating striæ are well marked and assist to distinguish the species from *E. medialis.* The latter also has much fewer plications, always three in number, and a well-defined fold and sinus.

Length about 22 mm.; width about 27 mm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Dawson, Corriganville, Devil's Backbone, hillside above Mullen's Quarry Cumberland, 21st Bridge, Maryland; Cedar Cliff, Cherry Run, West

Virginia; Warren Point, Pennsylvania. BECRAFT MEMBER. Cherry Run, West Virginia. ORISKANY FORMATION, SHRIVER MEMBER. North Branch. RIDGELY MEMBER. Knobly Mountain near Cumberland, 21st Bridge.

Collections.—Maryland Geological Survey, American Museum Natural History (figured forms).

EATONIA SINUATA Hall

Plate LXV, Figs. 36-38; Plate LXVI, Fig. 1

Eatonia sinuata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 91.

Eatonia sinuata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 438, pl. cia, figs. 3-6.

Eatonia sinuata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 206, pl. lxi, figs. 36-38.

Description.—"Shell circular or longitudinally oval: ventral valve concave, except in the umbonal region, from which point, as well as from the lateral margins, it slopes generally into the broad deep sinus without defined margins: dorsal valve convex, rising in front into a broad undefined mesial prominence, often nearly as high as the highest part of the central region of the valve; beak incurved. Surface marked by thirty-six to forty [the illustrations show a variation between 26-34] strong, elevated, rounded or subangular plications on each valve. Visceral impressions large, broad, and marked with radiating plications towards the margin, strongly defined by an elevated border: impression of the adductor muscles cardiform, small, located in the middle of the visceral impression, longitudinally striate.

"The two middle plications on the dorsal valve are separated by a wider depression than between those on other parts of the shell, which continues quite up to the beak: in this depression there is sometimes near the front a slender plication which becomes obsolete before reaching the beak." Hall, 1857.

Some excellent material of this fine and large brachiopod has been found during the past few years. This shows that all the plications on each side of the undefined fold and sinus are covered with fine radial striæ, of which there are from four to five on each plication and one or two in each depression. The striæ are best developed in the postero-lateral regions and diminish in strength toward the fold and sinus. The dorsal fold has from six to seven plications and the sinus six. The total number of plications on each valve varies from twenty-four to forty.

Length 4 cm.; width 4.5 cm.

Very young individuals are like *E. whitfieldi* and have been confounded with it. However, the undefined fold and sinus and the fine radial lines will distinguish it. The great number of plications, the fine striæ, and the undefined fold and sinus readily separate *E. sinuata* from *E. medialis*. However, when specimens have less than thirty plications they strongly resemble *E. medialis*, but are more elongate and the fold and sinus have more plications.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland, Collier's Run, 21st Bridge.

Collections.—Maryland Geological Survey, U. S. National Museum.

EATONIA HARTLEYI n. sp.

Plate LXVI, Figs. 2, 3

Description.—The specimens of this species are suggestive of *E. sinuata*, but are distinguished in having not only a deeper or more convex ventral valve and more plications, but especially in having from eight to eleven plications in the fold and sinus along the anterior margin, while in *E. sinuata* there are from four to seven. This difference is due to the fact that in *E. hartleyi* several plications are bifurcated shortly before the animal has attained half its growth. The total number of plications on a valve in the latter species varies between thirty-four and thirty-seven against twenty-six and thirty-four in *E. sinuata*. Externally this new species is not strongly suggestive of Eatonia, but more of Plethorhyncha, but as the interior muscular area is that of the former genus it is best referred to it.

Length 3 cm.; width 3.5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Martin Mountain, Allegany County.

Collection.—Yale University (Hartley Collection).

Genus RHYNCHONELLA Fischer

RHYNCHONELLA (?) BIALVEATA Hall

Plate LXVI, Fig. 4

Rhynchonella ? bialveata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 73.

Rhynchonella ? bialveata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 233, pl. xxxiv, figs. 1-4, 1861.

Rhynchonella ? bialveata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 327, pl. xlii, figs. 9, 10.

Description.—" Shell small, triangular or triangular-ovate, sometimes compressed: valves nearly equally convex; beak of dorsal valve incurved; beak of ventral valve almost straight and subangular; foramen narrow triangular, and continued to the apex of the beak. Surface ornamented by from twelve to fourteen simple angular plications on each valve; the two central of which, on the dorsal valve, die out a little before reaching the beak, near which they are somewhat depressed, but towards the front they become slightly elevated above the others, so as to form an indistinct mesial prominence: the middle plication on the ventral valve is smaller than the others, and depressed near the front so as to produce a faint sinus, which extends about two-thirds of the way to the beak, at which point the valve is most convex: the two plications bordering the sinus are larger and more prominent than those on each side of them, and become obsolete before reaching the beak. A few faint imbricating lines of growth are visible near the junction of the valves in front." Hall, 1857.

Length 4.5 mm.; width 3.75 mm.

This specimen is more transverse and shorter than is usual for the species, but it has all the other characters, including the two medial plications that arise in a sinus and make the narrow anterior dorsal fold. Weller found this species in the Lower Oriskany of New Jersey.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville.

Collection.—George M. Roeder.

Superfamily TEREBRATULACEA

Family CENTRONELLIDÆ

Genus RENSSELÆRIA Hall[1]

Individuals of this genus are prolific in the Upper Oriskany of Maryland, less abundant in the Becraft, apparently very rare in the New Scotland, and more common in the Keyser. They represent a progressive series of variable or plastic species beginning with small forms and terminating in giant forms of these early terabratuloids. When specimens are assembled in quantity from all the horizons it will be seen that the species intergrade, but if proper allowance is made for stratigraphic occurrence, recognizable distinction will be found.

Rensselæria *sensu-stricto* can be easily distinguished from Beachia by the radial striations and the nearly angular inflected crenated margins of the valves. The striations in Rensselæria are always pronounced, while in Beachia they are only well developed along the line of junction of the valves, making there a toothed edge, or along the edges of the rugosities. Over the surface of the valves the striations are never distinct, and when present are never sharply separated by deep grooves as in Rensselæria.

R. mutabilis begins in very small individuals in the Keyser and attains its specific characters in the Coeymans. In New York, Hall had derived his material from the New Scotland, but in Maryland the species is rare at this horizon. In the Lower Oriskany the developmental sequence is continued by *R. subglobosa* and in the higher southern Oriskany by *R. marylandica* and *R. circularis,* but by *R. ovoides* and *R. cayuga* in the northern Upper Oriskany.

RENSSELÆRIA MUTABILIS (Hall)

Plate LXVI, Figs. 5, 6

Meganteris mutabilis Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 97.

Rensselæria mutabilis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 254, pl. xlv, figs. 2*a*-2*p*, 1861.

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[1] For an extended description of this genus, see Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pp. 255-260.

Description.—"Shell ovate varying to elliptic and obovate, not sinuate on either valve; old specimens sometimes very gibbous, but generally compressed towards the anterior border in young individuals; valves nearly equally convex; ventral valve most elevated near the middle and towards the umbo; beak pointed, subangular along the lateral slopes, arched or closely incurved; foramen narrow, and extending nearly or quite to the apex of the beak: dorsal valve slightly less elevated and a little shorter than the opposite; beak not projecting, incurved. Surface marked by twelve to twenty-eight coarse obscure radiating striæ, crossed by fine indistinct lines of growth, and sometimes near the border by a few strong concentric undulations. The radiating striæ are usually obsolete on the upper half of the shell." Hall, 1857.

This species, like all the Rensselærias, varies considerably in form, incurvature of the ventral beak, and the degree of striation. However, the small size, nearly constant elongate form, and the incipient striation distinguish this species from those of the higher formations.

A variety occurring in the Keyser member at Tonoloway bears much more strongly developed plications than the typical form.

Length 10 mm.; width 9 mm.

Hall cites this species as from the New Scotland of New York, but most of the material from that State seen by the writer is from the Coeymans. As a rule, it is one of the characterizing fossils of the last-named zone, but besides its New Scotland occurrence, it is also known in very small specimens in the Keyser at New Bloomfield, Pennsylvania.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; at Miller's Spring near Cumberland, Corriganville, Tonoloway, Maryland. NEW SCOTLAND MEMBER. Near Cherry Run, West Virginia.

Collection.—U. S. National Museum.

RENSSELÆRIA SUBGLOBOSA Weller

Plate LXVI, Figs. 10-12

Rensselæria subglobosus Weller 1903, Geol. Surv. N. J., Pal., vol. iii, p. 329, pl. xlii, figs. 11-18.

Description.—"Shell subglobular in form, longer than wide. Pedicle valve strongly convex, its greatest elevation near the middle, sometimes slightly subcarinate along the median line near the beak. Beak sharply pointed, closely incurved over that of the opposite valve. Brachial valve a little less convex than the pedicle, its greatest elevation near the middle. Surface of each valve marked by from fifty to sixty simple, rounded plications, which become obsolete before reaching the beak.

"The dimensions of an average specimen are: Length 18 mm.; width 16 mm.; thickness 11.5 mm." Weller, 1903.

This species occurs typically and in abundance in the "Trilobite bed" at Port Jervis in southern New York and was at first regarded by the writer as a small form of *R. æquiradiata* Conrad. The latter, however, is much larger, about twice the size, proportionately more elongate, while *R. subglobosa* in addition tends to vary into broad forms, and is more abundantly striate. It is this Port Jervis form that is found in Maryland. Here, however, another variation appears, tending to have fewer striæ, which in some specimens are rather plications, strongly elevated and angular.

The elongate common and more typical specimens greatly resemble *R. mutabilis*, but are larger and far more abundantly striate.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Ernstville, Maryland; Cherry Run, West Virginia; Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

RENSSELÆRIA SUBGLOBOSA VAR. AVUS n. var.

Plate LXVI, Fig. 13

Description.—This variety differs from *R. subglobosa* in its broad subcircular form. In the Upper Oriskany it has become fixed into a distinct species which attains a larger size and is here named *R. circularis*.

Length 2.2 cm.; width 2.4 cm.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Ernstville, Maryland; Cherry Run, West Virginia; Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

RENSSELÆRIA SUBGLOBOSA VAR. CRASSA n. var.

Plate LXVI, Fig. 14

Description.—This variety is a coarsely striate or plicate form of *R. subglobosa.* It has from 25 to 46 plications on each valve, while the parent type has from 50 to 65 striæ.

Length 2.3 cm.; width 1.8 cm.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

RENSSELÆRIA CIRCULARIS n. sp.

Plate LXVI, Figs. 15-17

Description.—This species is the fixed Upper Oriskany form of the Lower Oriskany *R. subglobosa* var. *avus,* and it seems to be the stock that gives rise to *R. cayuga* Hall and Clarke. It is readily distinguished from other Oriskany Rensselærias by the nearly circular outline. The dorsal valve is regularly depressed convex and the ventral valve is deeper and somewhat ridged down the center. The lateral margins are not inflected.

R. circularis differs from *R. cayuga* and *R. ovulum* Hall and Clarke[1] in being from two to three times smaller and more circular in outline. Some of the young specimens of *R. cayuga,* if found alone, would be regarded as *R. circularis,* and this fact shows that the former is probably a descendant of the latter species.

Long after this description was written the writer received Clarke's work "Some New Devonic Fossils"[2] in which is described *R. atlantica.* The new form is from the Chapman Plantation, Maine, and is very similar to the Maryland species. The former is smaller, more rounded, with a less incurved ventral beak.

Length 2.5 cm.; width 2.7 cm.

[1] The writer has a large series of these species from the typical locality, and they grade into each other so completely that but one name can be applied to them. *R. cayuga* will be retained.

[2] Bull. 107, N. Y. State Mus., 1907, p. 243.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.
Collection.—U. S. National Museum.

RENSSELÆRIA MARYLANDICA Hall

Plate LXVI, Figs. 18-24

Rensselæria marylandica Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 461, pl. cviii, figs. 3*a*-3*m*, 1861.

Rensselæria intermedia Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 463, pl. cviii, figs. 2*a*-2*c*, 1861.

Rensselæria marylandica Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 258, pl. lxxvi, figs. 8-20.

Rensselæria intermedia Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, pl. lxxvii, figs. 26-28.

Description.—" Shell elongato-ovoid, the outline elliptical-ovate, broader above the middle and gently narrowing towards the front, which is sometimes compressed; without mesial sinus or elevation. Ventral valve ventricose, the greatest elevation at the first third from the beak, where it is sometimes subobtusely angular: beak small, incurved over the opposite valve, and sometimes so much incurved as to close the foramen partially or entirely; often, however, showing the deltidial pieces: the lateral margins, in old shells, abruptly inflected. Dorsal valve less convex than the opposite, the greatest gibbosity being at the first third below the beak, sometimes flattened towards the front and abruptly inflected at the lateral margins; leaving, with the inflection of the opposite valve, a flattened or concave space on each side.

" Surface marked by fine radiating striæ, which, in the silicified specimens, are often scarcely distinguishable on the upper part of the shell.

" The interior of the ventral valve shows a deep symmetrical cavity, the muscular impressions occupying a narrow oval space above the middle of the shell. The cardinal teeth are strong, and supported below by strong dental plates, which, on their anterior edges, are separated from the side of the shell, and, about halfway in the depth of the cavity, turn backwards towards the beak, come together in the rostral cavity, and reach into the foramen. From the anterior basal margins of these plates proceed the lamellæ which border the muscular impression, and which gradually become obsolete in the anterior direction: the muscular impression is oblong-subelliptical, and the narrow imprints of the adductor muscles are small and often but faintly defined. There is a medio-longitudinal septum, which is much less strongly marked than the marginal rim. The deltidial pieces are rarely preserved in the separated valves.

"The interior of the dorsal valve shows the strong hinge-plates, each with a wide triangular upper surface, and connected by a transverse process a little below the apex, beneath which a foramen passes from the cavity of the valve, opening at the slightly elevated beak in oval aperture. The hinge-plates are extended below along the surface of the shell in strong ridges, which are dichotomized at the beginning of the muscular impression. Anteriorly these plates project in strong crural processes, which are straight only for a short distance, and then diverge in two slender points to the cavity of the ventral valve, in their main direction trending upwards into the dorsal cavity, and then by an abrupt geniculation proceed in a converging direction to the commencement of the crural plate. This plate is extremely elongate and very slender, deeply emarginate behind, with a slender process proceeding from the center, which, with the two posterior branches, converge towards the bottom of the ventral cavity." Hall, 1859.

R. marylandica is undoubtedly the southern expression of the well-known Upper Oriskany fossil *R. ovoides* (Eaton). In fact, some of the Maryland specimens, if found in New York, would without hesitation be referred to *R. ovoides*. However, the majority of individuals have an expression of their own, and it is advisable to preserve this local variation under the geographic name *R. marylandica*. This difference in mature specimens consists chiefly in the fact that the latter species is always considerably smaller and more symmetrical than full-grown *R. ovoides*, but more particularly in the extreme narrowness of the valves and their very broad straight sides. New York *R. ovoides* also has very wide lateral, nearly plane surfaces, but the degree of development is less and the width of the shell is greater. Even when the great inflection is less pronounced *R. marylandica* is more elongate and less square shouldered posteriorly.

Young specimens of *R. marylandica,* before the inflection is much developed, resemble *R. subglobosa* and in this points to its ancestry. If the individual is of the elongate type the inflection may become very decided, developing into the typical form of *R. marylandica.* When the shell is shouldered posteriorly inflection is never so greatly developed and the individual remains smaller than the typical form. This form, before inflection develops, Hall named *R. intermedia,* but it seems to have no stratigraphic nor geographic significance; and the name can therefore be dropped.

Average length about 3.75 cm.; width about 2.5 cm.

This species is abundant at most localities. A few places only are named in the following paragraph:

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Hancock, Maryland; Warren Point, Pennsylvania, where it attains a length of 95 mm.

Collections.—Maryland Geological Survey, U. S. National Museum.

RENSSELÆRIA MARYLANDICA VAR. SYMMETRICA n. var.

Plate LXVI, Fig. 25

Description.—Retaining juvenile characters throughout life (those of *R. subglobosa*) and attaining the largest growth of Maryland Rensselærias. It is further distinguished by having the greatest width in the anterior region.

Length 4.5 cm.; width 3.4 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—Maryland Geological Survey.

RENSSELÆRIA KEYSERENSIS n. sp.

Plate LXVI, Figs. 26-28

Description.—Shell oval, biconvex, length and width subequal. Ventral valve gibbous, point of greatest convexity posterior to middle. Umbo elevated, extending a little beyond that of dorsal valve over which it is incurved. Shell flattened in middle or having a very shallow mesial sinus towards front. Dorsal valve convex, flattened in middle. Surface ornamented by numerous rounded striæ of which about six occupy 5 mm. Striæ obsolescent towards umbo. Shell substance punctate.

Length and width of large shells 4 cm.

The generic relationships of this species are not fully determined. It is probably a Rensselæria.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cut of Baltimore and Ohio Railroad ¾ mile southwest of Rawlings, abundant.

Collection.—Maryland Geological Survey.

[Swartz.]

Subgenus BEACHIA Hall and Clarke[1]

RENSSELÆRIA (BEACHIA) PROAVITA n. sp.

Plate LXVII, Figs. 1-3

Description.—This very early Beachia is distinguished from *R. cumberlandiæ,* to which it is closely related, in being from one-half to two-thirds smaller, more square shouldered and less elongate, and the dorsal valve is flatter.

At first it was mistaken for *R. mutabilis,* but since it has the nearly obsolete radial striations restricted to the anterior margins, a flatter dorsal valve, and is more square shouldered or transverse, it could not be left with this species. The great similarity of *R. proavita* to *R. cumberlandiæ* and *R. mutabilis* indicates that these species are closely related and that the latter is the stem species of Rensselæria. The writer has specimens of *R. mutabilis* from the Keyser of Bloomfield, Pennsylvania, ranging from mature examples 10 mm. long to young less than 5 mm. Among these are three examples of *R. proavita* ranging in length from 5 to 9 mm. They have no radial striæ nor marginal crenations and in this also agree with the earlier growth stages of typical *R. mutabilis.* These facts lead to the inference that *R. mutabilis* develops from a smooth-shelled terebratuloid, introduces marginal striæ, and then variation tends in two main lines. The stem branch—Rensselæria—continues the increase in number of

[1] *Beachia* Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 260.

radial striæ and shell obesity, while a side and less prolific branch tends to retain the juvenile characters of a nearly smooth and lentiform shell, but adds a well-defined false area and sharp but neat inflection of the valve margin—Beachia. The interior characters in the terminal forms are somewhat different, but in the early species they probably are alike.

Length about 10 mm.; width about same.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER (upper part). Pinto, Maryland; New Bloomfield, Pennsylvania.

Collection.—U. S. National Museum.

RENSSELÆRIA (BEACHIA) CUMBERLANDIÆ (Hall)

Plate LXVII, Figs. 4-6

Meganteris cumberlandiæ Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 101.

Rensselæria cumberlandiæ Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 464, pl. cviii, figs. 1*a*-1*f*, 1861.

Rensselæria cumberlandiæ Hall and Clarke, *ibidem*, vol. viii, pt. ii, p. 258, pl. lxxvii, figs. 23-25.

Description.—"Shell oval, ovate or elliptical; valves nearly equal, somewhat acutely rounded in front; no trace of a sinus in either valve; lateral margins abruptly inflected: ventral valve rounded and most convex along the middle, sloping laterally and forming a broad semielliptical curve from front to beak, a little more gibbous above than below the center; beak prominent, slightly arched; extremity perforate; perforation generally connected with the broad triangular foramen below, but probably often separated by the deltidial pieces, which, with the thickened dental apophysis, nearly or quite close the foramen: dorsal valve depressed convex, slightly the smaller; beak scarcely incurved. Surface apparently smooth, or marked only by obscure concentric lines and faint wrinkles of growth." Hall, 1857.

This species is most closely related to *R. æquiradiata* and *R. subglobosa* of the Becraft and Shriver members. It is, however, readily distinguished by the nearly or complete obsolescence of the radial plications, the presence of concentric growth rugosities, and the angular inflection of the lateral and anterior edges of the valves.

R. cumberlandiæ may be mistaken for immature *R. marylandica,* but a comparison of equally young specimens shows that the latter are always marked by faint radial striations. Elongate specimens of *R. suessana* may also be identified as *R. cumberlandiæ,* but here again the almost complete absence of the radial striæ in the latter distinguishes them.

Length 2.3 cm.; width 1.8 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collections.—Maryland Geological Survey, American Museum of Natural History, U. S. National Museum.

RENSSELÆRIA (BEACHIA) SUESSANA (Hall)

Plate LXVII, Figs. 7-15

Meganteris suessana Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 100.

Rensselæria suessana Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 459, pl. cvii, figs. 1-15, 1861.

R. (Beachia) suessana Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 260. pl. lxxvii, figs. 1-11.

Beachia suessana Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 352, pl. xlvii, figs. 5-14.

Description.—" Shell longitudinally obovate, varying to oval or subelliptical, somewhat compressed; valves nearly or quite equal; no traces of a sinus on either valve; front narrowly rounded; lateral margins very abruptly inflected: ventral valve depressed convex, most prominent along the middle, sloping very gradually towards the sides; beak pointed, small, very angular along its lateral borders, incurved, rising above the hinge-line but not touching the other valve, perforate in the apex by a small round aperture partly completed by the two small deltidial pieces, which, together with the thickened dental apophyses of the opposite valve, close the triangular foramen below: dorsal valve symmetrically depressed convex, sloping very gradually from near the middle laterally and towards the front, rounding a little more abruptly towards the beak, which is pointed and scarcely incurved: hinge-line nearly straight, or sloping from the beak at a very obtuse angle, much less than the width of the shell. Surface usually appearing to be smooth, but, on well-preserved specimens, remains of very faint simple radiating striæ may be seen towards the margin, which always become obsolete above." Hall, 1857.

This very variable species, of which Hall gave fourteen figures to illustrate the variation in form, has an aspect so unique that in mature examples it will not be confounded with any other Oriskany brachiopod. In the younger stages there are two shell forms, one with a wide ventral cardinal area and square shoulders and another with a pinched ventral beak and rounded cardinal angles. The former, described as the variety *immatura* on the following page, is the more common and typical expression of *R. suessana.* The latter may be confounded with *R. cumberlandiæ* but a careful comparison will show that that species is more elongate and pinched posteriorly, there being no cardinal angles.

Very common throughout the Ridgely member, but more particularly at about the middle of the Oriskany formation.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain, Williams Road, Ridgely, and Miller's Spring near Cumberland. Hancock, Maryland; Pendleton County, West Virginia, on the north fork of South Branch of the Potomac River.

Andrews, many years ago, gathered a great quantity in fine preservation from the two quarries now abandoned in the city of Cumberland.

Collections.—Maryland Geological Survey, American Museum of Natural History.

RENSSELÆRIA (BEACHIA) SUESSANA VAR. IMMATURA n. var.

Plate LXVII, Fig. 16

Description.—Square-shouldered form with well-developed ventral false cardinal area represents the main stem in *R. suessana.* In the Shriver member it is the only form thus far seen. The young specimens found in that member are decidedly square-shouldered and semicircular in outline. The exterior is smooth with strong growth varices and there is no inflection of the margins. This same form is also shown by the early growth varices of *R. suessana.*

Length 1.7 cm.; width 2 cm.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. Lowest beds at Cash Valley and Winchester Road near Cumberland, higher beds at Pinto.

Collection.—U. S. National Museum.

RENSSELÆRIA (BEACHIA) OVALIS (Hall)

Plate LXVII, Figs. 17-19

Meganteris ovalis Hall, 1857, Tenth Ann. Rept. N. Y. Cab. Nat. Hist., p. 101.

Rensselæria ovalis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 458, pl. cvi, figs. 2*a*-2*l*, 1861.

Megalanteris ovalis Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 280, pl. lxx, figs. 12-22.

Megalanteris ovalis Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 40, pl. v, figs. 13-16.

Description.—" Shell longitudinally oval, compressed, lateral margins subtruncate and abruptly inflected; front rather narrowly rounded: ventral valve slightly the more elevated, most prominent along the middle, sloping gradually towards the sides; beak pointed, arched so as to bring the apex above the hinge-line, but not touching the opposite valve, angular along the lateral slopes: dorsal valve regularly depressed convex; beak incurved. Surface marked by very faint simple radiating striæ, which become obsolete on the upper part." Hall, 1857.

This is a very rare shell in Maryland and is closely related to *R. suessana* from which it differs, not only in being larger, but also flatter or thinner, better developed ventral false area, and the absence of striæ. Hall describes the shell with " very faint " striæ, but none have been seen in the southern specimens, nor does Clarke show any in the work above cited.

Length 3.6 cm.; width 3.2 cm.

This shell is here referred to the subgenus Beachia because it greatly resembles *R. suessana* and, further, the brachidium in the type of Meganteris is not yet certainly worked out, nor is it known in *R. ovalis.*

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Knobly Mountain, Maryland; near Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus ORISKANIA Hall and Clarke[1]

The brachidium in this genus is unknown, but it is probably very similar to that in the subgenus Beachia. Oriskania is readily distinguished from Rensselæria by the hinge-plate which has a median vertical high ridge. Otherwise the general aspect of these shells is more that of Beachia than Rensselæria. Three species are now known of this

[1] Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 269.

genus, *O. navicella* Hall and Clarke, *O. sinuata* Clarke, and *O. lucerna* n. sp.

ORISKANIA LUCERNA n. sp.

Plate LXVII, Figs. 20-24

Description.—This species is most nearly related to *O. sinuata,* but differs in having a very prominent, ventral, false cardinal area which is decidedly curved dorsally, the dorsal valve is flatter or slightly concave and not sinuate, lateral commissure straight or concave and not sigmoid, and the outline of the shell is more quadrangular. In well-preserved specimens the exterior is marked with exceedingly obscure radial striæ of the same nature as in Beachia.

Mr. Roeder has two specimens of what appears to be this species, in which the dorsal valve is evenly convex and the lateral margins inflected as in *R. suessana.* These specimens with others more typical for *O. lucerna* remind one so much of *R. suessana* that it seems as though they must have descended from the latter.

Two specimens favorably preserved were broken open to ascertain the nature of the brachidium, but nothing more than the posterior ends of the descending branches was found. Evidently the brachidium is very delicate and is not easily fossilized, or its absence is due to secondary replacement by silica, since nearly all the Oriskany fossils are pseudomorphs. This shell in the Maryland region cannot be confounded with any other brachiopod.

Length 2.4 cm.; width 2.1 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Common at Ridgely, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family TEREBRATELLIDÆ

Genus TROPIDOLEPTUS Hall

TROPIDOLEPTUS CARINATUS (Conrad)

Plate LXVII, Fig. 25

Strophomena carinata Conrad, 1839, 3d Ann. Rept. N. Y. Geol. Survey, p. 64.

Leptæna laticosta de Verneuil, 1847, Bull. Soc. Géol. France, 2d ser., vol. iv, p. 703.

Tropidoleptus carinatus Hall, 1857, 10th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 151, figs. 1, 2.

Tropidoleptus carinatus Hall, 1859, 12th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 31, figs. 1-4.

Tropidoleptus carinatus Rogers, 1858, Geol. Penn., vol. ii, pt. ii, p. 828, fig. 672.

Tropidoleptus carinatus Hall, 1867, Nat. Hist. N. Y., Pal., vol. iv, p. 407, pl. 62, figs. 2, 3.

Tropidoleptus carinatus Meek and Worthen, 1868, Geol. Survey Ill., vol. iii, p. 427, pl. xiii, fig. 2.

Tropidoleptus carinatus Rathbun, 1874, Bull. Buffalo Soc. Nat. Sci., vol. i, p. 254, pl. ix, figs. 1, 9, 10, 26.

Tropidoleptus carinatus Derby, 1876, Bull. Mus. Comp. Zool., vol. iii, p. 282.

Tropidoleptus carinatus Rathbun, 1879, Proc. Boston Soc. Nat. Hist., vol. xx, p. 35.

Tropidoleptus carinatus Nettelroth, 1889, Kentucky Fossil Shells, Mem. Ky. Geol. Survey, p. 146, pl. xvii, figs. 14, 15.

Tropidoleptus carinatus A. Ulrich, 1892, N. Jahrb. f. Mineral., Beilageband, viii, p. 73, pl. iv, figs. 32-34.

Tropidoleptus carinatus Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 304, figs. 227, 228, pl. lxxxii, figs. 26-36.

Description.—" Shell transversely oval; hinge straight, not crenulated, generally a little less than the greatest breadth of the shell, rounded or very obtusely angular at the extremities; sides broadly rounded; basal margin slightly sinuous: dorsal valve concave, having a shallow mesial sinus, which is broad in front but continues above the middle of the shell as a narrow groove, not larger than those between the other costæ; beak very small, projecting beyond the hinge-line, straight or curving slightly outward; dental process extended beyond the hinge-line; ventral valve convex, slightly flattened and contracted toward the extremities, gibbous above the center and in the umbonal region; beak obtuse and truncated by the foramen; area distinct, variable in width, extending to the cardinal extremities, longitudinally striated, limited entirely to the ventral valve; foramen very broad, reaching to the beak and having a semicircular outline above, more or less closed by the prominent dental processes of the opposite valve. Plications usually simple and rounded, about eighteen to twenty on each valve, the middle one on the ventral valve being larger and more elevated than the others, so as to form a small mesial fold or carina. Surface ornamented by very fine distinct concentric striæ, presenting under a magnifier a very fine textile style of ornament; substance of the shell punctate throughout." Hall, 1857.

Length 1.8 cm.; width 2.4 cm.

The writer was much surprised to find an example of this species from the Upper Oriskany collected by Rowe from Shriver's Ridge, Cumberland. Heretofore this species was not known to occur in America in strata older than the Marcellus, but in South America the paleontologic evidence seems to indicate an earlier occurrence. There is now proof that the species occurs as low as the Upper Oriskany and recently Prof. Williams[1] has recorded its presence in the Chemung fauna. It is therefore a fossil characteristic of nearly the entire Devonian system.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Shriver's Ridge, Cumberland.

Collection.—Maryland Geological Survey.

Superfamily SPIRIFERACEA

Family ATRYPIDAE

Genus ATRYPA Dalman

ATRYPA RECTICULARIS (Linné)[2]

Plate LXVII, Figs. 26-28

Anomia reticularis Linné, 1767, Systema Naturæ, ed. xii, tome i, p. 1132.
Atrypa reticularis Hall, 1852, Nat. Hist. N. Y., Pal., vol. ii, p. 72, pl. xxiii, fig. 8; p. 270, pl. lv, fig. 5.

Description.—" Shell subrotund, more or less compressed, subtruncated above or on the hinge-line; valves more or less equal, the beak of the dorsal valve extending beyond the ventral valve, and the latter being deeper and more convex in older specimens; surface marked by dichotomous rounded striæ, which are crossed by concentric elevated lamellæ, giving a reticulated or decussated character to the surface. It is impossible to give a definite description of this very protean species, which commences its existence in the Clinton group and continues with various modifications

[1] Amer. Jour. Sci., vol. xiii, 1902, p. 429.
[2] For figures of the Upper Silurian and Lower Devonian variation see Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, pl. xlii, figs. 1*a-r*. For a complete American bibliography and synonymy see Schuchert, 1897, Bull. U. S. Geol. Survey, No. 87, pp. 154-155.

as far as the Chemung. In each of its geological positions, however, it presents peculiar characters and we are able to decide at once the geological position of specimens by these peculiarities. On its first appearance in the Clinton group, it shows its variable character in a remarkable degree, and it is scarcely possible to avoid referring the individuals to distinct species. In many of the young specimens the ventral valve is nearly flat, or slightly convex, with a depression along the center from beak to base. In specimens of medium size the valves are nearly equal and in older ones the ventral valve is the more convex. Again there are others where, in the young shell the ventral valve has no depression in the center, and is equally convex with the dorsal valve. In the radiating striæ or plications it is equally variable; many specimens having them very distinctly dichotomous, while others are nearly undivided from the beak. In many young shells the concentric striæ leave the plications nodulose at their crossing; while there are specimens having the plications quite free from such characters, and entirely smooth." Hall, 1852.

This ubiquitous brachiopod is a common fossil of the Silurian and Devonian systems in Maryland.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Tonoloway. COEYMANS MEMBER. Dawson, Devil's Backbone, Maryland; Keyser, West Virginia. NEW SCOTLAND MEMBER. Devil's Backbone, Miller's Spring near Cumberland. ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—Maryland Geological Survey.

[Maynard.]

ATRYPA ? BICONVEXA n. sp.

Plate LXVIII, Figs. 1-3

Description.—Shell subcircular in outline, wider than long; lateral, cardinal, and anterior margins rounded. Valves of almost equal convexity. Ventral valve convex, greatest convexity along the median portion of the valve, the anterior portion abruptly deflected; beak incurved, pointed. Dorsal valve convex, though not quite as convex in the median portion as the ventral valve, the convexity being uniform, greatest convexity about one-third the distance from the beak towards the anterior; beak small, pointed, not prominent and only slightly incurved. The anterior margin is abruptly inflected to correspond to the abrupt deflection of the anterior margin of the ventral valve. Surface marked by eight simple rounded plications on each valve which radiate from the beak and which are more prominent along and near the median portion of both valves. In the ventral valve the three medial plications form an undefined mesial elevation. There is, however, no indication of a sinus on the brachial valve. Both valves are marked by well-defined concentric imbricating lamellæ which give to the shell a distinctly rugose appearance.

Dimensions: 13 mm. long and 16 mm. wide.

This shell most closely resembles *Atrypa rugosa* of the Niagara. It is not as convex as that species, the plications are not as numerous and do not bifurcate, and it has no marked mesial depression on the dorsal valve.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Cash Valley, Maryland.

Collection.—U. S. National Museum.

[Maynard.]

Genus ATRYPINA Hall and Clarke

ATRYPINA IMBRICATA (Hall)

Plate LXVIII, Figs. 4-6

Leptocœlia imbricata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 108.

Leptocœlia imbricata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 246, pl. xxxviii, figs. 8-13.

Atrypina imbricata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, pl. liii, figs. 5, 6, 8-10.

Description.—"Shell longitudinally semielliptical or suborbicular: ventral valve convex, most prominent along the middle, and sloping laterally; beak small, incurved at the apex and perforated by a very small round aperture, one side of which is formed by the deltidium: dorsal valve flattened or depressed convex; beak scarcely elevated above the hinge; hinge sloping from the beaks at an angle of about 150°, rounded at the extremities, nearly equal to the greatest width of the shell; area narrow, shorter than the hinge. Surface marked by ten to twelve plications on each valve, of which the two on the middle of the ventral valve are larger and more elevated than the others, and separated by a wider and deeper depression than between those on each side. The central plication on the dorsal valve is larger than the others near the front, but usually dies out before reaching the beak. Shell marked by strong imbricating concentric lamellæ of growth." Hall, 1857.

Length 8 mm.; width 8 mm.

Compared with New York specimens, the single example observed has the ventral valve more carinated and the plications are somewhat smaller and greater in number; the latter in typical examples vary from six to eight, while the Maryland specimen has eleven. However, one New York individual has been seen with as many plications.

Occurrence.—Helderberg Formation, New Scotland Member. Cherry Run, West Virginia.

Collection.—U. S. National Museum.

Family SPIRIFERIDÆ

Genus SPIRIFER Sowerby[1]

This well-known genus occurs in both hemispheres, beginning at the base of the Silurian and persisting throughout the succeeding horizons of the Paleozoic. It is characterized by great variation in form and exterior ornamentation, but the internal features are far more constant. At various times authors have grouped the species chiefly according to external characters, but as yet no satisfactory arrangement exists based on ontogenetic and phylogenetic studies. For such work the literature cannot be relied upon, and as there are probably not less than 500 named species, no single collection is adequate. The grouping here adopted is that of Hall and Clarke published in 1893.

[1] See Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. iii, pt. ii, pp. 1-40.

SPIRIFER MACROPLEURUS (Conrad)

Plate LXVIII, Figs. 7, 8

Delthyris macropleura Conrad, 1840, Fourth Ann. Rept. N. Y. Geol. Surv., p. 207.

Spirifer macropleurus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 202, pl. xxvii, figs. 1*a*-1*p*; pl. xxviii, figs. 8*a*-8*d*, 1861.

Description.—" Shell large, with about six broad rounded ribs finely striated longitudinally; middle of the superior valve with a very broad and prominent rib, and there is a corresponding depression on the opposite valve." Conrad, 1840.

" Shell large, varying from semielliptical to semicircular or transversely elliptical, ventricose: valves nearly equally convex; hinge-line often scarcely equalling the greatest width of the shell. Area narrow. Foramen large. Ventral valve with a broad, deep curved sinus and three strong rounded plications on each side: beak moderately elevated above the opposite, and abruptly incurved. Dorsal valve with a broad rounded mesial fold and two strong rounded plications, with sometimes a third one on each side. Surface marked by fine closely arranged radiating striæ, which are crossed by finer concentric ones (the latter rarely visible)." Hall, 1859.

This well-known Spirifer, the guide fossil for the New Scotland horizon, is distinguished from all other Maryland species by its large size, few plications, and the finely radially striated surface. It is related to *S. eudora* of the Niagara fauna.

S. macropleurus was originally described from New York. The Maryland specimens differ very little from them and only in the plications, which, as a rule, are somewhat more abruptly elevated, with an additional one on each side of the fold and sinus.

It is found in profusion at all localities at which the cherty beds of the New Scotland member are exposed.

Length about 4 cm.; width about 6.5 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Devil's Backbone, 21st Bridge, Maryland; Keyser, Cherry Run, West Virginia; Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

SPIRIFER PERLAMELLOSUS Hall

Plate LXIX, Figs. 4-6

Spirifer perlamellosa Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 57, figs. 1, 2 (marked erroneously *Spirifer ventricosa* = *Nucleospira ventricosa*).

Spirifer perlamellosus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 201, pl. xxvi, figs. 1*a*-1*s*, 2*a*-2*g*, 1861.

Description.—" Shell trigonal or semicircular, more or less extended on the hinge-line, the extremities varying from obtuse or rounded to extremely mucronate. Ventral valve arcuate, the beak much extended beyond the opposite valve, and incurved at the apex; sinus deep, gradually expanding, and produced in front into a linguiform extension. Dorsal valve convex toward the middle, the mesial elevation very prominent, and the beak closely incurved against the area, or partially closing the foramen of the ventral valve. Area moderately wide, frequently much expanded, and becoming linear towards the extremities where the shell is much extended.

" Surface marked by from four to six strong and abruptly elevated plications on each side of the mesial sinus and elevation, concentrically marked by strong imbricating lamellæ, which are abruptly arched in passing over the plications, giving an extreme roughness to the surface. In well-preserved specimens, finer longitudinal lines mark the surface of these lamellæ. In ordinary specimens the concentric lamellæ are more closely arranged and more distinctly imbricate towards the margin; while near the beaks they are more distant, and are scarcely imbricate." Hall, 1857.

Length 1.7 cm.; width 3 cm.

In Maryland this well-known and widely distributed Helderberg brachiopod is abundant, but rarely attains the size of New York specimens. The plications, as a rule, are somewhat fewer in number, often are far more abruptly elevated, and vary in New York specimens from four to six, while in Maryland material there are from three to five. Again, in the southern specimens, the ventral cardinal area is more bent backward, while in the northern individuals it is more often vertical and relatively higher. A few localities only are cited in the following paragraph:

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Devil's Backbone, Maryland; Keyser, Cherry Run, West Virginia.

Collections.—U. S. National Museum, American Museum of Natural History.

SPIRIFER CUMBERLANDIÆ Hall

Plate LXVIII, Figs. 9-16

Spirifer cumberlandiæ Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 63.

Spirifer submucronatus Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 62.

Spirifer submucronatus Hall, 1859, Nat. Hist. N. Y., Pal., vol. III, p. 419, pl. xcvi, figs. 7*a-f*.

Spirifer cumberlandiæ Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 421, pl. xcvi, figs. 9*a*-9*g*.

Spirifera cumberlandiæ Hall, 1883, Second Ann. Rept. N. Y. State Geol., p. 58, figs. 16-23.

Spirifera submucronata Hall, 1883, Second Ann. Rept. N. Y. State Geol., pl. lviii, figs. 5-7.

Spirifer cumberlandiæ Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pp. 17, 36, pl. xxxiii, figs. 16-23.

Spirifer submucronatus Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, pp. 17, 36, pl. xxxiii, figs. 5-7.

Description.—"Shell broadly semicircular; valves moderately and nearly equally convex: ventral valve regularly convex; mesial sinus narrow, shallow, and flat in the middle; beak gently incurved, and projecting slightly beyond the hinge-line: dorsal valve having a narrow flattened mesial fold, with a faint depression down the center; beak scarcely incurved, and nearly in the same plane with the cardinal margin; hinge-line straight; extremities extended; area broad, nearly flat, parallel with the axis of the shell; foramen somewhat large, often partially or entirely closed [by deltidial plates]. Surface marked by from fourteen to seventeen simple rounded costæ, which are crossed by concentric elevated lines or lamellæ." Hall, 1857.

The lamellæ are again crossed by very delicate radiating striæ, but these do not terminate in minute spines as in *S. tribulis* and *S. intermedius.*

This species most resembles *S. intermedius,* but differs in having depressed and more numerous plications and relatively higher and more vertical ventral cardinal area; the valves are more appressed, causing the visceral area to be shallower, and the lamellæ are devoid of marginal spines.

S. submucronatus is nothing more than young specimens of *S. cumberlandiæ*. Both have the same general expression, and while the former has at times fewer plications, yet this difference is due either to age, or size, or individual peculiarities.

Mr. Andrews, who furnished Hall's material, collected most of his Oriskany fossils in the quarries on Green Street, back of the German Lutheran Church, Cumberland. They are no longer worked but are now built over by the church and neighboring houses. Although *S. cumberlandiæ* was gathered here, it is significant that none of the local collectors have this species in their collections. This shows that these quarries are of another horizon than those now furnishing fossils, and this is borne out by their geological structure, indicating that they are lower down in the Oriskany. *S. cumberlandiæ* seems to be restricted to a horizon about 150 to 200 feet above the base of the Oriskany.

Length 1.3 to 2.4 cm.; width 2.2 to 4.6 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. The original material came from the quarries back of the German Lutheran Church on Green Street, Cumberland, Devil's Backbone, east side of Nicholas Mountain, Collier's Run.

Collections.—Maryland Geological Survey, U. S. National Museum.

SPIRIFER MODESTUS Hall

Plate LXVIII, Figs. 17-22

Spirifer modestus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 203, pl. xxviii, figs. 1*a-e*, 1861.

Description.—"Shell small, subglobose. Ventral valve very gibbous near the middle and towards the beak, having a shallow undefined sinus extending from the beak to the front: beak prominent, acutely pointed, incurved. Dorsal valve regularly convex, semicircular or subtriangular: extremities rounded, sometimes an undefined mesial elevation: beak scarcely extending above the hinge-line, not incurved; hinge-line very short, rounded at the cardinal extremities. Area triangular, faintly defined, about half the width of the shell, arcuate. Foramen of medium size, narrow, triangular. Dental lamellæ slightly diverging, and extending more than half way to the base of the shell. Surface marked by faint concentric lines of growth." Hall, 1859.

This species was described by Hall from specimens found at Cumberland. As found in the Keyser of Maryland it corresponds to *Spirifer corallinensis* the typical spirifer of the New York Cobleskill. There is a close relationship between these two forms. *Spirifer modestus* differs chiefly from *Spirifer corallinensis* in its extremely shallow sinus and faint fold, and in the absence of distinct plications. It is also closely related to *Spirifer eriensis* from which it differs in having its beak much curved, cardinal slopes quite concave, greatest width two-thirds the distance from the front, cardinal angles rounded, and in being without plications.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Market Street Bridge Cumberland, southwest of Rawlings, Pinto, Cash Valley, Devil's Backbone, Tonoloway, Flintstone, Hancock, Breakneck Hill Allegany County, Maryland; Hyndman, Pennsylvania; Cedar Cliff, Knobly Mountain, Keyser, West Virginia.

Collection.—Maryland Geological Survey. [Maynard.]

SPIRIFER MODESTUS VAR. PLICATUS n. var.

Plate LXVIII, Figs. 23, 24

Description.—Shell large in comparison with the typical form of *S. modestus;* subglobose, somewhat transverse. Ventral valve very gibbous toward the beak, greatest convexity about two-thirds the distance from front to beak. Sinus usually well defined, extending from the beak to the front; beak prominent, pointed and incurved. Dorsal valve regularly convex, gibbous, greatest convexity just anterior to the beak; beak incurved scarcely extending above the hinge-line; extremities of the shell rounded and with a well-defined mesial elevation. Area triangular, faintly defined, about one-half the width of the shell. Surface marked by three or four indistinct plications on each side of the fold and sinus, and by faint concentric lines of growth.

Length 1.5 cm.; width 1.8 cm.

This variety differs from the typical form in having a well-developed sinus and mesial fold and much more pronounced plications.

It also resembles *S. vanuxemi* var. *prognosticus,* but differs from the latter in its much greater size and absence of spiniferous surface.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—Maryland Geological Survey.

[Maynard.]

SPIRIFER OCTOCOSTATUS Hall

Plate LXVIII, Figs. 25-29

Spirifer octocostatus Hall, 1857, 10th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 62.

Spirifer octocostatus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 205, pl. xxviii, figs. 4*a-e*, 1861.

Description.—"Shell subglobose: valves nearly equally convex. Ventral valve most elevated near the beak: sinus angular, extending to the apex: beak slightly incurved. Dorsal valve most convex in the middle: mesial elevation not prominent: beak rising little above the hinge-line, slightly incurved; hinge-line less than the width of the shell, rounded at the extremities. Area triangular, faintly defined, somewhat arcuate. Foramen narrow; a strong median septum dividing the muscular area, and extending to the apex of the foramen. Surface having about four rounded moderately prominent folds on each side of the mesial sinus and elevation, which become obsolete towards the beaks; concentrically marked by fine, regular, closely arranged imbricating lamellose striæ." Hall, 1859.

Length 1.5 cm.; width 2.2 cm.

The species Weller describes as *Spirifer octocostatus* in the Coeymans of New Jersey [1] is not well preserved, and it is probable that he had another form.

At Cash Valley and the section 1¾ miles northeast of Flintstone and at Hyndman, Pennsylvania, there is a species which has been identified as *Spirifer octocostatus*. It differs from the normal *S. octocostatus* in having

[1] Geol. Survey N. J., Pal., vol. iii, 1903, p. 288, pl. xxx, figs. 5-8.

the folds more angular and more elevated and they diverge more rapidly from the beak, with the sinus deeper. The beak is not so much incurved.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Cash Valley, Cumberland, Pinto, 1¾ miles northeast of Flintstone, Maryland; Hyndman, Pennsylvania; Keyser, West Virginia.

Collection.—Maryland Geological Survey.

[Maynard.]

SPIRIFER PAUCICOSTATUS n. sp.

Plate LXVIII, Figs. 30, 31

Description.—Shell small, much like Ambocœlia, but distinctly plicate. Ventral valve strongly convex, with a small not well-developed cardinal area; median sinus pronounced and bounded by two well-defined, depressed, rounded plications outside of which are shallow grooves separating them from the smooth lateral portions. Dorsal valve slightly concave with a shallow but broad median sinus bounded by two low and rounded plications. Surface marked by concentric lines and varices of growth. There may have been tubular spines, but the surface now appears to be smooth.

The two pairs of dorsal adductor scars are clearly differentiated, narrow, and extending to near the anterior edge of the valve. Cardinal process and crural plates well developed. Dental plates of the ventral valve prominent, thick, and restricted to the rostral region; diductor scars very narrow and long on each side, while the entire umbonal cavity is marked by vascular sinuses.

This little shell has the general expression of Ambocœlia, with the addition of two plications on each valve. It is, therefore, readily distinguished from all associated species. Of its ancestors nothing is as yet ascertained. Weller[1] has described from the Upper Oriskany of New Jersey *Metaplasia plicata* that reminds one of *S. paucicostatus.* It may prove that these are related shells, but the latter is readily distinguished in having fewer plications. Common in the Shriver member.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. Cash Valley, Devil's Backbone, North Branch, Pinto, 21st Bridge.

Collections.—Maryland Geological Survey, U. S. National Museum.

[1] Geol. Surv. N. J., Pal., vol. iii, 1903, p. 356, pl. xlviii, figs. 7-12.

SPIRIFER VANUXEMI Hall

Plate LXVIII, Figs. 32, 33

Spirifer vanuxemi Hall, 1859, Nat. Hist. N. Y. Pal., vol. iii, p. 198, pl. viii, figs. 17-23, 1861.

Description.—"Shell rhomboidal, moderately gibbous: extremities rounded. Ventral valve the less convex, having the beak elevated and incurved. Area small. Surface marked by broad rounded or somewhat flattened and sometimes undefined plications, of which there are from two to four on each side of the mesial fold and sinus; concentrically marked by fine closely arranged undulating striæ and stronger imbricating lines of growth, which are again crossed by still finer radiating striæ; the latter visible only under a magnifier." Hall, 1859.

The individuals referred to this species in Maryland differ somewhat from the typical *S. vanuxemi* of the Manlius of New York in their expression, although the differences hardly justify a distinct varietal name. They appear to be confined to the *Chonetes jerseyensis zone.*

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone beneath the Gypidula zone, Cash Valley, 1¾ miles northeast of Flintstone, Roundtop.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Maynard.]

SPIRIFER VANUXEMI VAR. PROGNOSTICUS n. var.

Plate LXVIII, Figs. 34, 35; Plate LXIX, Figs. 1-3

Description.—The variety *prognosticus* differs from *S. vanuxemi* in that matured examples have from five to six plications (young ones have from three to four) on each side of the dorsal fold, while in Maryland examples the latter has from three to four. Otherwise, the general expression is the same in both. This variety is a continuation of the Manlius *S. vanuxemi* and is prophetic of *S. cyclopterus* which it resembles in its general expression. The latter form, however, is always larger and may attain a size more than twice that of the variety *prognosticus,* yet it has but eight plications on each side of the dorsal fold. In mature forms of *S. cyclopterus* the plications vary between six and eight, and the cardinal area is relatively lower and always more incurved than in *S. vanuxemi* and its variety. The finer surface detail in all of these forms is spinose.

It is probable that Weller[1] had before him Coeymans examples of this species, for he states: "A few small specimens, which are apparently the young of this species [*S. cyclopterus*] agree closely with specimens of *S. vanuxemi* from the Manlius limestone, and at first were so identified..... It is possible that *S. vanuxemi* is ancestral to this Helderbergian species."

This variety occurs locally in abundance in the upper part of the Keyser member.

Length 8 mm.; width 10 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Winchester Road at Pinto in a shaly limestone, cut of Baltimore and Ohio Railroad ¾ mile southwest of Rawlings, Tonoloway.

Collections.—Maryland Geological Survey, U. S. National Museum.

SPIRIFER ERIENSIS Grabau

Plate LXIX, Fig. 7

Spirifer eriensis Grabau, 1900, Bull. Geol. Soc. Amer., vol. xi, pp. 366-367, pl. xxi, figs. 2*a*-*b*.

Description.—" Shell small, pedicle valve strongly convex, almost ventricose, subrhomboidal in outline, with the beak much elevated and gently incurved. Mesial sinus pronounced; angular in the center, with the sides nearly flat, gradually and uniformly increasing in width from the beak forward. Sometimes it is slightly rounded in the bottom. It is prolonged at the front of the shell as a prominent rounded lip. On either side of the sinus is a moderately strong, broadly rounded, but not very prominent plication, in addition to which there are about three or four on either side, which are fainter and progressively become narrower away from the sinus. Interspaces narrow, having the form of a depressed line, the broadest next to the plication adjoining the sinus. Brachial valve almost semicircular, moderately convex, with a straight hinge-line, which is shorter than the greatest width of the valve. Beak elevated above the hinge-line

[1] Geol. Surv. N. J., Pal., vol. iii, 1903, p. 287.

and incurved. Fold distinctly defined by a sharp depressed line on either side, but not elevated much above the general surface of the valve. It gradually and uniformly widens forward, is broadly rounded on top, and is occasionally marked by a slight central depression. Ribs almost obsolete, a faint depression outlining the first on either side of the fold in some specimens. Surfaces of both valves marked by fine, uniform, and subequally spaced concentric lines which curve forward in the sinus of the pedicle valve. Occasionally strong lines mark a temporary resting stage during growth. The whole surface appears to be covered with fine radiating striæ, which are interrupted by the concentric striæ, thus giving the surface a fimbriate appearance. On the interior of the pedicle valve are two short dental plates, diverging slightly more than the sides of the sinus. The cardinal area of this species is high, occupying in some specimens as much as a third of the total height of the valve. The strength of the ribs on the brachial valve varies somewhat in different specimens, but they are always much less marked than those of the pedicle valve, and they are usually quite obsolete.

"The species to which this most nearly approaches is the variety of *S. crispus* Hisinger found in the Coralline limestone at Schoharie. In this variety the ribs are much fainter than in the normal *S. crispus* of the Niagara shales and limestones of western New York. In many specimens from Schoharie the ribs are almost obsolete, comparing well with their character in *S. eriensis*. The sinus of the Schoharie specimens is subangular, and the fold flattened much as in the Bullhead limestone species. This variety is also proportionally higher than the normal form, giving a subrhomboidal outline to the pedicle valve, which strongly recalls *S. eriensis*. In general the ribs of this latter species are slightly broader and rather more flattened on top than is the case in the Coralline limestone species, and the interspaces are somewhat narrower. Taking all the variations into consideration, a very close relation must be accepted as existing between the two species. The specimens described by Whitfield as *S. vanuxemi* from the hydraulic limestone (Manlius?) of Peach Point, Put-in-Bay, Lake Erie, resembles rather more closely the normal *S. crispus* than it does the typical *S. vanuxemi* of the Manlius limestone of central

New York. The similarity to the Niagaran species was observed by Whitfield. The strong plications and greater width separate it from *S. eriensis*.

"Most of the specimens of *S. eriensis* were found at Williamsville. A few, however, came from the cement quarries in north Buffalo. Width of the pedicle valve illustrated, 10 mm.; length, 8.5 mm. Width of the brachial valve illustrated, 7.5 mm.; length, 6 mm." Grabau, 1900.

Only one specimen has been found in Maryland in the Cash Valley section associated with *Dalmanella clarki*. *S. eriensis* is very closely related to *S. modestus* and *S. plicatus* of Maryland. It may be distinguished from the former by its larger size and plications, and from the latter which it so closely resembles by its less incurved beak, greatest width near middle of valve, acute cardinal angles of brachial valve.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collection.—Maryland Geological Survey.

[Maynard.]

SPIRIFER CYCLOPTERUS Hall

Plate LXIX, Figs. 8-10

Spirifer cycloptera Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 58, figs. 1-5 (wrongly labeled *S. perlamellosa*).

Spirifer cyclopterus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 199, pl. xxv, figs. 1*a*-1*z* (? figs. 1*p*, 1*q*).

? *Spirifer concinnus* Hall, 1859, *ibidem*, pl. xxv, figs. 2*a*-2*f* (not figs. 2*g*-2*i*).

Spirifer cyclopterus Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 314, pl. xxxviii, figs. 1-6.

Description.—"Shell semicircular; extremities of the hinge-line more or less symmetrically rounded: ventral valve gibbous; beak moderately elevated, more or less incurved; sinus moderately deep, curved on the sides, and nearly flat in the middle: dorsal valve very convex towards the middle, the mesial fold abruptly elevated and very prominent; beak little elevated above the hinge-line, and scarcely incurved; area moderate, scarcely extending to the extremity of the hinge-line; foramen large. Shell marked by five to seven rounded plications on each side of the mesial line, concentrically marked by fine close imbricating lamellose striæ, which are more or less prominent, depending on the condition of preservation in the shell: surface of lamellæ ornamented by short fine vertical striæ or crenulations [these are tubular spines] which project in fimbriæ on the edge of the lamellæ." Hall, 1857.

This well-known New York species occurs abundantly in Maryland, but is rarely well preserved. In the southern material the fimbriate lamellæ are less crowded than in the New York individuals, and in this they approach more nearly to *S. tribulis* of the Lower Oriskany. In the Cumberland region there need be no difficulty in distinguishing *S. cyclopterus* from the associated Spirifers, but in Washington County, where the Becraft member is present, it may be confounded with small specimens of *S. concinnus*. However, the latter generally attains a larger growth, has more numerous and depressed plications, and when the fine surface detail —a rare feature—is preserved, it will be seen to be devoid of the fimbriate lamellæ.

Length 1.7 cm.; width 2.6 cm.

It is probable that the pauciplicate form of *S. cyclopterus* gives rise to *S. tribulis*, while the more abundantly plicate specimens develop into *S. intermedius*. However, it may be that the latter arises directly from *S. tribulis*.

Occurrence.—HELDERBERG FORMATION, COEYMANS and NEW SCOTLAND MEMBERS. This species is abundant in Allegany and Washington counties. BECRAFT MEMBER. Washington County.

Collections.—Maryland Geological Survey, U. S. National Museum.

SPIRIFER TRIBULIS Hall

Plate LXIX, Figs. 11-14

Spirifer tribulis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 420, pl. xcvi, figs. 8*a*-8*e*, 1861.

Spirifer tribulis Hall, 1883, Second Ann. Rept. N. Y. State Geol., pl. lviii, figs. 1-4.

Spirifer tribulis Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pp. 19, 37, pl. xxxiii, figs. 1-4.

Description.—" Shell transverse, varying from semicircular to semielliptical; cardinal extremities more or less rounded, gibbous in the middle. Ventral valve more convex than the dorsal: beak elevated and incurved; sinus narrow and shallow above, becoming deeper and subangular below; area variable, usually of moderate height, the exterior margins sometimes strictly defined. Dorsal valve very convex towards the umbo: beak incurved, and often elevated above the hinge-line; a narrow area. Surface marked by from four to six or seven plications on each side of the mesial fold and sinus: plications elevated, abruptly rounded, the depressions subangular towards the margin; concentrically marked by fine lamellose imbricating striæ and finer radiating striæ, which cover the entire shell. The interior of the ventral valve shows strong dental lamellæ, which are curved backwards beneath the area, and do not extend so low on the shell as its lower margin. Muscular area not defined in the specimen examined." Hall, 1859.

Length 1.5 cm.; width 2.3 cm.

Hall stated that this species resembled *S. cyclopterus* of the Helderberg and that "it may be only a variety of form, resulting from a change of condition in the sediment." Therefore he gave it the name *tribulis* meaning in this case of the tribe of *S. cyclopterus*. *S. tribulis* is certainly a direct development from the pauciplicate forms of that species, but it is readily distinguished in having fewer fimbriate lamellæ. At present this species is not often found about Cumberland, because most of the collecting is done in the higher Oriskany. In Mr. Andrews's day it was commonly met with in the lower beds of the Upper Oriskany.

It seems that either *S. tribulis* or the more abundantly plicate forms of *S. cyclopterus* gave rise to *S. intermedius*. On the other hand, from *S. tribulis* also developed *S. angularis* and *S. murchisoni*. The development of the fimbriate, simple spined spirifers is so rapid in the Oriskany that one is at times perplexed to know to which group single individuals shall be referred. The variations of *S. murchisoni* are in this respect most troublesome.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. Cash Valley and Devil's Backbone, Collier's Run, Winchester Road near Cumberland, Maryland. RIDGELY MEMBER. 21st Bridge. In the lowest beds of the Upper Oriskany it was abundant in the quarries now abandoned on Green Street and back of the German Lutheran Church, Cumberland.

Collections.—American Museum of Natural History, U. S. National Museum.

Spirifer angularis n. sp.

Plate LXIX, Figs. 15, 16

Description.—This species is related to *S. tribulis, S. intermedius,* but more particularly to *S. murchisoni.* However, it cannot be referred to any one of these forms. With *S. tribulis* it will not be confounded because the two are not found associated and *S. angularis* attains a larger size with a greater number of plications. Of the latter there are from seven to nine on each side of the median fold in *S. angularis.* From *S. intermedius* it is distinguishable by its smaller size and fewer and more angular plications; from *S. murchisoni,* by its smaller size, narrower fold and sinus, and greater alation.

Length 2 cm.; width 3.3 cm.

The specimen figured has the sinus and fold sharply angulated, which is the case in about one-half the individuals, while the remainder have those parts more rounded. In some respects *S. angularis* may be regarded as immature *S. murchisoni* var. *marylandicus,* but the uniformly smaller size and the comparatively greater alation prevent such a reference.

S. angularis is also related to the common Lower Devonian *S. hystericus* Schlotheim of the German Siegen.[1] The American form is distinguished by being less alate, having a higher ventral cardinal area, and especially by the fact that the German species never has the deeply excavate muscular area so characteristic of this species and *S. murchisoni.*

Occurrence.—Oriskany Formation, Ridgely Member. Ridgely; Miller's Springs, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

Spirifer intermedius Hall

Plate LXIX, Figs. 17-21

Spirifer intermedius Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, pp. 424, 430 (not *S. intermedius* (Schlotheim), 1813).

Description.—" Shell transverse, semielliptical; the ventral valve moderately and regularly convex, area of medium height, foramen large;

[1] See Dreverman, 1904, Palaeontographica, vol. l, p. 253, pl. xxx, figs. 1-7.

mesial sinus of moderate depth, rounded. Dorsal valve unknown. Surface (of a specimen one and a half inches wide) marked by [eight to] ten depressed plications on each side of the mesial sinus. [Detailed surface markings as in *S. tribulis.*] The dental lamellæ are not at all or but slightly thickened: the muscular impression is broad and strongly striated, with sometimes a filling of the cavity of the beak." Hall, 1859.

When Hall described this species he had "a few imperfect specimens of the ventral valve" and apparently regarded it as intermediate between *S. cumberlandiæ* and *S. murchisoni;* hence, the name, *S. intermedius.* In aspect it is intermediate, but not so in development. *S. murchisoni* and *S. intermedius* are derived from *S. tribulis,* as the former develops angulated plications, while the second form retains the rounded plication of the latter, but increases the number. *S. cumberlandiæ,* on the other hand, belongs to another phylum, whose ancestors are not yet determined.

Length about 3 cm.; width about 5 cm.

S. intermedius is distinguished from *S. cumberlandiæ* in being larger, attaining a width of $2\frac{1}{4}$ inches, is thicker and therefore has more convex valves, has fewer plications, and a lower and less erect ventral cardinal area. The surface lamellæ are also less strongly developed in *S. intermedius,* and these terminate in marginal spines, which is not the case in *S. cumberlandiæ.*

In 1813 Schlotheim described a Spirifer from the Middle Devonian as *Terebratulites intermedius,* and it is a remarkable coincidence that this should be a shell closely related to Hall's species. Both are fimbriate forms. However, it is regarded by Davidson as synonymous with *Spirifer speciosus* (Schlotheim). According to the rule of nomenclature, once a synonym always a synonym, Hall's name must be abandoned. However, so long as Schlotheim's name is not in use in Europe, the writer prefers to continue the use of Hall's American name.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Allegany and Washington counties, Maryland; Keyser, West Virginia; 6 miles northwest of Winchester, Virginia.

Collections.—Maryland Geological Survey, American Museum of Natural History, U. S. National Museum.

SPIRIFER MURCHISONI Castelnau

Plate LXX, Figs. 1-5

Spirifer murchisoni Castelnau, 1843, Essai Syst. Sil. l'Amér. Septent., p. 41, pl. xii, figs. 1, 2 (not *S. murchisonianus* de Koninck, 1843).

Spirifer arrectus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 422, pl. xcvii, figs. 1*a*-1*h*, 2*a*-2*i*, p. 430, 1861.

Spirifer murchisoni Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 46, pl. vi, figs. 26-30.

Spirifer murchisoni Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 329, pl. xlii, fig. 26; p. 354, pl. xlviii, figs. 1-4.

Description.—" Length three and a half centimeters; width six. Shell nearly two times wider than long, the sinus smooth; six ribs on each side. *Locality:* Schoharie, New York." Castelnau, 1843.

" Shell transverse, varying from semicircular to semielliptical; cardinal angles sometimes rounded, but often produced beyond the width of the shell below. Ventral valve more or less gibbous than the opposite: beak elevated and incurved; the area above the medium height, more or less concave, extending to the hinge extremities, separated from the exterior shell by a sharply defined margin; foramen large [covered by prominent deltidial plates]; sinus varying from a depression of moderate depth with curving sides and base, to a deep angular depression which elevates the mesial portion of the opposite valve in an angular fold. Dorsal valve often very convex in the middle and towards the front; the mesial fold often abruptly elevated, and varying from a rounded to a sharply angular prominence; the beak incurved beyond the hinge-line.

" Surface marked by from five to seven or eight plications on each side of the mesial fold and sinus, which are either round or subangular and more or less elevated. The entire surface is ornamented by fine closely arranged concentric striæ; and these are again crossed by finer radiating striæ, which are more prominent on the edges of lamellæ, giving to the perfect shell a granulose [rather a finely striate-spinose] exterior.

" The casts of the ventral valve, which are abundant in the sandstone, show a large prominent process which is strongly defined by the impressions of the dental lamellæ: this process, which indicates the form and dimensions of the muscular area, is variously striated, sometimes with a few strong ridges, and in others with finer longitudinal striæ, and more rarely the curving transverse striæ are preserved. The cast is strongly papillose on each side of the muscular area. The cast of the dorsal valve shows a sharp median line down the fold, indicating the interior median ridge." Hall 1859.

Length about 4 cm.; width about 5 cm.

In New York *S. murchisoni* is a common shell, fairly constant in its characters, and is one of the diagnostic fossils of the typical or Upper Oriskany. In Maryland the species is very variable, less abundant, and is usually smaller, though one specimen in Mr. Roeder's collection measures along the hinge-line 7.5 cm. The variations are along several lines, as transversity, gibbosity, increase in the width and depth of the sinus, and extreme tongue-shaped extension into the dorsal fold, but mainly in the character and abundance of the plications. These may be few in number, low and rounded, or subangular and even sharply angular when the fold and sinus are also decidedly angulated; or there may be more plications than is normal when they are subangulated (var. *marylandicus*).

In Washington County *S. murchisoni* almost shades into *S. intermedius*, and the two species are not readily distinguished. However, the *S. intermedius* of this region has less plications than the typical forms, and it may be that larger collections will show that it, *S. angularis, S. murchisoni*, and *S. murchisoni marylandicus* are but stratigraphic and local expressions of one variable species—*S. murchisoni*. Granting this, it would not be desirable to recognize all these forms by one name, and some are here regarded as species because no intermediate links occur. It is among these plastic forms persisting through great thickness of sediments that the best examples of gradual change through local variations are found. These variations in other localities may become fixed, and are then the easily recognized species. The Spirifers of the Oriskany of the Maryland region express rapid evolution, and some of the fixed forms are found in the Onondaga.

The name *S. murchisonianus* de Koninck (d'Omalius, Geology, 1843) is sufficiently distinct from *S. murchisoni* to be retained. Further, the former is also regarded by Davidson as a synonym for *S. disjunctus*.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Washington County, abundant.

Collections.—Maryland Geological Survey, American Museum of Natural History, U. S. National Museum.

SPIRIFER MURCHISONI VAR. MARYLANDICUS n. var.

Plate LXX, Figs. 6, 7

Description.—This variety may be distinguished from the species by the greater number of plications and their greater angularity, and by the fold and sinus. The plications in the variety vary in number from eight to ten on each side of the fold, while in the Maryland specimens of *S. murchisoni* the range is from six to eight.

Length 3.2 cm.; width about 4 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, abundant.

Collections.—Maryland Geological Survey, U. S. National Museum.

SPIRIFER HARTLEYI n. sp.

Plate LXX, Figs. 8-10

Description.—This species resembles *S. murchisoni* in its form and the few plications, of which it has from five to six on each side of the fold and sinus. However, it is less alate and gibbous and never has the wide angulated fold and sinus of that species, but rather of *S. tribulis,* in which it is narrow, low, and rounded. *S. hartleyi* differs from all the Maryland species of this genus by its depressed and strongly incurved ventral beak, an exaggerated character of *S. cyclopterus.* In a general way this species may be regarded as a very large *S. tribulis* in which divergence has taken place by the decided angulation of the plications, a slight reduction in their number, with a more depressed and more hooked ventral beak.

Length about 3 cm.; width about 4 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—U. S. National Museum.

SPIRIFER PERDEWI n. sp.

Plate LXX, Figs. 11-13

Description.—This large, massive, subquadrangular Spirifer has a width of 55 mm.; and will probably be most often confounded with *S. intermedius,* since it has much of the general exterior aspect of the latter. However, the subquadrate outline and less convex valves should readily distinguish it from that species. The only other subquadrate Oriskany form is *S. concinnoideus,* but this has a far greater number of plications. The surface detail is not preserved, but as the species strongly resembles *S. intermedius,* it is assumed that the plications are crossed by nearly obsolete lamellæ terminating in minute simple spines.

Length about 4 cm.; width about 5.25 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland, Maryland; north fork of the South Branch of the Potomac River, Pendleton County, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

SPIRIFER TRIBUARIUS n. sp.

Plate LXX, Figs. 14-16

Description.—Shell small, biconvex, plicate, with narrow cardinal areas. Cardinal angles more or less strongly rounded so that some specimens are transverse and others subrhomboidal in outline. Ventral valve most convex, with a small, low, not strongly incurved cardinal area; median sinus narrow, deep, and rounded, bounded by high and rounded or subangular plications, on each side of which are from two to three smaller ones. Dorsal valve convex, with a narrow median flattened fold, on each side of which are deep, narrow depressions, and outside of these are from two to four plications like those of the other valve. Ventral teeth strong and unsupported by dental lamellæ. Surface with many concentric, nearly obsolete lamellæ bearing very delicate spines.

Length about 10 mm.; width 15 mm.

This species may have developed from *S. paucicostatus* by adding a few lateral plications and attaining larger size. The specific name is intended to be suggestive of this and also of its similarity to *S. tribulis,* with which it should not be confounded since it has fewer and more widely separated plications and is also less transverse.

After describing this species the writer saw Weller's account of his *Metaplasia plicata*[1] which seems to be very closely related. The only differences are that the New Jersey form attains larger growth and the plications are more depressed and broader. Larger collections may show that *S. tribuarius* and *M. plicata* are but local expressions of the same species.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. Cash Valley, Nicholas Mountain, and Winchester Road near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

SPIRIFER ARENOSUS (Conrad)

Plate LXXI, Figs. 1-9; Plate LXXII, Fig. 1

Delthyris arenosa Conrad, 1839, Third Ann. Rept. N. Y. Geol. Surv., p. 65.

Spirifer arenosus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 425, pl. xcviii, figs. 1-8; pl. xcix, figs. 1-10; pl. c, figs. 1-8.

Spirifera arenosa Hall, 1883, Second Ann. Rept. N. Y. State Geol., pl. lv, figs. 3-7.

Spirifer arenosus Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pp. 24, 27, 37, pl. xxix, figs. 1-4; pl. xxx, figs. 3-8.

Spirifer arenosus Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 46.

Description.—" Shell trigonal, with radiating sulci; superior valve with a rounded elevation in the middle, having about 4 sulci upon it, or 5 ribs; inferior valve, with a corresponding furrow; basal margin undulated, prominent and angulated in the middle. Length 2¼ inches. Locality: Helderberg, in sandstone." Conrad, 1839.

" Shell, in the young state, semielliptical, with the beak a little elevated above the hinge-line; the old shell becoming ventricose, and the beak much elevated above the hinge-line, having a somewhat semioval form. The proportions vary from length and width equal, to width one-third greater than the length. Cardinal angles sometimes produced in acute terminations, but usually rounded, particularly in old shells.

" Ventral valve very regularly convex, the greatest convexity about one-third the distance below the beak. The cardinal angles, when pro-

[1] Geol. Surv. N. J., Pal., vol. iii, 1903, p. 356, pl. xlviii, figs. 7-12.

duced, are a little flattened. The mesial sinus is very shallow, being often little more than a flattening of the surface along that part of the shell. The umbo is broad, and the beak a little incurved over the area. Area in young shells narrow, and in old shells proportionally wider, and extending to the cardinal extremities: the foramen is wide, and, in old shells, partially closed above (by deltidial plates). The dental lamellæ are strong; the extremities, rising above the cardinal line and bending backwards beneath the area, are widely divergent as they extend from the beak downwards. The muscular impressions are large, and very strongly and beautifully marked. Dorsal valve of the same form as the ventral; its greatest convexity in the middle, with a very narrow cardinal area, above which the beak is slightly incurved. Mesial elevation very moderate, and sometimes scarcely defined.

"Surface marked by regular simple rounded or sometimes subangular plications, of which there are from ten to twenty on each side of the mesial fold and sinus. The mesial sinus is simple at the apex; but a plication becomes developed in the bottom of it, and each of the bordering plications is dichotomized; the central one dichotomizing once, and in old shells twice, before reaching the margin. Very young shells show a sinus with a simple plication in the bottom. The mesial elevation of the dorsal valve is simple in very young shells, showing first a central groove, then each marginal plication becomes dichotomized, and at the same time a central plication rises in the median groove; and the mesial fold, at its base, consists of five [or six] distinct plications, the result of the dichotomizing of a single one at the apex. Surface marked by fine concentric striæ and stronger imbricating lines of growth. [These are traversed by very delicate radial interrupted striæ.] In the casts of the interior, this fossil presents considerable variety of appearance, owing to the variable extent of the muscular area, the development of its markings, and depth of the cavity beneath the beak; characters due in part to the different ages of the shell, but often apparently to other causes." Hall, 1859.

This well-known and diagnostic fossil of the Oriskany is the most common shell about Cumberland. It is distinguished from all the associated spirifers by the plicated fold and sinus. In Washington County this species attains the largest growth—upward of 80 mm. in width. This size is as large as the largest New York examples, and they are more convex, with a decidedly wider and deeper ventral sinus. These specimens represent the typical form of *S. arenosus,* while the smaller ones, so common in the "sand pockets" about Cumberland, are a distinct variety easily recognized by the shallow valves with their almost obsolete fold and sinus.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. A single small specimen was found in the Lower Oriskany at North Branch. RIDGELY MEMBER. Allegany and Washington counties, Maryland; Keyser and Moorefield, West Virginia; Rock Enon Springs, Alexandria, Virginia. It is also found in the drift about Washington and Alexandria.

Collections.—Maryland Geological Survey, U. S. National Museum, American Museum of Natural History.

SPIRIFER CONCINNUS Hall

Plate LXXII, Figs. 2, 3

Spirifer concinna Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 60, figs. 1-3 on p. 61.

Spirifer concinnus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 200, pl. xxv, figs. *2g-2i;* pl. xxviii, fig. 7 (not figs. *2a-2f* of pl. xxv, probably a new species of the *S. cyclopterus* section).

Description.—"Shell semicircular or semielliptical; extremities rounded; valves almost equally convex: ventral valve gibbous towards the beak; beak more or less elevated above the hinge-line, and abruptly incurved at the apex; mesial sinus subangular, and produced into an angular extension which is much elevated, and sometimes slightly incurved in front: dorsal valve very convex in the center; beak scarcely incurved; mesial elevation obtusely angular; hinge-line equal to or a little less than the width of the shell; area of medium size, well defined, and extending to the extremities of the hinge-line. Surface marked by from twelve to fourteen rounded, little elevated, simple costæ on each side of the lobe and mesial sinus [marked by radial lines of minute interrupted granules]." Hall, 1857.

This species is common in the Becraft of Maryland and attains a width up to 45 mm. All the specimens are single valves and the thin edges have suffered abrasion before deposition, so that the species appears to be more alate than in New York. None of the examples show any trace of the fold or the sinus being plicated, a character of some of the New York material referred by Hall to this species. Some of the smaller specimens of *S. concinnus* are difficult to distinguish from *S. cyclopterus* without the aid of the detailed surface characters, but, as a rule, the latter have fewer and more elevated plications.

Regarding the New York material, it seems unwise to include in this species the New Scotland material figured by Hall (pl. xxv, figs. *2a-2f*). These specimens are unlike those of the Becraft in being more transverse and larger, while the surface lamellæ terminate in delicate spines, a character of *S. cyclopterus,* and not of *S. concinnus.* The latter has no lamellæ and the plications are ornamented by very delicate intermittent radial lines of pustules, a character best developed among the Ostiolati spirifers, to which group *S. concinnus* belongs. In restricting this species, as above indicated, Hall's original figures and his remarks in Paleontology of New York, vol. iii, have been followed, *i. e., S. concinnus* is here restricted to the Becraft subquadrangular specimens in which the fold and sinus are without plications.

Length 2.1 cm.; width 2.4 cm.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Warren Point, Pennsylvania; North Mountain, Maryland; Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

SPIRIFER PROAVITUS n. sp.

Plate LXXI, Fig. 17

Spirifer concinnus Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pl. xxx, figs. 1, 2.

Description.—Associated with *S. concinnus* in New York according to Hall are many specimens in which there are faint indications of a fold on each side of the medial sinus, and of several similar ones upon the corresponding mesial elevation. Since these specimens indicate the first departure toward the Aperturati spirifers so common in the Devonian and Carboniferous formations, it seems desirable to give them a distinct name. Therefore for the *S. concinnus* forms with the fold and sinus plicated the name *S. proavitus* is proposed. The type is the *S. concinnus* Hall and Clarke.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

SPIRIFER CONCINNOIDEUS n. sp.

Plate LXXII, Fig. 4

Description.—This subquadrate Spirifer has its nearest relationship in *S. concinnus* of the Helderberg (Becraft). It attains twice the size of the latter, is somewhat less convex, the dorsal medial fold less high, the ventral sinus less deep, and it is flattened along the center, while the depressed subangular plications range in number from fourteen to seventeen on each side of the center against twelve to fourteen in *S. concinnus.* The surface detail is not preserved in the material at hand, but being a subquadrate shell the plications were probably covered by a series of fine radial pustulose striæ devoid of imbricating lamellæ. The general form is very much like that of *S. concinnus,* with a vertical incurved ventral cardinal area of moderate size.

The subquadrate form of the shell readily separates *S. concinnoideus* from all the alate forms like *S. intermedius,* while the great number of depressed and small plications separates it from *S. perdewi* and *S. gordoni.*

Length 2.8 cm.; width 4 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. 21st Bridge, Maryland; north fork of South Branch of Potomac River, Pendleton County, West Virginia.

Collection.—U. S. National Museum.

SPIRIFER GORDONI n. sp.

Plate LXXII, Figs. 5-7

Description.—When the finer surface detail is preserved, this species is readily distinguished from all other Oriskany spirifers except *S. concinnoideus* by its exceedingly fine radial striæ. However, the Oriskany fossils rarely preserve the finer detail and for this reason it is not so easy to recognize this species. In general *S. gordoni* will be confused with *S. intermedius,* but it is distinguished by the rounded cardinal angles, making the species far less alate than *S. intermedius;* moreover, the fold is more depressed and the sinus has a flat central area. The latter character, as a rule, will alone distinguish this form from all other Cumberland species. *S. gordoni* differs from *S. perdewi* in being a more depressed or thinner and more transverse species.

Length 3.5 cm.; width 4.4 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus RETICULARIA McCoy

RETICULARIA BICOSTATA (Vanuxem)

Plate LXXII, Figs. 8-10

Orthis bicostatus Vanuxem, 1842, Geol. N. Y., Third Dist., pp. 91-94.
Spirifer bicostatus Hall, 1852, Nat. Hist. N. Y., Pal., vol. ii, p. 263, pl. liv, fig. 4.
Spirifera bicostata Hall, 1883, 2d Ann. Rept. N. Y. State Geol., pl. lxi, fig. 7.
Spirifer bicostatus Hall and Clarke, 1893, Pal. N. Y., vol. viii, pt. ii, pp. 19, 37, pl. xxxvi, fig. 7.

Description.—"Somewhat ovate triangular, the dorsal valve gibbous, with the beak extended and incurved over a short triangular area; ventral valve convex; surface marked by conspicuous concentric subimbricating striæ; dorsal valve with a distinct plication on each side of the sinus, and toward the base are two other obscure plications on each side, presenting three and sometimes four gentle undulations on the margin on each side of the center; cardinal line shorter than the width of the shell, and the area scarcely extending so far as the cardinal line; extremities distinctly rounded." Hall, 1852.

The forms found are all small. The ovate triangular outline, conspicuous concentric subimbricating striæ, and plications distinguish it from *Spirifer modestus.* It differs from *Spirifer crispus* of the Niagara in its fewer and less marked plications.

Length 13 mm.; width 14 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Roundtop.[1]

Collection.—Maryland Geological Survey.

[Maynard.]

Genus AMBOCŒLIA Hall[2]

AMBOCŒLIA UMBONATA (Conrad) ?

Orthis umbonata Conrad, 1842, Jour. Acad. Nat. Sci. Phila., vol. viii, p. 264, pl. xiv, fig. 4.

Ambocœlia umbonata Hall, 1867, Nat. Hist. N. Y., Pal., vol. iv, p. 259, pl. xliv, figs. 7-18.

Description.—The Maryland Helderberg material referred with some doubt to this species, and which is not well preserved, is indistinguishable from Hamilton specimens except in size, being less than half that of the latter. The writer would not make this identification and thus give *A. umbonata* a range from late New Scotland into the Chemung, were it not that he has this species from the Upper Oriskany of Armuchee Creek, northeast end of Lavender Mountain, Floyd County, Georgia. When better material is at hand, the Helderberg specimens may prove to be distinct.

As these pages are printing Clarke's Early Devonic History of New York and Eastern North America (Memoir 9, pt. 1, N. Y. State Mus., 1908, p. 182) comes to hand. From it we see that probably this same shell occurs at Gaspé, Canada. Clarke names it *Spirifer modestus nitidulus* and states that *S. modestus* " expresses in its outward form and characters the usual features of the Middle Devonic genus Ambocœlia save for the greater convexity of the dorsal valve. Ambocœlia unquestionably belongs in this category but has certain differentials in the arrangement of the

[1] It is possible that this species is from the Tonoloway formation.

[2] For a revised description of this genus, see Hall and Clarke, Nat. Hist. N. Y., Pal., vol. viii, 1893, pt. ii, pp. 54-56.

dorsal adductor scars and cardinal structure." To the writer the Maryland material has the interior characters of Ambocœlia but *S. modestus* is different and of the lower part of the Keyser member.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Highest shale zone at 21st Bridge.

Collection.—U. S. National Museum.

Genus METAPLASIA Hall and Clarke[1]

METAPLASIA PYXIDATA (Hall)

Plate LXXII, Figs. 11, 12

Spirifer pyxidatus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 428, pl. c, figs. 9-12, 1861.

Metaplasia pyxidata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 56, pl. xxxix, figs. 19-22.

Description.—" Shell semielliptical in outline, one side angularly gibbous in the middle; cardinal line equalling (sometimes a little greater or less than) the greatest width of the shell. Ventral valve with a narrow mesial sinus, in the summit of a broad, strong elevation; the beak abruptly incurved over a narrow linear area, which extends to the cardinal extremities; foramen of moderate width, with strong divergent dental lamellæ. The muscular impressions are well marked, and sometimes there is a thickened process from the interior filling the summit of the foramen. Dorsal valve flat at the sides and near the beak, with a broad depression below, in the center of which is a narrow mesial elevation. The margins of the shell on each side present a few undulations or marginal folds, and, in rare examples, these reach half way to the beak." Hall, 1859.

The surface, in its perfect condition, has been very delicately concentrically striated, shell substance fibrous and apparently impunctate.

[1] At the time Hall and Clarke (Nat. Hist. N. Y., Pal., vol. viii, pt. ii, 1893, p. 56) established this genus they had seen no specimens with calcified brachial spirals and concluded that the general structure was suggestive of Orthis. Recently a specimen of *M. pyxidata* was found by Mr. Roeder preserving the spirals, and these have the general structure of the Spiriferidæ. They are postero-laterally directed, have seven volutions to each comparatively large cone, and the descending lamellæ are very wide and devoid of processes or remnants of a connecting or transverse band.

The spiral cones are comparatively large and have seven volutions of the band. The descending lamellæ are very wide and are devoid of lateral processes or remnants of a connecting loop.

This species is readily recognized by the very high ventral fold with its narrow or linear sinus, and the flat dorsal shell with its very wide and deep sinus in the bottom of which there is a depressed plication.

This species is common in the upper half of the Oriskany, but does not appear to be gathered often because the valves are nearly always separated and attached to rock. Mr. Andrews found it commonly in the quarries, now abandoned, in the city of Cumberland.

Length 1.5 cm.; width 2.1 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain and Williams Road near Cumberland, Collier's Run.

Collections.—Maryland Geological Survey, American Museum of Natural History, U. S. National Museum.

Family SUESSIIDAE

Genus CYRTINA Davidson[1]

CYRTINA ROSTRATA (Hall)

Plate LXXI, Figs. 10-16

Cyrtia rostrata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 64.
Cyrtia rostrata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 429, pl. xcvi, figs. 1-6; pl. xcviii, figs. 8*a*-8*b*, 1861.
Cyrtina rostrata Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pl. xxv, figs. 1-8; pl. xxviii, fig. 6.
Cyrtina rostrata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 330, pl. xlii, figs. 23-25.

Description.—"Shell semicircular or triangular: ventral valve much elevated at the beak, a distinct sinus extending from beak to front; beak simple, angular, not incurved: dorsal valve depressed convex, semicircular; mesial fold moderately elevated, slightly flattened and marked with a faint, longitudinal, depressed line; beak scarcely elevated above the cardinal margin; hinge-line straight, equalling the greatest width of the shell; area broad triangular, plane, or rarely subarcuate; foramen

[1] For an excellent description of this genus, see Hall and Clarke, Nat. Hist. N. Y., Pal., vol. viii, 1893, pt. ii, pp. 43-46.

narrow, extending to the apex of the beak of the ventral valve, partly closed above by a central plate. Surface marked by nine to eleven elevated angular costæ on each side of the middle, crossed by strong imbricating concentric lamellæ." Hall, 1857.

This well-known species of Cyrtina is not rare, and occasionally a specimen of *Spirifer intermedius* is found with young examples still attached. Mr. Hartley has such a specimen with thirteen young of various ages all lying on their flat ventral cardinal areas, and this undoubtedly is their position in life. In the youngest stages this species is greatly alate, but toward maturity growth becomes strongest anteriorly, when the shells are comparatively less drawn out on the hinge-line.

To *C. rostrata* are also referred two examples from the Becraft. One, a dorsal valve, cannot be distinguished from typical specimens from the Upper Oriskany. The other is an entire individual, is decidedly alate, has nine plications on each side of the fold or sinus, and the dorsal valve is nearly flat. The same variation also occurs, but rarely, among the typical specimens of *C. rostrata*.

Length 10 mm.; width 21 mm.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Cherry Run, West Virginia. ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland, common.

Collections.—Maryland Geological Survey, U. S. National Museum, American Museum of Natural History.

Family RHYNCHOSPIRIDÆ

Genus RHYNCHOSPIRA Hall [1]

RHYNCHOSPIRA RECTIROSTRA (Hall)

Plate LXXII, Figs. 13-15

Waldheimia rectirostra Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 89.

Trematospira (*Rhynchospira*) *rectirostra* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 217, pl. xcva, fig. 1, 1861.

Description.—" Shell longitudinally ovate, tapering towards the beak at an angle of about 45°, slopes on each side of the beaks, flattened and not

[1] See Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 108.

plicated; beak of ventral valve straight, extending beyond the opposite, truncated at the apex by a round perforation partly formed by the deltidium; beak of dorsal valve incurved. Surface marked by twelve or thirteen prominent subangular plications, the two central of which, on the ventral valve, are slightly smaller than the others, and a little depressed. These two plications coalesce before reaching the beak: the central plication of the dorsal valve is smaller and a little more depressed than the others, and becomes obsolete before reaching the beak." Hall, 1857.

Length 11 mm.; width 8 mm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Since Hall's description of this species, no other examples have been found. The type specimen is very likely from the Lutheran Church quarry in Cumberland.

Collection.—American Museum of Natural History.

RHYNCHOSPIRA GLOBOSA (Hall)

Plate LXXII, Figs. 16-25

Waldheimia globosa Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 87.

Trematospira (Rhynchospira) globosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 215, pl. xxxvi, figs. 1*a-p*, 1861.

Description.—" Shell subglobose, oval: ventral valve a little larger than the opposite one, most gibbous in the umbonal region; beak prominent, rounded and arched, perforate at the extremity by a round aperture, one side of which is formed by the deltidium: dorsal valve shorter than the ventral; beak incurved. Surface marked by twelve to sixteen somewhat angular plications on each valve, two or three of which are slightly depressed on the middle of both valves, so as to produce sometimes a faint emargination in front; the depressed plications smaller than the others, and often becoming obsolete before reaching the beak." Hall, 1857.

Length 11 mm.; width 11 mm.

Specimens from the Keyser member have more numerous and finer plications than the typical form, in which respect they approach *R. formosa.* The shells are smaller and more globose than in the latter species.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Pinto, Cash Valley, Viaduct Cumberland, Tonoloway. NEW SCOTLAND MEMBER. Common at Devil's Backbone, Corriganville, Maryland; Keyser, West Virginia.

Collection.—Maryland Geological Survey.

RHYNCHOSPIRA FORMOSA Hall

Plate LXXII, Figs. 26-30

Waldheimia formosa Hall, 1857, 10th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 88.

Trematospira formosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 215, pl. xxxvi, figs. 2*a-t*, 1861.

Rhynchospira formosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 485, pl. xcv*a*, figs. 7-11, 1861.

Description.—"Shell longitudinally ovate. Ventral valve tapering towards the beak: beak prominent, rounded, arched or incurved, truncated at the apex by a round perforation, one side of which is formed by the deltidium. Dorsal valve gibbous, sometimes most prominent near the umbo: beak closely incurved beneath the opposite one. Surface marked by eighteen to twenty-two or twenty-three simple rounded or rarely subangular plications, two or three of which are much smaller and slightly depressed on the middle of each valve, so as to form a faint narrow sinus extending nearly or quite to the apex of the beaks, and giving a slight emarginate outline to the front. Surface marked by fine imbricating concentric lines of growth, which become strong lamellæ towards the margins of the shell: shell granulose." Hall, 1859.

Length 1.5 cm.; width 1.4 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Cash Valley, Tonoloway, Cookerly, ¼ mile east of Rush, Maryland; Keyser, West Virginia.

Collection.—Maryland Geological Survey.

[Maynard.]

Genus TREMATOSPIRA Hall[1]

TREMATOSPIRA SIMPLEX Hall ?

Plate LXXIII, Figs. 1, 2

Trematospira simplex Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 211, pl. xxviiia, figs. 2a-2f.

Trematospira simplex Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, pl. xlix, figs. 17, 18.

Description.—"Shell transversely elliptical or subrhomboidal, nearly once and a half as wide as long: hinge-line scarcely declining from the beaks; cardinal extremities rounded: valves moderately and almost equally convex, closely compressed at the latero-cardinal margins. Ventral valve having a well-defined mesial sinus, which extends more than half way from beak to base: beak elevated, scarcely incurved, and vertically truncated by a small perforation, between which and the hinge-line is a well-defined deltidium. Dorsal valve moderately convex in the middle, and slightly elevated towards the front of the shell: beak closely incurved beneath the deltidium of the opposite valve.

"Surface marked by four or five simple plications on each side of the center, two of which on the ventral valve are involved in the sinus; and three upon the opposite valve, the central one being broader and flattened towards the base: entire surface granulose or punctate, with faint indications of growth lines." Hall, 1859.

Length 9 mm.; width 12 mm.

Of this species but a single specimen has been seen. It is a sharp cast of the interior and is, therefore, a little more rounded posteriorly than is the case with the Tennessee specimens. The plications are sharply angular, simple, and none show any tendency to bifurcate. With more material it may prove to be distinct.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone.

Collection.—George M. Roeder.

[1] See Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 124.

TREMATOSPIRA MULTISTRIATA (Hall)

Plate LXXIII, Figs. 3, 4

Spirifer multistriata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 59, figs. 1-6.

Spirifer perforata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 60.

Trematospira multistriata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 209, pl. xxiv, figs. *3a-3f;* pl. xxviii*a*, figs. *5a-5f*.

Trematospira perforata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 208, pl. xxviii*a*, figs. *3i-3k*.

Retzia multistriata Billings, 1863, Geol. Can., p. 958, text fig. 458.

Trematospira multistriata Hall, 1867, Nat. Hist. N. Y., Pal., vol. iv, p. 276, text figs. 1-3.

Trematospira perforata Hall, 1867, *ibidem*, p. 276.

Trematospira multistriata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 126, text fig. 110, pl. xlix, figs. 9-14.

Trematospira perforata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, pl. xlix, figs. 5, 6.

Trematospira multistriata Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 43, pl. vi, figs. 1-4.

Trematospira multistriata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 315, pl. xxxviii, figs. 8-10.

Description.—" Shell transversely oval, or pentagonal with the angles rounded: ventral valve moderately convex towards the beak, with a broad (not sharply defined) sinus below, which often becomes obsolete before reaching the beak; beak abruptly incurved over the beak of the opposite valve: dorsal valve more convex than the opposite, the middle elevated in a broad scarcely defined lobe; beak closely incurved: hinge-line slightly declining on each side of the center, and rounded at the extremities; area narrow, strongly striated longitudinally. Surface marked by numerous fine striæ which bifurcate once or oftener between the beak and base of the shell, concentrically crossed by imbricating lamellæ. [Surface granulose.]" Hall, 1857.

In Maryland this characteristic Helderberg fossil does not attain the large size nor the abundant plicating of the New York full-grown examples. The southern examples agree better with the smaller forms of this species, which Hall named *T. perforata.* This form has the wider range, both geographic and geologic. However, there can be no doubt that the bundling of the plications, their number, and the general expression of *T. perforata* have no specific significance. This species grades into *T. multistriata,* the extreme development in size and plicating. The last-named feature varies in number from twenty-eight to forty-two, and the dorsal fold may be low and rounded or greatly elevated and rounded or subangular; the ventral sinus is always broad and pronounced, and may be regularly concave or subangular. The Maryland specimens have from twenty-five to thirty-six plications.

Length 1.5 cm.; width 2 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Devil's Backbone, Dawson, 21st Bridge, Maryland; Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

TREMATOSPIRA DEWEYI (Hall)

Plate LXXIII, Figs. 5-7

Waldheimia deweyi Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 89.

Trematospira (*Rhynchospira*) *deweyi* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 216, pl. xxxvi, figs. 3*a*-3*h*, 1861.

Parazyga deweyi Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 128, fig. 112, pl. xlix, figs. 40-46.

Description.—"Shell depressed subglobose, sometimes subquadrilateral with the sides curving, moderately compressed; valves nearly equal: ventral valve a little the most prominent towards the umbo, having a narrow faint sinus from near the beak to the front, where it sometimes produces a slight sinuosity; beak apparently not perforate, extending a little beyond the opposite beak, upon which it is closely incurved: dorsal valve symmetrically arched. Surface marked by about forty regular simple rounded striæ, crossed by indistinct lines of growth, and, near the front, occasionally by stronger imbricating concentric marks indicating interrupted stages of growth. [Shell granulose.]" Hall, 1857.

Hall and Clarke referred this species to their genus Parazyga, but as *T. deweyi* has no hirsute exterior and, further, because *T. equistriata* is referred by the same authors to Trematospira (both forms are very closely related), it seems better to refer both to the latter genus. *T. deweyi* is less transverse and more biconvex than *T. equistriata.*

Length 1.8 cm.; width 2 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Dawson, Corriganville, Cumberland, 21st Bridge.

Collection.—U. S. National Museum.

TREMATOSPIRA EQUISTRIATA Hall and Clarke

Plate LXXIII, Figs. 8, 9

Trematospira equistriata Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pl. xlix, fig. 47.

Description.—This species has not been described by Hall and Clarke. It differs from *T. multistriata* in being more equally biconvex, with a very much smaller sinus and no dorsal fold, and the plications are finer, simple, regular, and never fasciculate as in that species. Further, the anterior margin is emarginate and the outline diamond-shaped with the lateral ends rounded. There are six plications in the sinus with twenty-three on each side.

This species is distinguished from *T. deweyi* in being more transverse, less gibbous, with the ventral beak more incurved. It may turn out to be but a variety of *T. deweyi.*

Length 1.9 cm.; width 2.7 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Dawson, Corriganville, 21st Bridge, Maryland; Keyser, Cherry Run, West Virginia.

Collection.—U. S. National Museum.

Genus NUCLEOSPIRA Hall

NUCLEOSPIRA VENTRICOSA (Hall)

Plate LXXIII, Figs. 10-12

Spirifer ventricosa Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 57.

Nucleospira ventricosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 220, pl. xiv, fig. 1; pl. xxviii*b*, figs. 2-9, 14, 1861.

Description.—"Shell globose; valves almost equally convex: ventral valve having a narrow sinus extending down the center from beak to base; beak projecting above the other, strongly incurved and pointed (in many specimens the beaks are nearly equal); dorsal valve having a central depressed line, but less conspicuous than in the opposite valve; area very small, concave; surface marked by concentric lines of growth" and, "when perfect, covered with minute hair-like spines, which, when removed, leave a punctate surface." Hall, 1857.

Length 8 mm.; width 9 mm.

This species is readily confounded with small *N. elegans*. The outline and the convexity of the valves are not so reliable for distinguishing this species as is the dorsal elevation along the median portion of the valve. This part in *N. elegans* terminates in a sinus and is most marked in transverse specimens. Common in the New Scotland member.

Occurrence.—Helderberg Formation, Keyser Member. Moorefield, West Virginia. Coeymans Member. Devil's Backbone. New Scotland Member. Cumberland, North Mountain, Maryland; Cherry Run, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

Nucleospira elegans Hall

Plate LXXIII, Figs. 13, 14

Nucleospira elegans Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 222, pl. xxviii*b*, figs. 10, 11, 13 (? 12*c*, 12*d*, not 14 = *N. ventricosa*), 1861.

Description.—"Shell suborbicular, wider than long. Ventral valve gibbous, particularly towards the umbo, with a flattened or sometimes depressed mesial line down the center: beak elevated above that of the opposite valve, and incurved; area sometimes well defined. Dorsal valve depressed convex, somewhat gibbous towards the beak, with a narrow depressed mesial line above, which becomes a broad depression below, producing a gentle sinuosity in the outline of the front: beak small, closely incurved beneath the beak of the opposite valve. Surface of shell finely and beautifully punctate, and sometimes preserving remains of pilose covering." Hall, 1859.

This species, as a rule, is larger and decidedly more transverse than *N. ventricosa,* and is abundant in the New Scotland member.

The specimens from the Oriskany are of the transverse variety and are about twice as large as the normal New Scotland individuals.

Length 8 mm.; width 10 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Cash Valley. NEW SCOTLAND MEMBER. Cumberland, Maryland; Cherry Run, West Virginia. BECRAFT MEMBER. Cherry Run, West Virginia. ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—Maryland Geological Survey.

NUCLEOSPIRA SWARTZI n. sp.

Plate LXXIII, Figs. 15-17

Description.—Shell subcircular to transversely subelliptical in outline, subglobose. Breadth greater than length. Cardinal, lateral, and anterior margins rounded. Hinge-line shorter than the greatest width of the shell. Ventral valve convex, gibbous, greatest convexity about one-third the distance from the beak to the front; beak pointed and prominent, strongly incurved over that of the dorsal valve. In some individuals there is a faint undefined shallow sinus which may extend from the beak to the front, producing at the front a slightly emarginate appearance. Dorsal valve convex, less so than the ventral valve, approaching to depressed convex, point of greatest convexity about one-third the distance from the beak to the front; beak prominent and incurved under that of the ventral valve. Sometimes an indistinct mesial depression marks the anterior portion of this valve. Surface of both valves marked by indistinct concentric lines of growth which become more prominent towards the front where they become distinct concentric lamellæ.

This species is closely related to *N. elegans* from which it differs in being less transverse, its outline being more nearly subquadrate. It also differs in the lesser convexity and much less distinct sinus of brachial valve.

Dimensions: Large individuals 18 mm. wide, 16 mm. long.

It differs from *N. ventricosa* in being less globose, larger, the ventral valve much more convex than the brachial valve. The valves are of almost equal convexity in *Nucleospira ventricosa.*

Length 1.5 cm.; width 1.6 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cookerly, Devil's Backbone, Cash Valley, Maryland; Keyser, West Virginia.

Collection.—Maryland Geological Survey. [Maynard.]

Family CŒLOSPIRIDAE

Genus ANOPLOTHECA Sandberger emend.

In America these shells are usually known as Cœlospira and Leptocœlia. Schuchert[1] referred them all to Anoplotheca, holding that there is not sufficient difference between the American and European species to warrant generic or even subgeneric separation. Regarding Cœlospira and Anoplotheca Hall and Clarke state that "the only material difference, that can now be indicated between these forms, is one of greater geological than biological significance; the later, or middle Devonian forms (Anoplotheca) being more convex, more coarsely and sparsely plicated, and more strongly striated concentrically." Regarding Leptocœlia they write: "In general contour, structure of hinge, cardinal process, muscular scars, and internal septa, it agrees throughout with Anoplotheca and Cœlospira." *Leptocœlia flabellites* differs from *Cœlospira concava* "only in its greater size and coarser, simple plication of the surface." Certainly none of these differences are worthy of subgeneric rank. However, these shells can be divided into two natural groups on the basis of the contour of the dorsal shell. In one group it is concave, and in the other flat or convex. It is not known that the two groups blend, and there may be more significance in the form of the dorsal shell than can now be made out. For this reason the species may be arranged as follows:

Anoplotheca. Dorsal valve concave.
A. concava (Hall). New Scotland.
A. dichotoma (Hall). Oriskany.
A. equistriata Schuchert. Oriskany.
A. camilla (Hall). Oriskany and Onondaga.
A. lepida (Goldfuss). Middle Devonian of Europe.
A. venusta (Schnur). Middle Devonian of the Eifel.

Leptocœlia. Dorsal valve flat or convex.
L. acutiplicata (Conrad). Onondaga.
L. fimbriata Hall. Oriskany.
L. flabellites (Conrad). New Scotland to Onondaga.
L. infrequens (Walcott). Lower Devonian.

Leptocœlia hemispherica (Sowerby) Hall, *L. planoconvexa* (Hall), and *L. plicatula* (Hall) of the Clinton probably belong to a genus distinct from Anoplotheca and Leptocœlia.

[1] Bull. U. S. Geol. Surv., No. 87, 1897.

ANOPLOTHECA CONCAVA (Hall)

Plate LXXIII, Figs. 18, 19

Leptocœlia concava Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 107.

Leptocœlia concava Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 245, pl. xxxviii, figs. 1-7, 1861.

Cœlospira concava Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 42, pl. v, figs. 23-26.

Description.—" Shell ovate or suborbicular: ventral valve convex, elevated along the middle into a mesial prominence, which extends to the umbo; beak small, incurved beyond the hinge-line: dorsal valve [flattened] near the lateral margins, depressed in the middle, forming a shallow undefined sinus which is deeper in the center than at the front, and rapidly diminishes towards the umbo; beak straight: area small; foramen triangular and extending to the apex of the beak, sometimes closed below by a deltidium. Surface marked by fourteen to seventeen striæ, which sometimes bifurcate: the one on the middle of the mesial fold of the ventral valve is generally smaller than the others, giving a slightly grooved appearance along its center quite up to the beak." Hall, 1857.

Length 6 mm.; width 7 mm.

The Maryland specimens agree very well with New York material, and the only noticeable difference is that the former have fewer striæ, *i. e.,* from twelve to fifteen instead of from fourteen to seventeen.

Abundant in the New Scotland member of Allegany County.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville, Devil's Backbone, Dawson, Maryland; Cherry Run, West Virginia; Warren Point, Pennsylvania. BECRAFT MEMBER. Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

ANOPLOTHECA CONCAVA VAR. TONOLOWAYENSIS n. var.

Plate LXXIII, Figs. 20, 21

Description.—Shell small, ovate, greatest width at or near hinge-line. Ventral valve convex; mesial elevation pronounced near umbo, becoming less distinct anteriorly. Umbo quite elevated, beak small, incurved over dorsal valve. Dorsal valve convex on sides, having a deep mesial sinus which begins at beak and broadens toward front. Surface of ventral valve bearing in center a small plication which extends only part way to umbo; five plications occur on each side, those next center being stronger and elevated. Dorsal valve bearing one or two short median plications and about five stronger plications on each side.

Length 4 mm.; width 4 mm.

This small shell closely resembles *A. concava* of the New Scotland, but differs in its more ovate shape. The differences, however, are hardly more than varietal.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway, 227 feet above base of formation.

Collection.—Maryland Geological Survey.

[Swartz.]

ANOPLOTHECA EQUISTRIATA n. sp.

Plate LXXIII, Figs. 22, 23

Description.—This species resembles young or small *A. flabellites,* but differs in having a concave dorsal valve and no fold or sinus on either shell. Each valve has from eleven to thirteen simple, equal, subangular plications. The interspaces are as wide as the plications.

Length 8 mm.; width of the largest example 9 mm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—George M. Roeder.

ANOPLOTHECA DICHOTOMA (Hall)

Plate LXXIII, Figs. 24-26

Leptocœlia dichotoma Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 452, pl. ciii*b*, figs. 3*a*-3*c*.

Leptocœlia dichotoma Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 137.

Anoplotheca dichotoma Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, p. 144.

Cœlospira dichotoma Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 42, pl. v, figs. 27-32.

Anoplotheca dichotoma Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 358, pl. xlix, figs. 3-6.

Description.—"Shell oval ovate, concavo-convex. Ventral valve arcuate, strongly convex, or approaching to subcarinate in the middle and abruptly sloping at the sides; beak incurved. Dorsal valve concave, more abruptly depressed in the center, and flattened on the cardino-lateral margins. Surface marked by dichotomizing plications; the central one of the dorsal valve becoming tripartite, and the three lateral ones, which are simple at the origin, bifurcating and making six at the margin of the shell: on the ventral valve there are two smaller plications in the center, and four dichotomizing ones on each side; concentrically marked by a few imbricating lines of growth." Hall, 1859.

This species is the Oriskany continuation of *A. concava* of the Helderberg, but is readily distinguished from it by the greater size which is from two to three times larger, the greater number of plications and the less concave dorsal valve. The plications are not always decidedly dichotomous, some specimens having them quite regular, as in *A. concava.*

Length and width about 10 mm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. North Branch.

Collections.—Maryland Geological Survey, American Museum of Natural History, U. S. National Museum.

Subgenus LEPTOCŒLIA Hall

ANOPLOTHECA (LEPTOCŒLIA) FIMBRIATA (Hall)

Plate LXXIII, Figs. 27, 28

Leptocœlia fimbriata Hall, 1859, Twelfth Ann. Rept. N. Y. State Cab. Nat. Hist., text fig. 3, p. 33.

Leptocœlia fimbriata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 450, pl. ciii*b*. figs. 2*a*-2*f*.

Leptocœlia fimbriata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 137, pl. liii, figs. 47-52, 54, 55.

Description.—"Shell small, longitudinally semielliptical, the length less than the width. Ventral valve convex, more elevated along the middle, declining regularly at the sides, the cardinal angles somewhat compressed: beak small, little elevated above the cardinal line and slightly incurved, with a minute rounded foramen at the extremity, the lower side of which, when entire, is completed by two small deltidial pieces. Dorsal valve flat or slightly convex, the front and lower lateral margins abruptly inflected: beak straight; hinge-line of the ventral valve more declining, with border often grooved for the reception of the edge of the dorsal valve. The hinge-line of closed valves often ornamented by fibers or fimbria, forming a byssus-like appendage.

"Surface marked by about eleven or twelve rounded or subangular plications on each valve, two of which, in the middle of the ventral valve, are more prominent and slightly larger than the others; and between these there is a third (usually) smaller depressed plication, with a shallow sinus below the middle of the shell. On the dorsal valve the two central plications, below the middle, are a little stronger and more widely separated from the lateral ones, rising in front into a slight mesial elevation. When seen from the front, the margin of the shell presents a very distinct sinus, with a corresponding projection of the opposite valve, the entire margin being deeply serrate. The finer surface markings are mostly obliterated, some imbricating lines of growth alone remaining. The fimbriated appendage along the hinge-line has been observed in so many specimens, that I can only suppose it to belong to the animal economy. The remains of this appendage are sometimes observed upon the inner margins of the separated valves." Hall, 1859.

A. fimbriata is undoubtedly a local variation of the very widely distributed *A. flabellites,* but is a good species and may be recognized by the following characters: *A. fimbriata* never attains the size of *A. flabellites,* the plications are less angular and more depressed, causing the ventral sinus to be nearly obsolete and the two median plications of the dorsal valve less elevated anteriorly. The dorsal valve is flat with the lateral and anterior margins narrowly but rapidly rounded to meet the ventral shell. The cardinal angles are also more rectangular, and this becomes a pronounced feature when the cardinal fimbria are preserved.

The posteriorly directed cardinal fimbria are a peculiar feature of this species and are unlike any other outgrowth similarly situated in brachiopods. They are developed from both valves and each plate is concave to permit the opening and closing of the valves. Each plate seems to be made up of a bundle of filaments, and it is this feature that warrants the conclusion that their presence is due to the postero-lateral setæ and extensions of the pallium. Of course the setæ could not deposit the calcareous matter to form the fimbria, but this was accomplished by extensions from the pallium, as were the cardinal spines of Chonetes and the ventral spines of Productus.

Length 11 mm.; width 12 mm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, North Branch, Collier's Run.

Collections.—Maryland Geological Survey, U. S. National Museum, American Museum of Natural History.

ANOPLOTHECA (LEPTOCŒLIA) FLABELLITES (Conrad)

Plate LXXIII, Figs. 29-33

Atrypa flabellites Conrad, 1841, Fifth Ann. Rept. N. Y. Geol. Surv., p. 55.
Leptocœlia flabellites Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 449, pl. cvi, figs. 1*a*-1*f*; pl. ciii*b*, figs. 1*a*-1*f*, 1861.
Anoplotheca flabellites Schuchert, 1897, Bull. U. S. Geol. Surv., No. 87, pp. 144, 145.

Description.—"Suborbicular, compressed; ribs about thirteen, rounded; the two middle ribs of the flat valve largest and rectilinear rather distant at the base from the others, and separated by a deep interstice which produces a sinuous margin; middle of inferior valve depressed towards the base, the three middle ribs larger than the others." Conrad, 1841.

"Shell somewhat semielliptical, varying to suborbicular or transversely oval, generally broader than long. Ventral valve convex, most prominent along the middle, declining laterally: beak incurved, with a small round perforation in the extremity, which is completed on the lower side by the two deltidial pieces; or, in the absence of these, the foramen is completed by the umbo of the dorsal valve. Dorsal valve flat: beak straight; hinge sloping from the beaks at an angle of 110° to 160°, rounded at the extremities. Surface marked by ten to fourteen simple angular plications; two of which, on the middle of the ventral valve, are a little larger and slightly more prominent than the others; and, between these, there is a third smaller depressed plication, forming an indistinct sinus. On the dorsal valve the two middle plications are a little closer together, and slightly more prominent near the front, than the others; while the depressions separating them from these, each side, are a little wider and deeper than those between the other plications." Hall, 1859.

This well-known and prolific species has a very extended geographic distribution in both hemispheres, especially in eastern North America and at many places in Bolivia, Brazil, the Falkland Islands, and in South Africa. Its geologic distribution is also extensive. Near Cherry Run, West Virginia, the writer collected two small examples in the New Scotland zone and two medium-sized specimens in the Becraft. In no way, other than in size, are these distinguishable. In the Lower Oriskany of western Maryland, at many localities, this species is the commonest fossil, and it occurs throughout not only this division but the Upper Oriskany as well. From the latter horizon come the best specimens and often in considerable numbers.

Length 1.6 cm.; width 1.8 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cherry Run, West Virginia. BECRAFT MEMBER. ORISKANY FORMATION, SHRIVER MEMBER. Common. RIDGELY MEMBER. Common.

Collections.—Maryland Geological Survey, U. S. National Museum, American Museum of Natural History.

Family MERISTELLIDAE

Genus WHITFIELDELLA Hall and Clarke

WHITFIELDELLA (?) PROSSERI Grabau

Plate LXXIII, Figs. 34-36

Meristella lævis Whitfield, 1891, Ann. N. Y. Acad. Sci., vol. v, p. 510, pl. v, figs. 6 and 7.

Meristella lævis Whitfield, 1895, Ohio Pal., vol. vii, p. 411, pl. i, figs. 6 and 7.

Meristella lævis Sherzer, 1900, Geol. Survey Mich., vol. vii, p. 223, pl. xvii, figs. 6 and 7.

Whitfieldella cf. *lævis* Grabau, 1900, Bull. Geol. Soc. Amer., vol. xi, p. 369, pl. xxii, figs. 4*a-d*.

Whitfieldella prosseri Grabau, 1910, Michigan Geol. Surv., Publication 2, Geological Ser. 1, p. 152, pl. xxi, figs. 3, 8, 9, 12-13; pl. xxx, figs. 6-7.

Description.—" Shell of medium size, elongate, with strongly convex smooth valves. Pedicle valve arcuate from beak to base, greatest convexity in the umbonal region. Beak curved to a 90° angle with the edge of the valve apparently truncated by a circular foramen. The center of the valve is marked by a median depression which begins a short distance below the beak and extending forward gradually broadens without much deepening. Near the anterior end this sinus is gently rounded, sometimes almost flat bottomed. On the anterior end the sinus is marked by a slight rounded projection. Surface marked by concentric striæ which at intervals in some specimens become strong wrinkles near the front.

" On the interior the deltidial margins are supported by delicate dental septæ. These arise from the bottom of the valve on either side of the center and at first are inclined outwards for about one-half their height and then turn rather abruptly upwards making a marked angle. Near the upper end they bend outward again to the margins of the delthyrium.

" At the lower angle a thin short plate springs outward and upward connecting the septum with the shell. This plate is marked in the internal mold by a pronounced slit, cutting the mold of the lateral rostral chambers. The aspect of the whole is that of a broad spondylium resting on the bottom of the valve and supported laterally by the secondary lamellæ. Anteriorly the dental lamellæ extend as low, slightly outward curving ridges, which between them enclose a longitudinally striated muscular area.

" Brachial valve subquadrangular, the width slightly greater than the height; somewhat less convex than the pedicle valve, and regularly arched without median fold. In some cases the faintest longitudinal depressions occur near the front, in the lateral third of the slope, thus giving a suggestion of a median fold. The beak projects slightly above the cardinal line, being incurved. The postero-lateral margins are more or less regular curves, the antero-lateral ones have their outline curved to a larger radius thus making the sinus appear rather truncate. The anterior margin is slightly emarginate corresponding to the projection of the pedicle valve. Surface marked by lines of growth and in some specimens by irregular wrinkles. On the interior a strong sharp septum extends from the beak to something over one-third the distance to the front. Just below the beak it divides at the top, carrying a small but pronounced spondylium (cruralium). The sides of the spondylium curve out to the margin of the shell, joining it about one-half way between the elongate, narrow dental socket, and the beak.

"A characteristic pedicle valve measures: Length 25 mm.; height 20 mm.; greatest width 16.25 mm." Grabau, 1910.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cherry Run, West Virginia.

Collection.—Maryland Geological Survey.

[Maynard.]

WHITFIELDELLA (?) NUCLEOLATA (Hall)

Plate LXXIII, Figs. 37-40

Atrypa nucleolata Hall, 1852, Nat. Hist. N. Y., Pal., vol. ii, p. 328, pl. lxxiv, fig. 10.

Merista nucleolata Hall, 1859, 12th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 78.

Meristella nucleolata Whitfield, 1882, Geol. Wis., vol. iv, p. 321, pl. xxv, fig. 5.

Description.—"Shell round oval or oval ovoid; beak of the dorsal valve often much extended, and incurved over the ventral valve; surface concentrically striated; front of the shell indented, the indentation connected with a depression or groove down the center of the dorsal valve, and sometimes a similar one on the lower half of the ventral valve. This species approaches very closely the *A. nitida* of the Niagara group, but is less elongated, and the identation in front and the groove down the center of the dorsal valve are more conspicuous in the species from the Coralline limestone. There are sometimes, however, specimens which do not possess these characters, and the shell is then not easily distinguished from those in the Niagara group." Hall, 1852.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—Robert Gordon.

[Maynard.]

WHITFIELDELLA (?) MINUTA n. sp.

Plate LXXIII, Figs. 41, 42

Description.—Shell small to minute, elongated in a direction from beak to base, giving to the shell a somewhat subovate outline. Both valves strongly convex, gibbous to somewhat ventricose, lateral and antero-lateral margins regularly rounded, cardinal margins convex, but these curves are sharper than the curves of the anterior margin. Ventral valve the longer, convex, gibbous to subventricose. Greatest convexity just posterior to the middle of the valve. Beak slightly incurved, prominent, pointed, extending beyond that of the dorsal valve. Dorsal valve regularly convex, gibbous, greatest convexity in the umbonal region; beak pointed, incurved, filling the delthyrium of the ventral valve. Surface smooth or marked by very faint obscure concentric lines of growth and on exfoliated individuals fine silk-like striations radiate from the beak. No fold or sinus on either valve. In some individuals the anterior portion is prolonged into a modified linguiform extension, while in other individuals the anterior margin is rounded.

Size of largest individual 3 mm. long and 2 mm. wide.

This species is distinguished by its minute size. There is no fold or sinus on either valve.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Roundtop.

Collection.—Maryland Geological Survey.

[Maynard.]

Genus MERISTELLA Hall[1]

The species of this genus are readily divided into two groups according to the development of the fold and sinus. In the group with the oldest representatives, which is also the one with the greatest number of species, the ventral sinus becomes more and more accentuated in younger formations, while the anterior portion of this valve is tongue-shaped and may

[1] For an emended description of this genus, see Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, p. 73.

extend far upward into the dorsal fold. The median portion of the dorsal valve is elevated or ridged and toward the anterior margin may or may not bend ventrally, but usually remains nearly plane when the ventral shell extension rises to meet this ridge. This is the *M. arcuata* group. Besides this species there are in the Helderberg and Oriskany *M. arcuata atoka, M. blancha, M. lata, M. lenta, M. lentiformis, M. prænuntia* (Keyser), *M. princeps, M. rostellata, M. subquadrata,* and *M.* (?) *vascularia.*

The second section is devoid of the dorsal arcuation and the ventral sinus is rarely well developed. This is the *M. lævis* group and embraces *M. bella, M. lævis, M. symmetrica, M. walcotti, M. gigantea,* and *M. whitfieldi.*

MERISTELLA PRÆNUNTIA n. sp.

Plate LXXIII, Figs. 43-46; Plate LXXIV, Figs. 1-4

Description.—This species is prenuntial of *M. arcuata* Hall and *M. arcuata atoka* Girty[1] of the New Scotland member. Its variations are many—even forms with rudimentary plications occur—but none appear from which *M. lævis* could have developed. All are somewhat arcuated and an occasional specimen is present that could be readily regarded as a small *M. arcuata.* However, the many variations of *M. prænuntia,* all of which are united by intermediate forms, prevent the reference of this Keyser material to *M. arcuata.*

The characters of *M. prænuntia,* when contrasted with *M. arcuata,* are uniformly smaller growth, less dorsal arcuation almost always greater elongation (often there is a linear dorsal sinus extending almost to the beak), and the presence in many specimens of rudimentary plications. The ventral sinus is also apt to be angulated or sharply bounded laterally, sometimes quite so, and in such specimens the dorsal linear sinus is also more prominent, causing the anterior margin to be slightly notched. The angulation of the ventral sinus is carried to an extreme in the Indian Territory *M. arcuata atoka,* which has a decidedly notched anterior margin.

[1] Nineteenth Ann. Rept. U. S. Geol. Surv., 1899, p. 567, pl. lxxi, figs. 1*a*-1*f*.

M. prænuntia is undoubtedly derived from the Keyser *W.* (?) *prosseri*, which also has the linear dorsal sinus and subangulated ventral sinus. The latter, however, is always a smaller shell, is never arcuated dorsally, and there are no rudimentary plications. From the evidence at hand, it would seem that *M. whitfieldi* varied in two main directions, first towards elongation, rotundity, and reduction of the ventral sinus, resulting in *M. lævis* and *M. bella.* The other line tended to accentuate the ventral sinus, to obliteration of the linear dorsal sinus by arcuation of this region, and to a more subquadrate outline of the shell, resulting in the *M. arcuata* group.

Length 1.8 cm.; width 1.8 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Abundant. Keyser, West Virginia; Dawson, Corriganville, Tonoloway, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

MERISTELLA ARCUATA (Hall)

Plate LXXIV, Figs. 5-8

Merista arcuata Hall, 1857, Tenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 95, figs. 1-4.

Merista arcuata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 249, pl. xli, figs. 1*a*-1*f*, 1861.

Meristella arcuata Hall, 1867, *ibidem*, vol. iv, p. 298, text figs. 1, 2.

? *Merista lævis* ? Meek and Worthen, 1868, Geol. Surv. Ill., vol. iii, p. 376, pl. vii, figs. 8*a*-8*c*.

Meristella arcuata Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pl. xliii, figs. 1, 2; pl. xliv, fig. 5.

Description.—" Shell broad-ovate, sometimes transversely oval. Ventral valve longitudinally arcuate, gibbous in the central and umbonal region, having in front a shallow rounded depression scarcely reaching the middle of the valve; front margin (in old specimens) elevated and fitting into the broad rounded sinus of the opposite valve. Dorsal valve often abruptly elevated along the middle and sloping laterally, having no distinct mesial fold; beak incurved. Surface smooth, or marked by faint concentric lines and occasional stronger wrinkles of growth." Hall, 1857.

This species, as a rule, is subquadrate in outline, but sometimes is conspicuously elongated. The latter variety is usually referred to *M. lævis,* but there is a character by which *M. arcuata* is readily distinguished from that species, as well as from *M. bella* and *M. whitfieldi.* This feature is the extension of the deep and broad ventral sinus dorsally to meet the median elevated portion of the dorsal valve.

In Maryland *M. arcuata* occurs typically, and associated with it at Corriganville has been found one elongate form that was at first mistaken for *M. lævis.* It is, however, an arcuate form. It is this elongate, arcuate variety that Meek and Worthen also described and figured as *M. lævis* Vanuxem (?).

Length 2.8 cm.; width 3 cm.

This species occurs in profusion in the New Scotland limestone wherever these strata are exposed. A few localities only are given in the following paragraph:

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone, Corriganville, 21st Bridge, Maryland; Cherry Run, West Virginia; Warren Point, Pennsylvania. BECRAFT MEMBER. Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, New York State Museum, U. S. National Museum.

MERISTELLA LATA (Hall)

Plate LXXIV, Figs. 9-11

Merista lata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 431, pl. ci, figs. 3*a*-3*m*, 1861.

Meristella lata Hall and Clarke, 1893, *ibidem*, vol. viii, pt. ii, p. 78, pl. xliv, fig. 12.

Description.—" Shell subovate or subquadrate, sometimes longitudinally oval. Ventral valve longitudinally arcuate, gibbous in the middle, the greatest convexity about halfway from beak to base, with a shallow depression in front which extends upwards not more than one-third the length of the valve, and is not seen in young specimens: beak elevated and closely incurved over the opposite one. Dorsal valve abruptly elevated in the middle, and somewhat flattened at the sides.

"Surface marked by a few strong lamellæ indicating periods of growth, and by finer parallel striæ; while the entire surface is covered by faint radiating striæ. The casts of this species, in the dorsal valve, show the mark of a median septum reaching more than halfway to the base. The muscular impressions in the cast of the ventral valve are large and strongly defined." Hall, 1859.

This species shows considerable variation in outline, in the development of the sinus, and the prominence of the dorsal fold. Some specimens are less transverse than is typical, the sinus may be nearly obsolete and the dorsal fold in the anterior region considerably reduced. Such specimens approach *M. symmetrica,* but none have been seen that are so symmetrical as that species. As a rule, however, *M. lata* is readily distinguished from the associated transverse forms by its large size, broad shallow ventral sinus, and the ridged dorsal shell.

This widely distributed and common Oriskany Meristella is found usually as internal casts.

Length 3 cm.; width 2.8 cm.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Cherry Run, West Virginia. ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Maryland; Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, American Museum of Natural History.

MERISTELLA LENTIFORMIS Clarke

Plate LXXIV, Figs. 12, 13

Meristella lentiformis Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 44, pl. vi, figs. 5-11.

Description.—"Shell unequally convex; outline transversely oval; pedicle valve with short incurved beak and narrow cardinal slopes bordered by obtuse cardinal ridges diverging from the beak. Umbo slightly convex or flat, the surface sloping to the sides very gradually. A median sinus starts at the umbo and rapidly broadens, producing a general depression in the pallial region, which is rather sharply deflected. The sinus is produced into a lingulate extension at the anterior margin. The general flatness of this valve is more marked in young shells, the anterior deflection becoming prominent with the increase of age. The brachial valve has a full beak curved into the delthyrium of the opposite valve, and is elevated medially into a broad ridge-like concavity terminating in a fold on the anterior margin. The lateral slopes are gently concave. The surface of both valves is smooth or bears only concentric growth lines.

"On the interior the apophyses and impressions are those characterizing the genus. Particularly well developed is the broad, flabellate, muscular scar of the pedicle valve and the median septum of the brachial valve, extending for more than half the length of the shell. The brachial valve resembles in its less extreme conditions that of the associated specimens of *M. lata,* but the shell taken in its entirety cannot be confounded with any other species." Clarke, 1900.

M. lentiformis is generally much smaller than *M. lata.* It is also far more transverse, the ventral sinus more pronounced with the tongue-shaped extension more protruding into the dorsal fold, and the dorsal umbo more suddenly heaped than in *M. lata.* In the Lower Oriskany the specimens are all small, but in the Upper Oriskany they attain a width of 30 mm. and a length of 25 mm.

Occurrence.—Oriskany Formation, Shriver Member. North Branch, common, Winchester Road near Cumberland, common. Ridgely Member. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Meristella rostellata n. sp.

Plate LXXIV, Figs. 14, 15

Description.—Shell attaining a large size, elongate, rostrate, and sinuate. Outline variable from elongate oval to subquadrate, with the greatest width in the anterior third. Anterior margin a little drawn out into a lingulate extension owing to the ventral sinus. Ventral valve depressed convex except in the rostral region, which is very convex, and the large beak incurved over the dorsal shell; sinus narrow, shallow, and defined only in the anterior third, terminating in a short but well-defined lingulate extension. Dorsal valve decidedly rectangular posteriorly, regularly convex excepting in the anterior third, where it is modified by a depressed convex and narrow medial fold. Surface usually marked by strong varices of growth. Interior characters very much like those of *M. lata*.

As a rule, species of Meristella are very variable in form, and this is the case with *M. rostellata*. However, the elongate form will separate it from *M. lata*, and the presence of a fold and sinus distinguish it from *M. symmetrica*. *M. walcotti* is a more obese species and less wide in the anterior region than *M. rostellata*. *M.* (?) *vascularia* agrees in shape very well with this species, but differs in not having the great incised muscular pit of most Meristellas. *M. princeps* of the New York Becraft zone seems to be the nearest in form, but the sinus and fold are far more pronounced.

Length 5 cm.; width 4.5 cm.

Difficulties are always experienced in identifying small or immature specimens of large Meristellas, and this is particularly the case with *M. rostellata*. Some specimens will undoubtedly be mistaken for small elongate individuals of *M. lata*, and because of the imperfect preservation one cannot be certain of their reference to either species. With mature examples there need be no great difficulty.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

MERISTELLA SYMMETRICA n. sp.

Plate LXXIV, Figs. 16-19

Description.—The large size, thin shell, nearly round outline, symmetrical and regularly biconvex form, without fold or sinus, distinguish this species from the associated Meristellas. Some specimens are more elongate than others, but none can be said to be elongate. The average size is 38 mm. long by 35 mm. wide, but a specimen found by Mr. Gordon measures 60 mm. in length by 60 mm. in width. The ventral muscular pit is somewhat narrower and less deeply excavated than in *M. lata*.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus MERISTA Suess

MERISTA TYPA (Hall)

Plate LXXIV, Figs. 20-24

Camarium typum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 487, pl. xcv*a*, figs. 2*a*, 3, 5, 6, 1861.

Camarium elongatum Hall, 1859, *ibid.*, p. 488, pl. xcv*a*, fig. 4.

Merista typum Hall, 1860, 13th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 93, figs. 10-13.

Merista typa Hall and Clarke, 1893, Nat. Hist. N. Y., Pal., vol. viii, pt. ii, pl. xlii, figs. 7-12.

Description.—"Shell short-oval or subelliptical, length but little greater than the width, very ventricose or subglobose. Ventral valve much the larger, extremely arcuate, the curvature from beak to base being somewhat more than half a circle; most gibbous on the umbo and near the front, which is bent abruptly upwards, and produced into a broad rounded extension: beak incurved, thin and pointed; umbonal slopes sharply angular, subparallel to the cardinal margin, with a moderately broad, smooth and slightly concave space between; foramen large, triangular, reaching nearly to the extremity of the beak. Dorsal valve most gibbous on the umbo, elevated in front into a prominent mesial fold; the sides curved downwards, and produced to meet the receding edges of the opposite valve: beak rather large, incurved beneath the opposite beak, and apparently filling its foramen. The interior of the ventral valve has a deep large rostral cavity, and a more or less highly arched transverse septum, which, rising from beneath the rostral cavity, extends to near the middle of the valve, and reaches about two-thirds across its transverse diameter. From the bases of the dental plates, rise two diverging thickened elevated ridges, which extend to the sides of the arching septum, and, uniting with it, gradually die out upon its surface. Surface of the shell, when sufficiently well preserved, bears evidence of faint radiating striæ." Hall, 1859.

Length 2.5 cm.; width 2.1 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Cash Valley, Viaduct and Market Street Bridge Cumberland.

Collection.—Maryland Geological Survey.

MOLLUSCA[1]

CLASS PELECYPODA

Order PRONODESMACEA

Section PALAEOCONCHA

Family GRAMMYSIIDAE

Genus GRAMMYSIA Verneuil

GRAMMYSIA sp. ?

Plate LXXV, Fig. 1

Description.—An incomplete individual, evidently belonging to this genus has been found in the Keyser member. It is the only representative of the genus that has been found in the state. The specimen being broken off just posterior to the beaks prevents determination but it probably is a new species.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

[Maynard.]

Section SCHIZODONTA

Superfamily PTERINACEA

Family PTERINEIDAE

Genus PTERINEA Goldfuss

PTERINEA HALLI Clarke

Plate LXXVIII, Figs. 11, 12

Avicula securiformis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 290, pl. liii, figs. 11-14, 1861.
Pterinea halli Clarke, 1903, Bull. N. Y. State Mus., No. 5, p. 495.

Description.—"Shell subrhomb ovate, slightly oblique; length and height varying from nearly equal, to the height one-fourth greater than

[1] The authors responsible for the text of the Mollusca are indicated for each species.

the width, moderately convex in the middle and on the umbo: anterior margin long, slightly concave above and curving to the base; posterior margin below the sinus, somewhat abruptly curving into the broad rounded basal margin: anterior wing small, trigonal, subacute, distinctly separated by a sinus from the body of the shell; posterior wings large, subacute at the extremity, not strongly distinct from the body of the shell, extending as far as, or a little beyond, the margin of the shell; marginal sinuosity long and shallow. Surface marked by moderately strong radiating costæ and strong elevated concentric striæ." Hall, 1859.

To this species is referred a fragment which has the sculpture and outline, as far as this latter can be made out, of Hall's species. It is freely admitted that such reference is a mere conjecture.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

Genus LEPTODESMA Hall

LEPTODESMA ? sp.

Plate LXXV, Fig. 2

Description.—Three incomplete internal casts whose outlines and other characters cannot be made out with certainty are tentatively referred to this genus. The ligamental area is long and wide and longitudinally striated. Beneath the beaks are several fine transverse teeth, and posterior to the beak is a hinge margin evidently corresponding to a tooth in the shell. The anterior extremity seems to be neither nasute nor auriculate. The anterior muscular impression is small and deep. In the cast the position of pallial line is marked anteriorly by a sharp ridge. A part of an exterior from the same rock mass shows the surface of the shell to be marked only by irregular concentric growth lines.

Length 5.5 cm.; height 4.5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Rock Enon Springs, Virginia.

Collection.—U. S. National Museum.

[Ohern.]

Family AMBONYCHIIDAE

Genus MYTILARCA Hall

MYTILARCA MARYLANDICA n. sp.

Plate LXXV, Figs. 3, 4

Description.—Shell inequivalve, slightly inequilateral, convex, depressed, subtrigonal in outline; anterior side concave beneath beaks, thence broadly rounded, antero-ventral margin truncate, posterior extremity sharply rounded to subangular. Beaks prominent, approximate. Left valve convex, the maximum inflation being in the umbonal region; right valve less convex, much depressed toward ventral side. Muscular markings and exterior ornamentation not seen.

Length 20 mm.; height 24 mm.

The specimen figured is a cast of the interior, the only individual seen. The truncation of the postero-ventral side seems due, in part at least, to poor preservation, and the irregularity in the outline of the anterior margin is caused by mechanical displacement of a portion of the cast. The precise horizon from which this species comes is unknown.

Occurrence.—HELDERBERG FORMATION. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

MYTILARCA CORDIFORMIS (Hall) ?

Plate LXXV, Figs. 5, 6

Megambonia cordiformis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 278, pl. 1, figs. 6*a*, *b*, 1861.

Description.—"Shell cordiform, extremely gibbous from the base upwards to the umbones, which are elevated and incurved, not compressed at the basal or lateral margins; anterior cardinal extremity slightly auriculate, the prominence covering the muscular impression small. Surface marked by concentric lamellose striæ." Hall, 1859.

Two specimens in the collection of Mr. George M. Roeder from an unknown horizon appear to belong to this species. In both specimens both valves are present. The individuals are smaller than Hall's figure but in other respects are very similar.

Occurrence.—HELDERBERG FORMATION. Cumberland.

Collection.—George M. Roeder. [Ohern.]

Subgenus PLETHOMYTILUS Hall

MYTILARCA (PLETHOMYTILUS) ROWEI n. sp.

Plate LXXV, Fig. 7

Description.—Shell equivalve; not strongly inequilateral; gibbous; broadly ovate; umbonal slope expanding somewhat rapidly from umbones to about one-fourth or one-third the length of the shell, then arching broadly and gently to the postero-basal margin, sloping gradually to the postero-dorsal and suddenly to the antero-basal margin; postero-dorsal margin almost rectilinear to about three-fourths the length of the shell, posterior extremity subcircularly rounded, basal margin broadly rounded, anterior margin rectilinear (?) to beak; beaks prominent, approximate. Surface of interior smooth, interrupted irregularly by broad, often discontinuous, concentric furrows. Hinge-line not seen.

Greatest length 73 mm.; greatest width 55 mm.

All the specimens seen are casts of the interior, but there is little doubt as to the generic affinities. The naming of the species is a humble compliment to the late Dr. R. B. Rowe.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Hancock.

Collection.—Maryland Geological Survey.

[Ohern.]

Genus AMPHICŒLIA Hall

AMPHICŒLIA ULRICHI n. sp.

Plate LXXV, Figs. 8-10

Description.—Broadly triangular subovate in outline. Length and height about equal. Valves equal, somewhat gibbous from the center to the beaks, sloping abruptly to the anterior margin, while the decline from the most gibbous portion of the shell to the posterior and ventral margins is more gradual, giving to the shell a cuneiform profile. The cardinal line arcuate. Cardinal slopes concave in the vicinity of the beak in the casts. Anterior and posterior cardinal margins and ventral margin regularly rounded. In the posterior portion of the shell at the point of greatest length, the shell is extended making the form inequilateral. The umbones in the better preserved individuals are equal and opposite, broad and gibbous, and are curved inward and forward over the hinge-line and placed considerably anterior to the middle. Surface of both valves marked by moderately strong radiating costæ. The costæ are low, rounded, and simple, six or seven occupying the space of 5 mm. in the umbonal region, the costæ are indistinct toward the base in the individuals at hand, but the general appearance indicates that they become wider toward the base. Shell varying in size from small individuals to quite large ones for this genus.

This species most closely resembles *Amphicœlia costata* (Hall and Whitfield) of the Niagara of Ohio. It differs, however, in being less ventricose, the beaks are more nearly central, and the costæ are more numerous.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

[Maynard.]

Family PINNIDÆ

Genus PALEOPINNA Hall

PALEOPINNA LATA n. sp.

Plate LXXVI, Fig. 1

Description.—Shell large, very oblique, axis and hinge-line making an angle of about 23°; greatest length to greatest height as about 3 to 4; anterior margin truncate and emarginate, ventral margin broadly and regularly curving, posterior margin more rapidly rounding and recurving to meet the hinge-line; left valve gibbous in middle and anteriorly, depressed posteriorly and dorso-posteriorly; right valve not known. Umbo wide, beak probably extending to posterior limit of body; a narrow ridge extending from beak (?) along hinge-line to posterior end of dorsal margin. Interior marked by broad obsolete growth lines. Exterior unknown.

Length 8.75 cm.; height 6 cm.

The description is from the cast of the interior of the left valve of a single specimen. It has all the marks of this genus and is readily separable from the other species of this genus by its great breadth. A part of the postero-dorsal extremity and of the beak is broken off.

Occurrence.—Oriskany Formation, Ridgely Member. Hancock.

Collection.—Maryland Geological Survey.

[Ohern.]

Family PTERIIDAE

Genus ACTINOPTERIA Hall

Actinopteria communis (Hall)

Plate LXXVI, Figs. 2-4

Avicula communis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 286, pl. lii, figs. 1-7; pl. liii, figs. 1, 4, 6, 1861.

Actinopteria communis Clarke, 1900, Mem. N. Y. State Mus., No. 3, vol. iii, p. 34, pl. iv, figs. 1, 2.

Actinopteria communis Weller, 1903, Pal. N. J., vol. iii, p. 292, pl. xxxi, fig. 21.

Description.—"Shell obliquely ovate; the left valve gently convex in the middle, and becoming gibbous towards the beak, which in the young shell is narrow and projecting above the hinge-line; right valve flat or gently concave in the middle and below, and becoming slightly convex on the umbo; anterior side gently curving to the base which is broadly rounded, the curvature of the posterior side being more abrupt: anterior wing small, trigonal, obtuse at its extremity, strongly defined from the body of the shell: posterior wing three times as long as the anterior wing, obtusely or subacutely pointed, extending more or less beyond the margin of the shell, concave on the outer or lateral margin, its junction with the body of the shell not strongly defined.

"Surface of the left valve marked by slender, sharply defined, rounded radii, the principal of which are distant from two to four or five times their width, and the spaces occupied by one, two or three finer interstitial radiating striæ (these radii are but faintly, and sometimes not at all perceptible on the posterior wing, except along its upper margin, while they are not seen on the anterior wing); concentrically marked by fine lamellose striæ, which, in the more perfectly preserved surfaces, are elevated and subimbricating: these striæ are usually conspicuous on both the anterior and posterior wings. Surface of the right valve marked by broader and scarcely elevated radii and less defined concentric striæ." Hall, 1859.

This species is rare in the Lower Devonian of Maryland. That it is subject to wide variations is apparent from Hall's figures, and it may be questioned whether that author has figured but one species. However, no further light can be obtained from the few Maryland forms.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland, Tonoloway ? COEYMANS MEMBER. Dawson, Corriganville. NEW SCOTLAND MEMBER. Dawson, Devil's Backbone. Horizon unknown. Miller's Spring, Cedar Cliff, West Virginia. ORISKANY FORMATION. Locality not known.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

ACTINOPTERIA COMMUNIS (Hall) var.

Description.—A few imperfect specimens from the Oriskany resemble in a general way *A. communis* (Hall). The left valve shows fine, alternating striæ, crossed by finer, concentric striæ, giving to the whole a cancellated effect which is somewhat more marked on the posterior wing. These specimens are very like those figured by J. M. Clarke under this species and may be wholly identical with them. It seems best, however, to designate them as a variety, but their fragmentary condition will not permit definition.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Winchester Road and Miller's Spring near Cumberland.

Collection.—Maryland Geological Survey.

[Ohern.]

ACTINOPTERIA TEXTILIS (Hall)

Plate LXXVI, Fig. 5

Avicula textilis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 288, pl. lii, figs. 9, 10 ?; pl. liii, figs. 2, 3, 5, 7, 10, 1861.

Actinopteria textilis Weller, 1903, Pal. N. J., vol. iii, p. 332, pl. xliii, figs. 13, 14.

Description.—" Body of the shell obliquely subovate; length about once and a half the height, becoming regularly convex from the base, gibbous in the middle, and gently depressed along the line of junction with the posterior wing; ventral margin very regularly and broadly curved; hinge-line greatly extended: posterior wing long, nearly three times its greatest width, the extremity extending beyond the margin of the shell, the margin moderately sinuate. Surface marked by regular strong radiating ribs, which, at the base, are distant from each other three times their width; the intermediate space marked by a central finer ray, and, on each side between it and the larger costæ, are one or two still finer rays, which are scarcely perceptible to the naked eye: these are crossed by concentric ridges, giving a cancellated surface and a slightly nodose character to the larger costæ. The wing is marked by strong radiating and concentric striæ, which are of nearly equal size, and slightly nodose at their junction." Hall, 1859.

Length 4.7 cm.; height 4.5 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cumberland, Dawson.

Collections.—Maryland Geological Survey, George M. Roeder.

[Ohern.]

ACTINOPTERIA TEXTILIS VAR. ARENARIA (Hall)

Plate LXXVII

Avicula textilis var. *arenaria* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 465, pl. cix, figs. 1, 2; pl. cx, fig. 2, 1861.

Avicula textilis var. *arenaria* Weller, 1903, Pal. N. J., vol. iii, p. 360, pl. l, fig. 1.

Description.—"Shell large, obliquely subovate; the proportions of length and height variable. Left valve becoming moderately and regularly convex from the base, the greatest convexity being about the first third below the hinge-line. Posterior wing large, extending along the margin of the body of the shell halfway from beak to base. Anterior wing small, triangular, wrinkled. The right valve is slightly concave, smaller than the other, faintly marked by the radiating ribs, which sometimes are scarcely seen. Surface marked by strong radiating ribs sometimes regularly dichotomizing and subequal, and in other specimens quite unequal, showing a few stronger ribs, with several finer ones between, and these are crossed by strongly elevated imbricating lamellæ." Hall, 1859.

Several specimens from the Oriskany of the state are referred to this variety. The close resemblance between *A. communis,* the typical *A. textilis* and the varietal form, casts doubt upon the identification of the forms as they occur in Maryland.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Warren Point, Pennsylvania; west side of Queen's Point opposite Keyser, Miller's Spring, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

ACTINOPTERIA VIRGINICA n. sp.

Plate LXXVIII, Figs. 1, 2

Description.—Body of the shell obliquely ovate, gibbous, maximum inflation about one-third the distance from the beak to the base. From this point the shell arches rapidly to the beak and gently to base; contracts rapidly on either side of the umbo near the beak and less so as the distance from beak increases; beaks not prominent; posterior wing not sharply separated from body, convex; anterior wing not seen; anterior extremity suddenly rounded, basal margin broadly and regularly arcuate, posterior extremity broadly rounded; surface of body covered by low, arched, radiating ribs, between which, toward the margin, finer ones are interposed; posterior wing unornamented. Hinge-line straight.

The description is from a cast of the interior of a left valve which is not quite complete. The species bears some resemblance to *A. recticosta* Hall, but the general outline and the character of the radiating ribs at once separate it. Another imperfect cast in the Maryland Geological Survey collection is doubtfully referred to this species. It is, however, more oblique, the large ribs are smaller and the small ones larger in proportion than the specimen described. It is not improbable that further collections will separate this as another species, the material now in hand not warranting such procedure.

Length 6.5 cm.; height 4.5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Near Fountain, four miles southwest of Keyser, West Virginia; Hancock, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

Actinopteria reticulata Weller

Plate LXXVI, Fig. 6

Actinopteria reticulata Weller, 1903, Pal. N. J., vol. iii, p. 245, pl. xxii, fig. 3.

Description.—"Left valve large, subrhomboidal in outline; the body subovate, with an obliquity of 27° between the hinge-line and the umbonal ridge; beak but slightly elevated above the hinge-line. Anterior margin nearly straight or slightly sinuate, forming a rounded angle of about 80° with the hinge-line; basal margin regularly curved; posteriorly it rounds more abruptly into the nearly straight or slightly sinuate posterior margin which is nearly parallel with the anterior margin. Posterior wing large, slightly convex, limited below by a moderately distinct, rounded sinus; the posterior cardinal extremity obtuse. The body of the shell is marked by conspicuous, concentric lines of growth and by more or less discontinuous, radiating costæ. Near the margin of the shell the concentric lines are more crowded and the radiating costæ are less conspicuous, but on the upper portion of the shell the two sets of markings give to the surface a nodose appearance. The posterior wing is marked like the body of the shell, but the radiating markings are much less conspicuous. Right valve unknown.

"The dimensions of the type specimen are: Height 35 mm.; oblique length from beak to postero-basal extremity 48 mm.; length of hinge-line 29 mm." Weller, 1903.

The individual specimen at hand is badly broken and consists of only one valve. The general character of the shell agrees with this species and the body of the shell is marked by conspicuous concentric lines of growth and by more or less discontinuous radiating costæ. There is little doubt as to the identification, although the individual is only in part preserved.

Occurrence.—Helderberg Formation, Keyser Member. Keyser, West Virginia.

Collection.—U. S. National Museum.

[Maynard.]

Genus AVICULA Klein

AVICULA RECTICOSTA Hall?

Plate LXXVI, Fig. 7

Avicula recticosta Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 466, pl. cix, fig. 3, 1861.

Description.—"Shell slightly oblique, subrhomboidal: hinge-line greater than the greatest width of the shell below; width equal to about once and a third the height, very moderately convex. Posterior wing large, extending nearly as far backwards as the posterior margin of the shell. Anterior wing smaller, triangular, slightly concave on the outside. Surface marked by strong dichotomizing subequal ribs, which proceed principally in pairs from the umbo to the margin of the shell. Posterior wing with fine radiating ribs and close concentric laminæ; the anterior wing being marked only by the concentric striæ." Hall, 1859.

To this species is referred, doubtfully, a single fragmentary individual.

Occurrence.—ORISKANY FORMATION. Locality unknown.

Collection.—Robert H. Gordon.

[Ohern.]

Section ISODONTA

Family PECTINIDAE

Genus AVICULOPECTEN McCoy

AVICULOPECTEN (?) CUMBERLANDENSIS n. sp.

Plate LXXVIII, Fig. 3

Description.—Shell subcircular, length and height about equal; slightly oblique; left valve gibbous, the maximum inflation being anterior to the center of the shell which curves thence steeply to the anterior, and much less so to the basal and posterior margins; anterior margins broadly sinuate at junction of anterior wing and the body of the shell, thence slightly convex outward to anterior extremity, thence the margin is almost semicircular to the posterior wing which is widely sinuate, the maximum excavation being at about two-thirds the distance from the extremity of the wing to the body of the shell; anterior wing small, concave; posterior wing large, convex, the extremity being nearly a right angle and on line with the posterior extremity of the body; hinge-line straight, equal to greatest width of shell. Surface of body ornamented with coarse, radiating ribs which are subequal on the anterior, and alternating on the central and posterior parts; the radiating ribs are crossed by finer concentric striæ and irregular growth lines; surface of posterior wing ornamented with alternating ribs which are somewhat finer than those of the body and crossed by concentric striæ, the two sets of markings giving a cancellated effect.

Right valve and interior not seen. The description is from a single left valve, which is figured. The label has been lost but the specimen is no doubt from the Helderberg as is shown by other fossils in the rock mass.

Length about 5 cm.; height 5.2 cm.

Occurrence.—HELDERBERG FORMATION. Locality unknown.

Collection.—Maryland Geological Survey.

[Ohern.]

AVICULOPECTEN TENUILAMELLATUS (Hall)

Plate LXXVIII, Fig. 4

Avicula tenuilamellata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 281, pl. li, figs. 1 and 2, 1861.

Description.—" Shell orbicularly subovate: left valve scarcely convex; right valve flat; hinge-line straight, shorter than the greatest width of the shell: anterior wing small, short, acute, separated from the body by a deep narrow sinus, not extending as far forward as the anterior margin of the shell; posterior wing short, broader than the anterior, acute at the extremity, not extending to the line of the posterior margin of the shell. Surface marked by a few unequal concentric wrinkles, and by fine, closely arranged, elevated, subimbricating, lamellose striæ, which extend over the wings in like manner. Central portion of the shell marked by faint radiating striæ." Hall, 1859.

This shell is cited by Hall as occurring in the Lower Helderberg rocks of Albany and Schoharie counties, New York. The individual at hand is a badly weathered left valve probably of this species.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

[Maynard.]

Section DYSODONTA

Superfamily MYTILACEA

Family MODIOLOPSIDAE

Genus MEGAMBONIA Hall

MEGAMBONIA LAMELLOSA Hall

Plate LXXVIII, Fig. 5

Megambonia lamellosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 467, pl. cix, figs. 5, 6, 1861.

Description.—"Shell obliquely ovoid, very gibbous in the middle and towards the umbo; the body of the shell rather abruptly narrowed above the middle. Anterior wing short, rounded, very convex, separated from the body of the shell by a broad rounded depression, leaving a sinus in the margin. Posterior wing broad triangular, extending more than two-thirds the entire length of the posterior slope; its junction with the body of the shell marked by a depression. Surface marked by concentric lamellose striæ, which, on some parts of the specimens, are very prominent. Faint remains of radiating striæ are sometimes perceptible on the casts." Hall, 1859.

It has been found only in the form of casts, but is not uncommon in the Oriskany of Maryland.

Length about 3.5 cm.; height 2.5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Queen's Point opposite Keyser, Miller's Spring, and Knobly Mountain, West Virginia; near Cumberland, Hancock, Maryland.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

Order TELODESMACEA

Superfamily CYPRICARDIACEA

Family PLEUROPHORIDAE

Genus CYPRICARDINIA Hall

CYPRICARDINIA CF. LAMELLOSA Hall

Plate LXXVIII, Figs. 6, 7

Cypricardinia lamellosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 266, pl. xlix*a*, figs. 1*a*, *b*, *c*, 1861.

Description.—" Shell subovoid, gibbous; umbones slightly elevated; anterior extremity abruptly rounded and extending little beyond the beak, somewhat contracted on the base anterior to the middle, with an undefined depression extending thence nearly to the umbones; posterior slope prominent, with a scarcely defined ridge; cardinal margin compressed, obliquely subtruncated above and rounded towards the base. Surface marked by strong elevated distant lamellæ; the surface of each one showing under a magnifier, distinct radiating striæ, and sometimes another set of striæ cancellating the first." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia.

Collection.—U. S. National Museum.

[Maynard.]

CYPRICARDINIA SUBLAMELLOSA Hall

Plate LXXVIII, Fig. 8

Cypricardinia sublamellosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 267, pl. i, fig. 1, 1861.

Description.—" Shell transversely elongated; anterior extremity contracted; umbones very depressed; posterior slope convex, without a defined ridge; extremity somewhat acutely rounded. Surface marked by rounded concentric striæ or ridges, which are more prominent on the posterior half of the shell." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone.

Collection.—Maryland Geological Survey.

[Ohern.]

INCERTAE SAEDES

Genus ILIONIA Billings

ILIONIA SINUATA (Hall)

Plate LXXVIII, Figs. 9, 10

Anatina ? sinuata Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 265, pl. xlix, figs. 3*a-d*, 1861.

Description.—"Shell thin, equivalve, compressed, inequilateral, subrhomboid, with the posterior side much wider than the anterior; posterior? rounded, much compressed near the extremity, with a distinct shallow groove extending from near the beak obliquely to the postero-basal margin, and a second broad groove extending from the hinge-line, immediately behind the beak, vertically to the base of the shell, each one producing a slight sinuosity in the margin of the shell: umbones vertical, or not perceptibly inclined to either side of the shell; anterior cardinal slope nearly flat, compressed and subalate. Surface concentrically marked with fine subimbricating striæ, which are undulated in passing over the depressed lines on the anterior side of the shell." Hall, 1859.

Several specimens from an unknown horizon in the Lower Helderberg are referred to this species but not without doubt. All are in the form of interior casts and none have the outline sufficiently complete to permit restoration. Nevertheless, from the entire collection enough can be gathered to show a very close resemblance to Hall's figures and description. The Maryland forms are in general much larger than those figured by Hall.

Occurrence.—HELDERBERG FORMATION. East of Martin Mountain, Allegany County, on road leading to Rush.

Collection.—Maryland Geological Survey.

[Ohern.]

CLASS GASTROPODA

Subclass STREPTONEURA

Order ASPIDOBRANCHIA

Suborder RHIPIDOGLOSSA

Family PLEUROTOMARIDAE

Genus PLEUROTOMARIA Defrance

PLEUROTOMARIA LABROSA Hall

Plate LXXX, Fig. 1

Pleurotomaria labrosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 339, pl. lxvi, figs. 1-5; pl. lvii, figs. 6*a*, *b*, 1861.

Description.—"Shell rhomboid ovate. Spire little elevated above the body of the shell: volutions three or four; the upper ones small and moderately increasing, the last one ventricose, much expanded on the outer side, and subangular: aperture broadly ovate; the columellar lip extremely thickened, the callosity extending to the outer lip. Surface marked by prominent spiral ridges with wider furrows between, and, on the upper part of the volution, by a broader band or groove, which is margined by carinæ: lines of growth marked by strong elevated lamellose striæ, which are undulated in passing over the spiral ridges; those marking the broader spiral band are less strongly elevated, and make a single retral curve, indicating the marginal sinus." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

Family BELLEROPHONTIDAE

Genus BELLEROPHON Montfort

BELLEROPHON CF. AURICULATUS Hall

Plate LXXIX, Figs. 1, 2

Bellerophon auriculatus Hall, 1852, Nat. Hist. N. Y., Pal., vol. ii, p. 334, pl. lxxvi, figs. 7*a*, *b*.

Description.—"Convolute; volutions somewhat flattened from the dorsal side; last volution rapidly enlarging; aperture expanded, curving outwards and nearly reflexed at the lateral angles. The remains of a carina, with arched striæ diverging therefrom, are visible upon the dorsal side." Hall, 1852.

Several specimens in the collection of Mr. Roeder are tentatively referred to this species. In general aspect they resemble Hall's figures very closely, but are much smaller. Precise horizon unknown.

Diameter of shell 1.5 cm.; of aperture 1.5 cm.

Occurrence.—HELDERBERG FORMATION. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

BELLEROPHON HELDERBERGIÆ n. sp.

Plate LXXIX, Figs. 3, 4

Description.—Convolute, volutions somewhat flattened dorso-ventrally; last volution expanding rapidly, aperture expanded. Umbilicus small. Dorsal carina pronounced. Surface ornamentation unknown.

This species differs from *Bellerophon auriculatus* in its more rapidly expanding volutions and distinct dorsal carina.

Diameter of shell 1.4 cm.; of aperture 1.5 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collection.—U. S. National Museum.

[Maynard.]

Genus CYRTOLITES Conrad

CYRTOLITES EXPANSUS Hall

Plate LXXIX, Figs. 5, 6

Cyrtolites ? expansus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 479, pl. cxiv, figs. 4, 5, 1861.

Cyrtolites expansus Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 28, pl. iii, figs. 20-23.

Description.—"Shell obliquely depressed conical; the apex incurved, but making scarcely or no more than, a single volution, very rapidly expanding from the apex; the body vantricose; subcarinate on the dorsum:

aperture nearly circular. Surface of cast marked by faint transverse ridges and finer longitudinal striæ." Hall, 1859.

". . . . characterized: 1 by the sharply concentric lamellæ of the surface; 2 by the broadly expanded aperture; 3 by the well-defined median ridge on the earlier parts of the shell, on which the striæ have a pronounced retral bend, the ridge being obsolete at the margin." Clarke, 1900.

In the collection of Mr. George M. Roeder is to be found the only entire specimen which the writer has seen from Maryland. The agreement with Hall's description is very exact.

Diameter of shell 6.2 cm.; of aperture 4.75 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Williams Road near Cumberland.

Collections.—Maryland Geological Survey, George M. Roeder.

[Ohern.]

Order CTENOBRANCHIATA

Suborder PLATYPODA

Superfamily GYMNOGLOSSA

Family PYRAMIDELLIDAE

Genus LOXONEMA Phillips

LOXONEMA FITCHI Hall

Plate LXXIX, Fig. 7

Loxonema fitchi **Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 296, pl. liv, figs. 9, 11*a*, *b*, 1861.**

Description.—" Shell subfusiform, very gradually attenuate: volutions seven or eight. Surface unknown." Hall, 1859.

Volutions broadly arched, wide, suture deeply impressed. A few imperfect casts which may be from the Helderberg agree well with Hall's description and figures. In the state of their preservation no further features can be observed.

Occurrence.—HELDERBERG FORMATION. Tonoloway.

Collection.—Maryland Geological Survey.

[Ohern.]

LOXONEMA sp.

Plate LXXIX, Fig. 8

Description.—Pyramidal, apical angle small; volutions convex, their height about two-thirds of their diameter. Sutures straight, moderately deep. Surface ornamentation unknown.

Length 25 mm.; diameter of largest volution 9 mm.

The generic relations of this species are unknown. It differs from *Loxonema fitchi* in its less oblique volutions. It resembles *Loxonema* sp. described by Weller[1] from the Decker Ferry of New Jersey.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley.

Collection.—Maryland Geological Survey.

[Maynard.]

Superfamily TAENIOGLOSSA

Family LITTORINIDAE

Genus HOLOPEA Hall

HOLOPEA sp.

Description.—A large specimen, coming from an unknown horizon in the Lower Devonian, was studied, which evidently belongs to this genus, but whose condition of preservation does not permit identification or description. In general aspect it is not unlike *H. antiqua*, but any attempt at further identification is hazardous till further collections are made.

Occurrence.—HELDERBERG FORMATION. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

HOLOPEA sp.

Plate LXXIX, Fig. 9

Description.—The large specimen figured represents a form which is referred with doubt to this genus. A part of the body whorl has been broken off, all surface features have been obliterated and the whole shell

[1] Pal. N. J., vol. iii, 1903, pl. xxii, fig. 11.

laterally compressed, thus making identification impossible. The writer is very much in doubt as to the horizon to which this specimen belongs.

Length 4 cm.; diameter 3.2 cm.

Occurrence.—Helderberg Formation. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

Genus ORTHONYCHIA Hall

Orthonychia tortuosa (Hall)

Plate LXXIX, Figs. 10-12

Platyceras tortuosum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 472, pl. cxiii, figs. 1-5, 1861.

Orthonychia tortuosa Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 30.

Platyceras tortuosum Weller, 1903, Geol. Survey N. J., Pal., vol. iii, p. 362, pl. xlix, figs. 13-17.

Description.—" Shell spirally ascending, making a little more than one free volution: volutions widely separated, very gradually increasing in size towards the aperture, which is scarcely expanded; peristome very oblique. A broad spiral fold sometimes marks the inner side of the spire." Hall, 1859.

Surface marked by irregular, undulating lamellæ, the undulations evidently marking the position of sinuses. As high as three distinct folds are observable on the interior of the spire.

Length 5 cm.; maximum diameter 3 cm.

Occurrence.—Oriskany Formation, Ridgely Member. Devil's Backbone, Hancock, Knobly Mountain near Cumberland.

Collections.—Maryland Geological Survey, Maryland Academy of Sciences.

[Ohern.]

Genus PLATYCERAS Conrad

Platyceras nodosum Conrad

Plate LXXIX, Figs. 13, 14

Platyceras nodosum Conrad, 1841, Ann. Rept. Pal. N. Y., p. 56.

Platyceras nodosum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 473, pl. cxv, figs. 1-6; pl. cxvi, figs. 1-4, 1861.

Platyceras nodosum Clarke, 1900, Mem. N. Y. State Mus., No. 3, vol. iii, p. 31.

Description.—" Subfalcate, with numerous thick obtuse nodes. This is a cast in the sandstone, and the shell was probably covered with spines. Length two inches." Conrad, 1841.

" Shell obliquely subovate: volutions contiguous, about two or three, very rapidly expanding from the apex; summit of the spire on a plane with, or a little above, the outer volution; aperture round. Surface marked by round obtuse nodes and strong interrupted or tortuous lamellose striæ." Hall, 1859.

This species in its typical form with well-marked nodes, has been found only in the Oriskany formation at Warren Point. However, several localities furnish specimens with irregular swellings. Such specimens are doubtfully referred to this species.

Diameter of shell 6.5 cm.; of aperture 5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, east side of Nicholas Mountain, Maryland; Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

[Ohern.]

PLATYCERAS GEBHARDI Conrad

Plate LXXX, Figs. 2-9

Platyceras gebhardi Conrad, 1840, Ann. Rept. N. Y. Geol. Survey, p. 206.
Platyceras gebhardi Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 312, pl. lvi, figs. 5*a*, *b*, 6, 7, 9; pl. lv, figs. 6*a*, *b*; p. 474, pl. cxvii, figs. 1-10, 1861.
Platyceras cf. *gebhardi* Clarke, 1900, Mem. N. Y. State Mus., No. 3, vol. iii, p. 30, pl. iii, fig. 29.
Strophostylus gebhardi Weller, 1903, Geol. Survey N. J., Pal., vol. iii, p. 318, pl. xxxix, figs. 1-3.

Description.—" Shell obliquely subovate or subglobose, somewhat gradually expanding, and becoming ventricose in the last volution. Spire composed of about four volutions, which are contiguous except the last one near the aperture, the apex being nearly in the plane of the outer volution: aperture expanded, campanulate, and sometimes with the lip reflexed. Surface marked by fine transverse undulating striæ, which are sometimes distinctly bent backwards along a line near the dorso-lateral curvature of the shell, or nearer to the middle of the summit, and rarely slightly carinated along this line. In a few specimens, distinct revolving striæ are seen cancellating the transverse striæ." Hall, 1859.

This is the most common species of gastropod in the Lower Devonian of the state. It varies widely in size and in the character of the apex which is sometimes above and sometimes below the plane of the body whorl. See further remarks under var. *ventricosum*.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain, Monster Rock, opposite Keyser, West Virginia; Nicholas Mountain, Hancock, Cumberland, Flintstone, Maryland; Warren Point, Pennsylvania. HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cumberland, Maryland; Cherry Run, Miller's Spring, West Virginia; Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

PLATYCERAS GEBHARDI VAR. VENTRICOSUM Conrad

Plate LXXXI

Platyceras ventricosum Conrad, 1840, Ann. Rept. Pal. N. Y., p. 206.
Platyceras ventricosum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 311, pl. lvi, figs. 1-4, 8; pl. lvii, fig. 4; p. 475, pl. cxviii, figs. 3-9, 1861.
Platyceras ventricosum Meek and Worthen, 1868, Geol. Survey Ill., vol. iii, p. 441, pl. ii, figs. 4*a*, *b*.
Platyceras ventricosum Nicholson, 1874, Rept. upon the Pal. of the Province of Ontario, p. 115, pl. ii, figs. 1, 1*a*.
Platyceras ventricosum Nettleroth, 1889, Kentucky Fossil Shells, p. 168, pl. xxv, fig. 10.

Description.—" Shell ventricose; aperture very large and campanulate; volutions three, contiguous, depressed below the upper margin of the whorl." Conrad, 1845.

" The shell is obliquely ovate spreading rapidly from the apex, and becoming extremely ventricose below; aperture campanulate; the lip in contact with the spire, and sometimes strongly reflexed. Surface marked by fine transverse or concentric lamellose striæ, which are somewhat undulated and rarely finely cancellated by faint, revolving striæ. Volutions contiguous throughout, or the last one free; peristome continuous or interrupted, free or in contact with the body volutions, sometimes abruptly expanded at the margin." Hall, 1859.

This variety is made a species by Hall. In the specimens from Maryland the difference between the typical *Platyceras gebhardi* and the variety is so slight that it cannot be regarded as of specific value. Indeed, it is extremely doubtful if even a varietal difference exists and the writer is of the opinion that further collections will show the complete identity of Hall's two species.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, east side Nicholas Mountain, Hancock.

Collection.—Maryland Geological Survey.

[Ohern.]

PLATYCERAS MAGNIFICUM Hall

Plate LXXXII, Figs. 1-6

Platyceras magnificum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 476, pl. cxix, figs. 1-6, 1861.

Description.—"Shell obliquely subovate. Spire depressed below the plane of the outer volution: volutions two or three, very rapidly expanding and becoming extremely ventricose below, usually free or with the first one contiguous; aperture expanded, subcircular, campanulate, and often with the margin reflexed, particularly on the left side. Surface marked by distinct transverse lamellose undulating striæ." Hall, 1859.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, east side Nicholas Mountain, Cash Valley, Maryland; Warren Point, Pennsylvania; Miller's Spring, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

PLATYCERAS SUBFALCATUM n. sp.

Plate LXXXII, Figs. 7, 8; Plate LXXXIII, Figs. 1-3

Description.—Shell subfalcate; whorls (of casts) one; very rapidly expanding from beak to aperture, becoming extremely ventricose, and suddenly contracting at the aperture; surface marked by low, distant, parallel, longitudinal undulations, sometimes becomes slightly nodulose; aperture subcircular; outer surface and peristome not seen. Found only as internal casts.

This species in the character of the undulations, bears some resemblance to *P. platystomum* of the Lower Helderberg of New York; but its shape and the constriction of the aperture show it to be distinct from other species of the genus.

Diameter of shell 4.5 cm. to 8 cm.; of aperture 3.2 cm. to 6 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Hancock.

Collection.—Maryland Geological Survey.

[Ohern.]

PLATYCERAS PATULUM Hall

Plate LXXXIII, Fig. 4

Platyceras patulum **Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 477, pl. cxix, fig. 3, 1861.**

Description.—"Shell subhemispheric. Spire forming about three volutions, which are usually contiguous, sometimes free, very rapidly expanding, the last one extremely ventricose and assuming a hemispheric form; apex much below the plane of the last volution. Aperture nearly circular; peristome much expanded upon the side of the body volution, and thickening below in the form of a columellar lip. Surface transversely striated." Hall, 1859.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—Frank Hartley.

[Ohern.]

PLATYCERAS REFLEXUM Hall

Plate LXXXIII, Figs. 5, 6; Plate LXXXIV, Figs. 1, 2

Platyceras reflexum **Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 477, pl. cxx, figs. 1-7, 1861.**

Description.—"Shell spiral, obliquely or arcuately subconical, spirally ascending; the apex consisting of one or two free, but closely approximating volutions; the body volution diverging, and spreading somewhat rapidly towards the aperture: aperture broad, the peristome often sinuous and sometimes abruptly expanded: volutions round or subangular, and rarely distinctly angular, with the aperture subquadrate. Surface transversely striate; the striæ sometimes bent abruptly backwards on the surface, indicating the existence of a marginal notch at some period of growth." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville. ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, east side Nicholas Mountain.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

PLATYCERAS ? CALLOSUM Hall

Plate LXXXIV, Figs. 3, 4

Platyceras ? (*Platyostoma* ?) *callosum* Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 478, pl. cxx, figs. 8*a*, *b*, 1861.

Description.—"Shell obliquely ovoid, ventricose. Spire consisting of about three volutions; the apex minute, and the first two volutions nearly in the same plane; the last volution expanding greatly below. Aperture suborbicular: peristome continuous, thickened and coalescing with the body volution at its lower side; the umbilical cavity closed by a callosity; the shell, approaching the aperture, becoming lamellose; the lamellæ elevated and imbricating. Surface marked by undulating transverse striæ and obscure revolving striæ, with obsolete parallel undulations. The lines of growth are strongly arched forward on the middle of the back of the shell." Hall, 1859.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (fide Hall).

Collection.—American Museum of Natural History.

[Ohern.]

PLATYCERAS SINUATUM Hall?

Plate LXXXIV, Figs. 5, 6

Platyceras sinuatum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 314, pl. lv, figs. 5, 7; pl. lvii, fig. 2, 1861.

Description.—"Shell depressed, somewhat obliquely ovoid: volutions about three, contiguous, the last one becoming very ventricose, a little flattened on the upper side, and expanded laterally to the axis of the spire:

aperture broad, campanulate; margin deeply sinuate. Surface marked by fine concentric or transverse lamellose striæ, and stronger wrinkles or folds. The striæ are abruptly bent backwards on the upper dorsal side, and a deep sinus marks the labrum: the lower side of the aperture is likewise deeply sinuate." Hall, 1859.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. East side Nicholas Mountain.

Collection.—Maryland Geological Survey.

[Ohern.]

PLATYCERAS TRILOBATUM Hall?

Plate LXXXIV, Figs. 7, 8

Platyceras trilobatum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 316, pl. lvii, figs. 5*a*, *b*, *c*, 1861.

Description.—" Body of the shell obliquely or arcuately ovoid, trilobate: volutions three or four, the last one (or more) becoming free, gradually expanding to the aperture; the apex closely involved and rising above the plane of the outer volution, or sometimes on the same plane, concave towards the suture: aperture subangularly ovate, sinuate on the right and left sides, and the shell extended in front. Surface marked by two strong spiral depressions corresponding to the sinuosities of the aperture, and crossed by lamellose striæ which are strongly undulated on the sinuosities of the last volution, and are marked by other undulations on the earlier volutions, indicating former sinuosities in the margin of the aperture." Hall, 1859.

A specimen in the U. S. National Museum is much smaller than those figured by Hall, but in other respects closely resembling this species. The three sinuses are shown better by the undulating striæ on the surface than by the aperture. It is referred, with hesitancy, to this species; the absence of the spire making identification uncertain.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville.

Collection.—U. S. National Museum.

[Ohern.]

PLATYCERAS TENUILIRATUM Hall?

Plate LXXXV, Figs. 1, 2

Platyceras tenuiliratum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 317, pl. lviii, figs. 1-5; and pl. lix, figs. 6*a*, *b*, 1861.

Description.—" Shell small, depressed, subovoid or subdiscoid, with the last volution very ventricose. Spire slightly raised above the plane of the outer volution: volutions about three, the first and second very minute, and the last one rapidly expanding; aperture campanulate, with the lip broadly reflexed on the posterior and part of the right side. Surface marked by fine thread-like striæ, which often become lamellose on the last volution, and these are cancellated by very fine revolving striæ." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, KEYSER ? MEMBER. Cash Valley.

Collection.—U. S. National Museum.

[Maynard.]

PLATYCERAS ANGULARE n. sp.

Plate LXXXV, Fig. 3

Platyceras angulare Rowe, 1900, MSS.

Description.—" Shell depressed, subconical, sides sloping gradually toward the aperture; whorls about one; aperture and apex not known. Surface marked by five or six strong angular longitudinal ridges running from the apex to the aperture. Upon these ridges are oblong nodes. Where the shell is not exfoliated fine concentric striæ transverse the shell at right angles to the ridges. The general shape together with the sharp angular ridges separated by broad shallow sinuses distinguish this species from all others.

" Dimensions: Width 3 cm.; height 3.7 cm." Rowe, 1900.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Warren Point, Pennsylvania.

Collections.—Maryland Geological Survey, New York State Museum (fide Rowe).

[Rowe.]

PLATYCERAS MULTISINUATUM Hall

Plate LXXXV, Figs. 4-6

Platyceras multisinuatum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 319, pl. lviii, figs. 8*a*, *b*, *c*, and 9*a*, *b*, 1861.

Description.—" Shell subdiscoid in the young state; apex nearly on a plane with the outer volution: volutions about three, the first ones minute; outer one becoming free, ventricose, rounded or scarcely angular below, somewhat flattened on the upper side, marked by several ridges and shallow depressions on the upper and dorsal side: aperture somewhat longitudinally oval; peristome sinuate, with a deeper sinuosity on the anterior margin. Surface marked by fine transverse striæ, which are strongly undulated on the inequalities of the shell, and crossed by fine longitudinal or revolving striæ." Hall, 1859.

A single individual has been observed which shows as nearly as can be seen, the features in the above description. Although this specimen is fragmentary, the peculiar markings of the species leave no doubt as to the identity of the former. The revolving striæ are not observable.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Cumberland?

Collection.—George M. Roeder.

[Ohern.]

PLATYCERAS PLATYSTOMUM Hall?

Plate LXXXV, Fig. 7

Platyceras platystomum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 326, pl. lx, figs. 1*a*, *b*, 2; pl. lxi, figs. 1*a*, *b*, *c*, 1861.

Description.—" Shell obliquely depressed conical, arcuate on the upper part of the first volution; the apex obtuse, consisting of about a single close volution: aperture expanded, campanulate, and sometimes slightly reflexed. Surface marked by longitudinal plications, which are more or less strongly developed, and are crossed by fine closely arranged lamellose striæ, which are often crowded into wrinkles upon the middle and lower part of the shell." Hall, 1859.

A poorly preserved specimen from the Oriskany is, with grave doubt, referred to this species. The general form of the shell agrees, in a measure, with published descriptions and figures of this species. However, the plications are not observable except faintly on the interior side of the body whorl. The shell has been silicified and portions have again been dissolved away and the apex is broken off, rendering exact determination impossible.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain, West Virginia.

Collection.—Maryland Geological Survey.

[Ohern.]

PLATYCERAS SPIRALE Hall

Plate LXXXV, Figs. 8, 9

Platyceras spirale **Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 331, pl. lxiii, figs. 4-9, 1861.**

Platyceras spirale **Meek and Worthen, 1868, Geol. Survey Ill., vol. iii, p. 389, pl. vii, figs. 12*a*, *b*, *c*.**

Description.—"Shell spirally ascending: apex consisting of a single minute close volution, below which are one or two widely separated and gradually enlarging volutions: aperture spreading, rounded or broad oval; peristome sinuate. Apex and upper part of the shell smooth, or with only fine transverse striæ, more or less distinctly plicated on one side below with strong lamellose undulating striæ." Hall, 1859.

Length 2.25 cm.; diameter of aperture 1.8 cm.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville.

Collection.—U. S. National Museum.

[Ohern.]

PLATYCERAS GRACILE n. sp.

Plate LXXXV, Figs. 10-13

Description.—Shell spirally and obliquely ascending; whorls one or one and one-half; shell gracefully and spirally tapering regularly to an acute apex, the summit of which lies about in the plane of the right side of the aperture; surface marked by irregular growth lines which often tend toward irregular, low undulations; aperture slightly higher than wide;

peristome not seen. Most of the specimens show irregular wide grooves extending spirally from the ventral side of the aperture half, or more, of the length of the shell.

This species has some resemblance to *P. tortuosum* Hall, but is easily separated by its much larger size, more rapid expansion, and by the greater obliquity of the apical portion of the shell.

Length 4.5 cm.; diameter of aperture 3.5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Maryland; Knobly Mountain, West Virginia.

Collection.—Maryland Geological Survey.

[Ohern.]

PLATYCERAS SUBCONICUM n. sp.

Plate LXXXVI, Figs. 1-3

Description.—Shell arcuately to obliquely conical; whorls, one or a little more, free; shell expanding rapidly at first, then somewhat more gently; apex blunt, twisted so as to project on the right side of the shell; aperture subcircular; peristome not observed. Some individuals show a surface marked by faint irregular growth lines. Wide, obsolete, longitudinal ridges are seen on a few shells. The aperture is sometimes irregularly sinuous on the ventral side due to an irregular crinkling of the shell.

This species was recognized as new by the late Dr. Rowe, and to it he applied the name *subconicum*. It seems, however, that he did not describe the species; but the name given by him is here retained.

Length about 4 cm.; diameter of aperture 4.3 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Maryland; Knobly Mountain, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

PLATYCERAS NEWBERRYI Hall

Plate LXXXVI, Fig. 4

Platyceras newberryi Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 333, pl. lxiii, figs. 14*a*-*e*, 1861.

Description.—"Shell subdiscoidal, with the last volution expanded: volutions about three, nearly in the same plane; the first two minute and closely involved, the last one free, somewhat rapidly expanding, flattened upon the back and becoming ventricose towards the aperture: aperture rounded or broad oval. Surface marked by strong transverse or slightly oblique nodes or ridges upon the dorso-lateral angles of the last volution, about eleven or twelve on each side, which are sometimes connected by a low ridge across the back (the two upper volutions being rounded and free from such ridges). Entire surface marked by regular even thread-like longitudinal striæ." Hall, 1859.

A single individual of this species has been found in the state. Of its identity there is little if any doubt, but, as seen in the specimen figured, the transverse ridges are very oblique, due, in part at least, to distortion.

Height 1.5 cm.; diameter of aperture 2.3 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

[Ohern.]

Genus STROPHOSTYLUS Hall

STROPHOSTYLUS TRANSVERSUS Hall

Plate LXXXVI, Figs. 5-7

Strophostylus transversus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 470, pl. cxiv, figs. 1*a*, *b*, *c*, 1861.

Description.—"Shell obliquely ovate, symmetrical. Spire little elevated: volutions about four, the last one extremely ventricose and very much extended on the margin; aperture subcircular; outer lip very thin, curving downwards and spreading over the surface of the adjacent volution. Collumellæ lip spirally grooved: suture canaliculate. Surface finely striated in direction parallel to the lines of growth, with a few more strongly marked imbricating lines of growth." Hall, 1859.

Length 3.75 cm.; maximum diameter 4.5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (fide Hall).

Collection.—American Museum of Natural History.

[Ohern.]

STROPHOSTYLUS MATHERI Hall

Plate LXXXVI, Figs. 8, 9

Strophostylus matheri Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 471, pl. cxviii, figs. 1*a*, *b*, 1861.

Description.—" Shell obliquely ovoid or subglobose; the spire elevated: volutions about four, the last comprising almost the entire bulk of the shell. Aperture subcircular, a little higher than wide: peristome continuous, thin, joining the adjacent volution on the lower side or becoming free on the posterior side, and joining the outer margin of the columellar lip. Volutions very symmetrically decreasing: suture canaliculate; the depression deepening towards the last volution, till, in older forms, the last volution is sometimes quite free at the aperture. Surface marked by fine transverse striæ, which, in older specimens, become towards the aperture elevated, lamellose, and imbricating." Hall, 1859.

Hall's type specimen of this species came from Cumberland. The writer has seen but a single individual.

Length 2.5 cm.; diameter 2.4 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, east side Nicholas Mountain.

Collection.—Maryland Geological Survey.

[Ohern.]

STROPHOSTYLUS ANDREWSI Hall

Plate LXXXVI, Fig. 10

Strophostylus andrewsi Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 472, pl. cxviii, fig. 2, 1861.

Description.—" Shell somewhat semiovoid. Spire very slightly elevated above the last volution, which is extremely ventricose: aperture subcircular, a little higher than wide; peristome very oblique to the axis of the shell, expanding over the inner side of the previous volution, but not continuous with the outer edge of the columellar lip, which is angular, the lip short, and terminating abruptly below. Surface marked by fine equal striæ." Hall, 1859.

Length 2.5 cm.; diameter 3.5 cm.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland (fide Hall).

Collection.—American Museum of Natural History.

Genus DIAPHOROSTOMA Fischer

DIAPHOROSTOMA VENTRICOSUM (Conrad)

Plate LXXXVII, Figs. 1, 2

Platyostoma ventricosa Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 275, pl. xvii, fig. 5.

Platyostoma ventricosa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 300, pl. lv, figs. 9*a*, *b*, *c*, *d*; p. 469, pl. cxii, figs. 1-10; pl. cxiii, figs. 7, 8; pl. cxv, fig. 8, 1861.

Platyostoma ventricosa Nicholson, 1874, Rept. upon the Pal. of the Province of Ontario, p. 117, pl. ii, fig. 4.

Diaphorostoma ventricosum Clarke, 1900, Mem. N. Y. State Mus., No. 3, vol. iii, p. 30, pl. iii, figs. 25-28.

Platyostoma ventricosa Weller, 1903, Geol. Survey, N. J., Pal., vol. iii, p. 361, pl. xlix, figs. 7-11.

Description.—" Globose: whorls somewhat scaliform, or flattened above; lower part of columella prominent; labrum reflected; width and length of aperture nearly equal." Conrad, 1842.

" Shell globose or depressed globose and often obliquely ovoid, varying in form. Spire moderately elevated, consisting of three or four volutions, the last of which is extremely ventricose; volutions flattened upon the upper side; aperture circular or subovate; columellar lip reflexed. Surface marked by fine closely arranged striæ parallel to the lines of growth." Hall, 1859.

Length of maximum form 7 cm.; diameter 9 cm.

This species is very common in the Oriskany of Maryland. Some forms of *Platyceras gebhardi* bear a strong resemblance to this form, but the latter always has an elevated spire which, with the prominence of the lower part of the columella, serves to distinguish the species.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland, Hancock, east side Nicholas Mountain, Maryland; Warren Point, Pennsylvania; Knobly Mountain, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

DIAPHOROSTOMA DEPRESSUM (Hall)

Plate LXXXVI, Figs. 11, 12

Platyostoma depressa Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 301, pl. lv, figs. 4*a*, 4*b*.

Description.—"Shell depressed globose. Spire short, little elevated above the body of the shell: volutions three or four, a little depressed at the suture and regularly curving on the top and sides; aperture round or transversely suboval. Surface somewhat lamellose-striate." Hall, 1859.

This species as found in Maryland is poorly preserved. Only about a half-dozen individuals have come under the notice of the writer, most of them being in the U. S. National Museum and having been identified by Schuchert.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. South end of Nicholas Mountain (?). HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

DIAPHOROSTOMA DESMATUM Clarke

Plate LXXXVI, Figs. 13, 14

Diaphorostoma desmatum Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 29, pl. iii, figs. 13-19.
Platyostoma desmatum Weller, 1903, Pal. N. J., vol. iii, p. 262, pl. xlix, fig. 12.

Description.—The U. S. National Museum has a very small specimen of this species from the Lower Oriskany. The species lacks a definite description; what has been published being comparisons rather than descriptions. The specimen figured was identified by Schuchert.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

[Ohern.]

Genus PLATYOSTOMA Conrad

PLATYOSTOMA NIAGARENSE Hall

Plate LXXXVII, Figs. 3, 4

Platyostoma niagarense Hall, 1852, Pal. N. Y., vol. ii, p. 287, pl. lx, figs. 1*a*-*v*.

Description.—"Globose; volutions three or four; body whorl large, inflated towards the aperture which is dilated; sutures deep; spire depressed (rarely elevated); shell thin; surface striated across the volutions, and in well-preserved specimens longitudinally marked by filiform undulating striæ. The spire appears to be depressed often when the shell retains its natural proportions, and at other times from pressure; in a few examples it is considerably elevated. The fine undulating longitudinal striæ do not always appear, and sometimes only upon a portion of the surface, even when there is no appearance of abrasion. In other examples they have evidently been worn off, leaving the transverse striæ well preserved." Hall, 1852.

Length 1.8 cm.; diameter 1.9 cm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Viaduct Cumberland.

Collection.—U. S. National Museum.

[Maynard.]

Order OPISTHOBRANCHIATA

Suborder CONULARIDA

Family TENTACULIDAE

Genus TENTACULITES Schlotheim

TENTACULITES ? ACUS Clarke

Plate LXXXVII, Fig. 5

Tentaculites ? acus Clarke, 1900, Mem. N. Y. State Mus., No. 3, vol. iii, p. 28, pl. iii, figs. 1-7.

Description.—"Shells having as large size as those of *T. elongatus* but with the exterior surface smooth or with very faint, distant, broad, concentric depressions and fine, indistinct and somewhat irregular growth striæ. The internal cast is similar to that of *T. elongatus,* but has the constrictions less deep. Specimens of this species are not uncommon. The wall of this species is thick and cellular, and a transverse section gives two or more concentric circles at any plane, showing the ensheathment of the funnel-like divisions of the interior. This structure is much more pronounced than in any species of Tentaculites observed by the writer and, though more regular than in Cornulites, may prove to be of the same nature." Clarke, 1900.

The writer has seen but a single specimen of this species. The condition of preservation is such that no details could be learned further than those given by the author of the species.

Occurrence.—HELDERBERG FORMATION, BECRAFT MEMBER. Warren Point, Pennsylvania.

Collection.—Maryland Geological Survey.

[Ohern.]

TENTACULITES ACULUS Hall

Plate LXXXVII, Figs. 6, 7

Tentaculites aculus Hall, 1888, Nat. Hist. N. Y., Pal., vol. vii, p. 6 (supplement to vol. v), pl. cxiv, figs. 15-17.

Tentaculites acula ? Weller, 1903, Pal. N. J., vol. iii, p. 336, pl. xliii, fig. 11.

Description.—"This species is distinguished by the regular, equidistant annuli and the few annulations on the intervals." Hall, 1888.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge, Cash Valley, North Branch.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

TENTACULITES ELONGATUS Hall

Plate LXXXVII, Figs. 8-10

Tentaculites elongatus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 136, pl. vi, figs. 16-21, 1861.

Tentaculites elongatus Hall, 1888, Nat. Hist. N. Y., Pal., vol. vii, p. 6 (supplement), pl. cxiv, fig. 14.

Tentaculites elongatus Clarke, 1900, Mem. N. Y. State Mus., No. 3, vol. iii, p. 27, pl. iii, figs. 8-12.

Tentaculites elongatus Weller, 1903, Pal. N. J., vol. iii, p. 295, pl. xxxii, fig. 4; p. 319; p. 363, pl. l, figs. 4, 5.

Description.—"Body extremely elongated and very gradually tapering to the apex, which is sometimes slightly curved; marked by strong, sharp annulations of which more than three occur in the space of the diameter of the tube. Section cylindrical. Surface ornamented by fine close annulating striæ. Length from one to three inches. Annulations four or five in the space of a quarter of an inch at the base of the larger specimens, and about nine in the same space near the apex." Hall, 1859.

It is not always easy to distinguish this species from *T. aculus;* but in the latter the annulations are more closely and regularly arranged, especially on the earlier portions of the shell. In New York this species occurs in both the Helderberg and the Oriskany.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Dawson. NEW SCOTLAND MEMBER. Devil's Backbone. ORISKANY FORMATION, SHRIVER MEMBER. Cumberland, west side of Queen's Point opposite Keyser, Winchester Road near Allegany Grove.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

TENTACULITES GYRACANTHUS (Eaton)

Plate LXXXVII, Fig. 11

Echinus gyracanthus Eaton, 1832, Geological Text Book.

Tentaculites ornatus Vanuxem, 1842, Final Rept. on the Geol. of the 3d Dist. N. Y., p. 112, fig. 3.

Tentaculites ornatus Mather, 1843, Final Rept. on the Geol. of the 1st Dist. N. Y., p. 349, fig. 3.

Tentaculites irregularis Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 137, pl. vi, figs. 22, 23, 1861.

Tentaculites gyracanthus Hall, 1888, Nat. Hist. N. Y., Pal., vol. vii, p. 5 (supplement to vol. v), pl. cxiv, figs. 7-13.

Tentaculites gyracanthus Weller, 1903, Pal. N. J., vol. iii, p. 264, pl. xxiv, figs. 19, 20.

Description.—" Body small, acicular, tapering to an acute point. Annulations rounded, inequally distant, from six to twelve in the space of one-eighth of an inch: intermediate spaces marked with rounded annulating striæ. Length rarely more than half an inch." Hall, 1859.

" Shell elongate, circular in cross-section, annulate, gradually tapering to the apex. Annulations smooth, rounded, situated at irregular intervals, from one to three in the space of 1 mm.; the interspaces between the annulations are marked by fine, annular striæ. In internal casts the annulations are smaller and the fine, annular striæ are lacking from the interspaces." Weller, 1903.

This species occurs in great numbers in the Manlius formation of the Upper Silurian of New York and gave to this horizon its first name (Tentaculite limestone). It also occurs in large numbers in the Tonoloway formation and locally in the upper part of the Keyser member of the Helderberg.

Length 5.6 mm.; diameter .7 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Keyser, West Virginia; Dawson, Devil's Backbone, Tonoloway, Maryland.

Collection.—Maryland Geological Survey.

[Maynard.]

CLASS CEPHALOPODA

Subclass TETRABRANCHIATA

Order NAUTILOIDEA

Suborder ORTHOCHOANITES

Family ORTHOCERATIDAE

Genus ORTHOCERAS Breyn

ORTHOCERAS LONGICAMERATUM Hall

Plate LXXXVIII, Figs. 1-3

Orthoceras longicameratum Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 343, pl. lxx, fig. 1; pl. lxxi, figs. 1, 5, 1861.

Description.—" Shell elongated, very gradually tapering; chamber extremely elongated. Septa numerous, highly arched, about four or five in the space of the diameter of the shell. Siphuncle moniliform. Surface unknown." Hall, 1859.

The exact horizon is unknown.

Occurrence.—HELDERBERG FORMATION. Cumberland.

Collection.—U. S. National Museum.

[Ohern.]

ORTHOCERAS SCHUCHERTI n. sp.

Plate LXXXVIII, Fig. 4

Description.—Shell subcylindrical, tapering very gradually; septa convex, siphuncle not observed. Surface marked by numerous simple rounded somewhat abruptly elevated concentric annulations, at least five occurring in the space of 10 mm. Surface too badly weathered to observe any transverse or longitudinal striæ if present.

This species closely resembles *Orthoceras tenuiannulatum* (Hall) of the Helderberg. It may be distinguished, however, by its smaller apical angle and by possessing shallower and more numerous annulations.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

[Maynard.]

ORTHOCERAS RIGIDUM Hall?

Plate LXXXVIII, Fig. 5

Orthoceras rigidium Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 344, pl. lxx, figs. 3*a-d*, 1861.

Description.—"Shell elongate, gradually tapering; section circular. Septa moderately convex, distant from each other about one-sixth the diameter of the tube. Siphuncle central, narrow in its passage through the septum. Surface marked by fine sharply elevated equal transverse striæ." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone.

Collection.—Maryland Geological Survey.

[Maynard.]

Suborder CYRTOCHOANITES

Family OOCERATIDAE

Genus CYRTOCERAS Goldfuss

CYRTOCERAS ? DUBIUM n. sp.

Plate LXXXVIII, Fig. 6

Description.—Shell small, arcuate, tapering. Chamber of habitation about one-third total length, inflated, slightly constricted towards aperture. Air chambers subequal in depth, diminishing rapidly in diameter towards apex, average depth 3 mm. in specimen 25 mm. long. Septa concave, thin edge slightly curved dorso-ventrally. Aperture, siphuncle and exterior not observed.

Length 25 mm.; diameter of chamber of habitation 15 mm.

A single specimen has been observed whose generic relations are very insecure.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Devil's Backbone.

Collection.—Maryland Geological Survey.

[Swartz.]

ARTHROPODA[1]

Subbranch BRANCHIATA

CLASS CRUSTACEA

Subclass TRILOBITA

Order OPISTHOPARIA

Family PROETIDAE

Genus PROËTUS Steininger

PROËTUS PACHYDERMATUS Barrett

Plate LXXXIX, Fig. 1

Proëtus pachydermatus Weller, 1903, Pal. N. J., vol. iii, p. 248, pl. xxii, figs. 16-21.

Description.—"Head semicircular in outline, with a broad, flattened, marginal border, the genal angles produced into sharp spines. Glabella subtriangular, with a pair of small, disconnected, ovoid basal lobes, obtusely pointed in front, bordered by a sharply defined dorsal furrow; the first and second pairs of lateral furrows are rather faint, slightly curved and directed obliquely backward from the margin of the glabella; the third pair more prominent, curved, directed backward and connecting with the occipital furrow by a less sharply defined depression. Cheeks convex to the marginal border, the eyes opposite the third pair of lateral glabellar furrows. Facial sutures making a sigmoidal curve from the anterior

[1] The authors responsible for the text of the Arthropoda are indicated for each species.

margin of the head to the front of the eye-lobe, and after passing around the eye, bending outward and cutting the posterior margin near the base of the genal spines. Occipital segment broadened in the middle with a small median tubercle. Thorax unknown. Pygidium semielliptical in outline, broader than long, with a broad, flattened, marginal border; the axis much elevated, occupying about one-third the entire width in front, tapering gradually to the obtusely rounded extremity which lies just within the flattened border, divided into thirteen or fourteen segments; the pleuræ strongly convex to the flattened border, divided into eight or nine sharply grooved segments, which become obsolete at the marginal border.

"The entire surface of the glabella except the lateral furrows, also the axial portion of the occipital segment, covered with fine, irregular papillæ; the anterior portion of the cheeks is covered with elongate, raised, vermiform markings, which become shorter and papillose posteriorly. The marginal border and genal spines are smooth, except on the edge, where they are covered with fine, elongate, raised lines. The axial and pleural segments of the pygidium are papillose, the flattened border being smooth within, but toward the margin covered with fine, raised tubercles and elongate flexuose markings." Weller, 1903.

This species was discovered and named by Dr. S. T. Barrett; who gave a brief description of it. By him it was found in the "Coralline limestone" and is cited by Weller from the Decker Ferry formation of New Jersey. It is not unlikely that the single specimen from Maryland may have come from the Keyser member.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—George M. Roeder.

[Maynard.]

PROËTUS CF. PROTUBERANS Hall

Plate LXXXIX, Figs. 2-4

Proëtus protuberans **Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 351, pl. lxxiii, figs. 5-8, 1861.**

Description.—"Entire form oblong elliptical. Head semicircular, very gibbous; the glabella very prominent, rounded in front, not distinctly lobed; the cheeks sloping abruptly from the eyes to the outer margin: posterior angles subacute (perhaps prolonged into spines in entire specimens); eyes prominent. Occipital annulation prominent; the furrow strong, and marked below each posterior angle of the glabella by a small tubercle. Thorax consisting of nine or ten articulations (the specimen being too imperfect for actual determination). The axis is very prominent, semicylindrical, and the lateral lobes nearly flat for a little distance from their origin, and then bending abruptly downwards. Pygidium semicircular: axis very prominent, marked (in the cast) by eight annulations; lateral lobes marked by four or five ribs. Surface granulate; the anterior border, and articulating surfaces of the axis striate: exfoliated surfaces striate." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Corriganville.

Collection.—American Museum of Natural History.

[Ohern.]

Genus CORDANIA Clarke

CORDANIA CYCLURUS (Hall and Clarke)

Plate LXXXIX, Figs. 5, 6

Phaëthonides cyclurus Hall and Clarke, 1888, Nat. Hist. N. Y., Pal., vol. vii, p. 137, pl. xxiv, figs. 26-28; pl. xxv, fig. 11.

Description.—" Cephalon. The intra-sutural portion, which is the only part known, indicates a semicircular outline for the head; frontal and lateral areas depressed and concave; frontal margin elevated, rising to the height of the glabella, broad, thickened and rounded. Palpebral lobes conspicuous. Glabella subpyriform, convex, slightly flattened above, bounded by a sulcus which is strong at the side and obsolete in front. Baso-lateral lobes strong; antero-lateral impressions well marked. Cheeks appressed and elevated along the lateral margins of the glabella. Thorax not observed. Pygidium semicircular; length to width as 1 to 2. Axis prominent, elevated and longitudinally arched; width less than one-third that of the shield, rapidly tapering to an apex just within the posterior border; composed of nine annulations which are transverse, rounded and separated by moderately broad sulci. Pleuræ evenly rounding to the flattened border, and bearing seven annulations, which are strongly sulcate. Border broad, depressed or flat. All the pleural annulations pass over the border to its edge, where the anterior and posterior limbs are of equal strength. Doublure broad.

"The cephalon shows traces of low pustules over the glabella, and upon the depressed frontal area, where they become elongate or lachrymate, sometimes anastomosing, leaving elongate depressions between them; the frontal border also bears an irregular row of conspicuous tubercles. The pygidium is marked by regularly arranged pustules; a median row upon the axis, bifurcating at the fifth or sixth annulation, thence backward continuing double until it becomes obsolete. Four rows of finer pustules are also visible on the axis, two on either side of the median row. The pleuræ bear three or four rows of small pustules, and the interspaces of the crust are minutely granulose, and punctate. The lower surface of the doublure is marked by faint radiating or venate striations." Hall and Clarke, 1888.

This species, as it occurs in Maryland, differs somewhat from Hall and Clarke's types in that the former have a somewhat longer glabella and the position of a single pair of side furrows is merely indicated by a pair of depressions on the sides of the glabella.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND (?) MEMBER. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

Genus CYATHASPIS Burmeister

CYATHASPIS AUSTRALIS n. sp.

Plate LXXXIX, Figs. 7, 8

Description.—Cephalon. Semielliptical transversely; length to width about as 1 to 2; genal angles (imperfect in only specimen seen) produced, diverging posteriorly; border smooth, thickened, a broad well-defined sulcus lying concentrically within the thickened border and extending from base to base of the genal angles. Facial sutures originating in posterior margin, extending directly and very obliquely inward and forward to the palpebral lobes, thence directed obliquely outward and forward to marginal sulcus where they curve sharply inward and forward to the frontal margin. Glabella U-shaped, moderately and regularly convex, bounded by a deep, well-defined sulcus which widens markedly near the palpebral lobes; basal lobes pyriform, slightly alternate anteriorly, oblique, conspicuous; baso-lateral furrows well marked, very convex on inner side, antero-lateral furrows obsolete; frontal area regularly convex to marginal sulcus.

Eyes large, very prominent, visual area semicircular, palpebral lobes small. Cheeks small, sloping steeply to marginal sulcus; a well-defined furrow running from base of genal angles obliquely inward and forward, almost parallel to facial suture, to posterior extremity of palpebral lobe; occipital furrow narrow but sharply marked; occipital ring moderately broad on axis, tapering laterally. Thorax elongate, subequally trilobate; segments thirteen (?); axis well arched, but slightly depressed medially, of same width to two-thirds or more of the distance from cephalon, then tapering posteriorly; pleuræ depressed on interior portions, abruptly deflected distally; each annulation bearing a longitudinal furrow which runs from near the anterior side in the axial region obliquely to the middle of the annulation, becoming obsolete distally; the smaller anterior portion of each annulation with a small spine at fulcrul line as in *C. crespedota*. Pygidium not seen. Surface of cephalon smooth; that of the thorax covered by small irregular pustules, which are more numerous on the axis.

This species bears a close resemblance to *C. crespedota* of the Hamilton of New York, but is quite distinct. *C. cœlebs* of the Lower Helderberg of that state differs widely from this species especially in the features of the axis of the thorax. Only a single individual of this genus has so far been reported from the Lower Devonian of Maryland. The exact horizon is unknown.

Occurrence.—HELDERBERG FORMATION. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

Order PROPARIA

Family CALYMENIDAE

Genus CALYMENE Brongniart

CALYMENE CAMERATA Conrad

Plate LXXXIX, Fig. 9

Calymene camerata Conrad, 1842, Jour. Acad. Nat. Sci., Phila., vol. viii, p. 278.

Calymene camerata Hall, 1852, Pal. N. Y., vol. ii, p. 337, pl. lxxviii, figs. 1*a-f*.

Description.—"Cephalic shield wide, subcrescent form; anterior margin elevated in a strong fold, a deep groove separating it from the front of the glabella and cheeks; glabella broader and nearly straight in front, furnished on each side with three distinct tubercles, the posterior one very large and prominent, the anterior one minute; eyes opposite to the central lobe of the glabella; the furrow between the glabella and cheeks very deep; a projecting lobe from behind the eye touches or unites with the middle of the three lobes of the glabella, and a similar projecting plate from the inner anterior angle of the cheek touches the front lobe of the glabella near its anterior angle. Axis of the body convex, nearly as wide as the lateral lobes; pleura convex and straight for half their length, and then gently curved downwards and flattened, grooved along the center. Caudal shield with eight rings in the middle lobe; lateral lobes with six flat ribs strongly bent downwards; surface granulate, with larger tubercles on the glabella and other parts.

"The specimens examined are all imperfect, and the surface markings are also more or less obliterated. The characteristic features are the deep furrow along the front and cheek margins, and between the glabella and cheeks, and the projecting lobes from the inner margins of the cheeks which touch or unite with the glabella, arching over the axial furrow. In the two separated cephalic shields, the portion beyond the facial suture is wanting, and in the more entire specimen it is too obscure to be characterized." Hall, 1852.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cash Valley, Devil's Backbone, Maryland; Keyser, West Virginia.

Collection.—U. S. National Museum.

[Maynard.]

Genus HOMALONOTUS Koenig

HOMALONOTUS SWARTZI n. sp.

Plate LXXXIX, Figs. 10-12; Plate XC, Figs. 1, 2

Description.—Cephalon unknown. Thorax very broad, trilobation obsolete, axial portion broadly arched, pleural portions steeply descending; segments curving gently forward in axial portion; posterior portion of each segment broad axially, tapering gradually toward fulcra; transverse suture of each segment of nearly constant width, a narrower and less steep secondary suture anterior to and parallel with the primary; pleuræ bending suddenly downward at fulcra, the transverse suture curving forward distally, leaving the posterior portion of the segment very broad. Pygidium large, subtriangular in outline, lateral margins at base nearly rectilinear, posterior extremity not seen; faintly trilobate, the faint longitudinal furrows making with each other an angle of about 40°; axis very broad, depressed, annulations ten or eleven, low and broad, arching broadly anteriorly; pleuræ profoundly arched along fulcra and incurved at base, each bearing ten annulations which are broad, low, nearly direct, and becoming obsolete distally. Dimensions of pygidium: Length about 82 mm.; width 72 mm.

A cast of a pygidium, which is taken as the type of the species, was discovered by Dr. C. K. Swartz and is named for him. In size this species is comparable to *H. major* Whitfield. The above incomplete description of the thorax is from a single thoracic segment from Miller's Spring, West Virginia. The pygidium and the segment presumably belong to the same species. Both occur in the Oriskany, and are of large proportions and the fulcra are of about equal sharpness.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Sand quarry 4 miles southwest of Hancock .(pygidium), Maryland; Miller's Spring (thoracic segment of glabella), West Virginia.

Collection.—Maryland Geological Survey.

[Ohern.]

HOMALONOTUS VANUXEMI Hall

Plate LXXXIX, Figs. 13-15; Plate XC, Fig. 3

Homalonotus vanuxemi Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 352, pl. lxxiii, figs. 9-14, 1861.

Homalonotus vanuxemi Hall and Clarke, 1888, *ibidem*, vol. vii, p. 11, pl. v*b*, figs. 1, 2.

Homalonotus vanuxemi Weller, 1903, Pal. N. J., vol. iii, p. 321, pl. xxxix, figs. 7, 8; p. 338, pl. xliv, figs. 4-7.

Description.—"Thorax long: sides subparallel, the middle lobe flattened on the exterior surface; articulations arching forward; longitudinal furrows faintly defined, being a simple undulation in the articulations; lateral lobes narrow, the articulations bent abruptly downwards at the sides. Pygidium subtriangular with the articulating side much longer and broadly curving, extremely convex: axis prominent in the young specimens, and becoming subdued in older ones; width, at its upper extremity, equal to that of each of the lateral lobes. Annulations fourteen or fifteen in the cast, and twelve ribs visible on each of the lateral lobes. Surface of the test punctate and striato-punctate: cast punctate." Hall, 1859.

Cephalon convex depressed, having the shape of a flaring U, lateral lines rectilinear, making with each other an angle of about 54°, anterior margin somewhat broadly rounded. Length to width about as 2 to 3; genal angles rather abruptly but regularly rounded. Facial sutures originating in genal angle nearer the lateral margin, thence running obliquely forward, rounding and passing inward parallel to posterior margin of cephalon toward points posterior to the eyes, thence again obliquely inward to the eyes, thence forward to anterior margin. No transverse suture observed, but may be present.

Glabella subescutchenoid, broader posteriorly, lateral margins almost rectilinear, but slightly concave outwards, anterior angles rounded, posterior angles sharp, length five-eighths, or less, that of the cephalon, lateral furrows undefined in specimens observed. Cheeks free, sinuous on surface and abruptly deflected marginally. Eyes situated on large elevated protuberances which are slightly elliptical parallel to the lateral margin of the cephalon and each bounded by a wide shallow furrow which is less definite adjacent to lateral margin of the cephalon. Visual areas small, nearly circular, but slightly elongate parallel to the longer axis of the protuberances upon which they are situated.

The description is from two specimens belonging to the U. S. National Museum from near Franklin, Pendleton County, West Virginia. One shows the genal angles well, but neither has the anterior extremity of the cephalon. So far as the writer knows these two specimens and a fragment in the New York State Museum are the only specimens of the cephalon of this species yet discovered.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland, Maryland; opposite Franklin, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

Family PHACOPIDAE

Genus PHACOPS Emmrich

PHACOPS LOGANI Hall

Plate XCI, Figs. 1-4

Phacops logani Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 353, pl. lxxiii, figs. 15-25, 1861.

Phacops logani Weller, 1903, Pal. N. J., vol. iii, p. 231, pl. xl, figs. 3, 4.

Description.—" General form elliptical. Head semicircular in outline, broadly concave above, with the posterior angles curved and declining more abruptly. Glabella somewhat pentagonal; length and greatest breadth nearly in the proportion of three to four; very prominent in front, projecting beyond the rudimentary frontal limb, which becomes more developed on each side, and below which is a defined groove, marking the limits of the lower side of the cephalic test. Upper surface convex, gibbous in front, having two pairs of transverse grooves, the middle and posterior ones of which are but faintly defined; while the third or anterior ones, extending from the inner angle of the eye backwards, and a little inwards, are scarcely conspicuous, and, on many specimens, not observable. First annular furrow strongly defined, and sometimes with a small tubercle at the summit: first or intercalated annulation narrow and well defined, and terminated at each extremity by a strong oblong tubercle, which is wider than the annulations, and usually marked by two pustules at the summit, one on each side of the center. Occipital furrow wider and more strongly defined than the intercalated one, slightly sinuous, and terminating in a deep cavity at each extremity: occipital annulation broad and strong, slightly sinuate at the extremities, and, when entire, marked by one larger central pustule and several smaller ones.

Eyes of medium size, their summit less elevated than the glabella, extending backwards to the line of the occipital furrow, composed of seventeen vertical ranges of lenses; the entire number of lenses in full-grown specimens about one hundred, and varying in the specimens examined from ninety-three to one hundred and three.

"The axis of the thorax is prominent, and narrower than each of the lateral lobes; the annulations furnished with a prominent node at each extremity. The lateral lobes are flat or somewhat concave towards the axis, the articulations bending abruptly downwards from the middle towards the extremities: each articulation strongly grooved, the groove extending beyond the curvature. Pygidium semicircular; the axis prominent, with about nine annulations; the lateral lobes having about five or six ribs, each with a groove along the center. Surface of the glabella pustulose, and of the articulations granulose, with some larger granules or pustules. The crust is thin, and the interior of the glabella shows distinct cavities corresponding to the external pustules. Hypostoma hastate; the buccal extremity obtuse, with a minute central point." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. Devil's Backbone, Corriganville, Maryland; Cedar Cliff, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

PHACOPS sp. ?

Plate XCI, Figs. 5-7

Description.—Two pygidia and a larger cephalon from the Oriskany are too poorly preserved to determine or describe. They are associated in the brown sandstone south of Cumberland and are assumed as belonging to the same species.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—George M. Roeder.

[Ohern.]

Genus DALMANITES Emmrich

DALMANITES ASPINOSUS Weller

Plate XCI, Fig. 16

Dalmanites aspinosa Weller, 1903, Pal. N. J., vol. iii, p. 252, pl. xxii, fig. 15.

Description.—" Known only from the pygidium which is longitudinally semielliptical in outline, obtusely pointed posteriorly. Axis regularly tapering and rounded posteriorly; in the type specimen reaching to within 4.5 mm. of the posterior margin, which makes it about six-sevenths of the entire length of the pygidium; marked by about 16 annulations, which gradually decrease in size posteriorly until they become entirely obsolete. The pleura are rather strongly convex to the margin, with no flattened or concave border; marked by ten prominent, narrow grooved ribs, which extend to the margin of the pygidium and are separated by broad, concave furrows. The dimensions of the type specimen are: Length 32 mm.; width 40 mm.; convexity 9 mm." Weller, 1903.

The individuals in Maryland are smaller than those from New Jersey. However, the characteristics, *i. e.*, the absence of any spinous extension from the posterior extremity, the absence of any flattened or concave marginal border and the sharp pleural angular ribs which are present, distinguish this species conspicuously from other members of the genus.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Cash Valley.

Collection.—U. S. National Museum.

[Maynard.]

DALMANITES KEYSERENSIS n. sp.

Plate XCI, Figs. 8, 9

Description.—Head semielliptical, posterior edge semicircular. Glabella convex, length from posterior furrow to anterior margin 10/11 width of the frontal lobe. Frontal lobe rhomboidal, length 3/5 its width. Posterior lobes narrower, separated by well-defined transverse furrows, the two anterior furrows appearing as narrow pit-like depressions on either side of center, becoming faint towards sides; posterior furrow extending entirely across axis. Eyes very prominent, elevated, exterior sides set with numerous facets which are absent next glabella from which they are separated by a deep sulcus. Margin elevated and angular, bounded by a depression which separates it from glabella and cheeks. Genal angles broad, greatly extended, their length equal to length of glabella. Thorax not observed. Surface of glabella finely papillose. Part of a pygidium was associated with the head and probably belongs to the same species. It is semielliptical, its axis tapering gradually, its anterior diameter 1/8 width of pygidium. Pleuræ broad, extending to margin. Posterior extremity unknown. A single specimen is known.

Length of head exclusive of genal angles 16 mm. Length of angles 15 mm.; width of head 30 mm.; width of frontal lobe of glabella 12 mm.

The head of this species resembles that of *D. pleuroptyx,* but the frontal lobe is more sharply limited by furrows; the posterior lobes are much narrower in proportion to width of anterior lobe, and their width does not diminish so rapidly posteriorly; the transverse furrows are more pit-like. The genal angles are broader and proportionately longer. This may be *D. aspinosa* of Weller, but the head of that species has never been described, while the pygidium of this form is known only by a fragment which is too imperfect to permit confident determination, although it resembles the pygidium of *D. aspinosa.* It seems best to describe it as new pending the discovery of additional material. It occurs in the *Chonetes jerseyensis zone.*

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway 193.1 feet above base of formation.

Collection.—Maryland Geological Survey.

[Swartz.]

DALMANITES MULTIANNULATUS n. sp.

Plate XCI, Figs. 12-15; Plate XCII; Plate XCIII, Fig. 1

Description.—Complete cephalon not seen. Fragments show the following characters: Convex, depressed; a broad concave border extends from one genal angle to the other; within and concentric with this is a narrower arched ridge; with and concentric with this ridge is a second concave furrow narrower than the first; glabella large, becoming narrower posteriorly; frontal lobe depressed, broadly elliptical transversely, surrounded by a broad, shallow furrow except at the posterior extremity; first lateral lobe much larger than the others, subtriangular; second lobe smaller than the first and larger than the third; third lobe narrow, having about the same width as the occipital ring; first and second lobes almost coalesced towards their outward extremities, a slight tendency towards coalescence likewise observable between the second and third lobes; second and third lobes extending obliquely inward and forward, the former being more oblique than the latter and both suddenly excavate at their inner extremities; eyes large, elevated, bounded (at least exteriorly) by a broad, concave furrow; genal angles much extended, rectilinear, or slightly concave outwardly, till near the posterior extremity where they bend noticeably inward; neck furrows wide and deep; hypostoma with highly developed ornamentation, the anterior extremity possessing a process which bifurcates a short distance beyond the general outline of the hypostoma, each branch extending arcuately outward and forward (25 mm. in the specimen figured); on either side of this bifurcating process are three shorter obtuse projecting processes each in succession being more and more subdued. Thorax not seen.

Pygidium convex, greatly depressed, outline broadly triangular, the lateral margins gently convex outwards; axis broad, depressed, tapering gradually to a rounded apex posteriorly; dorsal furrows broad, deep, interrupted by the transverse furrows except posteriorly, and making with each other an angle of about 20°; axis with 19 transverse, broad, subrectilinear ridges, the intervening furrows being broad and shallow axially, but suddenly deeper at about half the distance from the axial line to the dorsal furrows; pleuræ with about 16 transverse tips, the 8 or 9 anterior of which are divided by a well-marked, broad, longitudinal groove, the remaining posterior ones being more or less acute; the transverse ribs are arched slightly forward till near the lateral margins when they bend suddenly backwards. No caudal spine observed.

The surface of the cephalon is ornamented with numerous irregularly placed, rather small pustules. The axial portion of the pygidium bears on each of the transverse ridges several spines more crowded toward the dorsal furrows, but with no regular arrangement observable; the plural ribs studded with pustules varying greatly in size and occupying usually a medial position on the rib.

The cephala are fragments and are completely separated from their pygidia. Each belongs to a large species. Relying then on the highly probable conjecture of identity of localities and on the large size of the individuals, the writer has referred the pygidia and the fragmentary cephala to the same species. It must remain for future investigation to show the truth or falsity of such reference.

The species presents features of interest in the character of the frontal ornamentation. Dr. J. M. Clarke has discussed this feature of the genus.[1] The present species seems to have close affinities with *D. bicornis* Hall, of the Waldron fauna, as regards the bifurcating frontal process, but it shows a much higher development of this feature than does any other species of this genus of which the writer knows.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Knobly Mountain near Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

DALMANITES LATUS n. sp.

Plate XCIII, Fig. 2

Description.—Cephalon and thorax unknown. Pygidium broadly ovate in outline, the lateral margin incurving rapidly on approaching the posterior extremity which in outline has the form of a low arc; axis of medium width, tapering gradually to a subacute terminus; dorsal furrows narrow, direct, deeply incised by transverse furrows especially anteriorly; segments 17, narrow; transverse ridges narrow, erect, convex anteriorly, wider than the intervening furrows, probably not ornamented; pleuræ 14 in number, slightly curved for about three-fourths of their length from the dorsal furrows, then curving suddenly backward; ridges narrow, about

[1] The Oriskany Fauna of Becraft Mountain. Mem. N. Y. State Mus., vol. iii, No. 3, 1900, pp. 16, *et seq.*

as wide as the intervening furrows, erect, each with a longitudinal groove in the middle which becomes obsolete on the posterior ribs, and bears an occasional pustule.

This species is founded on a single pygidium in the U. S. National Museum. Its broadly ovate outline, the number and character of the annulations mark it as a distinct species.

Occurrence.—Oriskany Formation, Ridgely Member. Cumberland.

Collection.—U. S. National Museum.

[Ohern.]

Subgenus SYNPHORIA

Dalmanites (Synphoria) stemmatus Clarke

Plate XCIII, Fig. 3

Dalmanites (Synphoria) stemmatus Clarke, 1900, Mem. N. Y. State Mus., vol. iii, No. 3, p. 15, pl. i, figs. 6-16; pl. ii, figs. 1, 2.

Description.—" Species attaining considerable size. Cephalon convex, abruptly sloping to the genal margins. Genal extremities somewhat produced but relatively short and terminating in broad obtuse angles. Dorsal furrow deep except at the junction of the glabellar lobes with the palpebral lobe, where it becomes shallow and very much elevated. Frontal lobe of glabella large, rounded in front, slightly elongated at the axial extremity, but not projecting beyond the frontal border or facial suture. First lateral furrows long, deep and oblique, extending nearly three-fourths the diameter of the lobe. Glabellar surface behind the frontal lobe slightly if at all depressed medially. Second and third lobes wholly confluent at their extremities, often but a remnant of the second lateral furrows remaining. Together these coalesced lobes have a subtriangular or subclavate outline and are convex and elevated at their distal extremities, rising above the full height of the glabella and almost to the height of the palpebral lobe. The third lobes are small and narrow, making an annular segment, varying but little in width; their extremities are almost concealed beneath the projecting lobes in front. Occipital furrow deep; occipital segment long and very much arched; no central spine or tubercle. Cheeks with steep lateral slopes; somewhat concave within the thickened margin. Furrows beneath the eyes deep, narrow with clevated margin having a vertical, outward slope. Occipital furrow widening from the dorsal furrows outward and coming to a rather abrupt termination without meeting the submarginal depression of the cheeks or extending on the genal expansion. Eyes large, elevated, the palpebrum higher than the palpebral lobe.

"The thickened border bears a row of crenulations or crescentic ornamental processes, which are the most extended at the anterior extremity; here also the anterior three of these processes are somewhat coalesced. From this extremity may be counted, on both sides of the terminal process, from 12 to 15 similar processes, becoming uniformly smaller toward the genal extremities and finally disappearing altogether at or near the lateral termination of the facial suture. In smaller specimens the number of these processes may be considerably less.

"The surface of the cephalon is ornamented, on the frontal lobe of the glabella, with coarse pustules of varying size; this lobe also bears the elongate median scar which occurs in many species of the genus. The coalesced second and third lobes are also pustulose, but less strongly. The cheeks directly beneath the eyes bear traces of low ramifying grooves similar to those found in *Dal. pleuroptyx* of the Helderbergian fauna and *Dal. anchiops* of the Schoharie grit. Thorax not observed. Pygidium very broadly triangular, the length and width being as 2 to 3. The margin curves slightly outward on each side and terminates behind in a broad, rounded extremity which is slightly elongated, but is not produced into a spine. The axis bears 10 or 11 annulations, and the pleuræ 9 or 10. The ribs are undivided by a median groove and are without coarse tubercles." Clarke, 1900.

A specimen in the collection of Mr. Gordon is referred to this species. The determination has been made from the cast of the cephalon. Crushing has somewhat deformed the cast, but the features are still fairly definite, except on the anterior extremity. The agreement with the description of *D. stemmatus* is very close, but the following differences are noted: (1) The occipital furrow is parallel to the posterior margin of the cephalon for less than one-half the distance from the axis as in typical forms. Thence the posterior margin diverges as is not true of typical forms, making thus with the occipital furrow and the lateral margins scalene areas. (2) The genal angle is somewhat more acute. (3) The third side-lobes bear each a small node on the distal ends.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—Robert H. Gordon.

[Ohern.]

Subgenus CORYCEPHALUS

DALMANITES (CORYCEPHALUS) DENTATUS Barrett?

Plate XCIII, Fig. 4

Dalmanites dentata Barrett, 1876, Amer. Jour. Sci., 3d ser., vol. xi, p. 200, pl.
Dalmanites dentata Barrett, 1876, *ibid.*, vol. xii, p. 70.
Dalmanites (*Corycephalus*) *dentatus* Hall and Clarke, 1888, Nat. Hist. N. Y., Pal., vol. vii, p. 58, pl. xi*a*, figs. 4-6.
Dalmanites dentatus Weller, 1903, Geol. Survey N. J., Pal., vol. iii, p. 339, pl. xliv, figs. 1-3.

Description.—"Head subcrescentiform, the lateral and anterior margins forming a parabolic curve, the genal angles extended into rather blunt spines. Glabella depressed convex, broadest in front, surrounded by a well-defined dorsal furrow, frontal lobe broader than long, subelliptical to subrhomboidal in outline. First pair of lateral furrows broad and deep, extending obliquely backward from the dorsal furrow and connected across the median portion of the glabella by a shallow depression. First and second lateral lobes partially coalescent externally by the shallowing of the second lateral furrows, the third pair of lateral lobes entirely separate from the second. Second and third pairs of lateral furrows indistinctly continuous across the median portion of the glabella by slight depressions. Occipital furrow sharply defined, continuous across the glabella and extending out upon the cheeks. Occipital segment of about the same width, but a little higher than the posterior lateral lobes. Cheeks convex in general contour, with a slightly thickened marginal border. Eyes large, subcrescentiform, their summits as high or higher than the glabella, their anterior extremities opposite the first and their posterior extremities opposite the third lateral furrows of the glabella, bounded externally around the base of the faceted surface by a sharp depression, beyond which is a subangular ridge. Between this ridge and the slightly thickened cheek margin the surface is concave. The entire lateral and anterior margin of the head is ornamented with a continuous series of from twenty-five to thirty-five triangular, tooth-like processes, largest in front and decreasing regularly in size to the genal angles. The surface of the glabella and those portions of the cheeks lying between the eyes and the glabella, except in the furrows, is covered with rather coarse, irregularly arranged, circular tubercles, the outer portions of the cheeks, including the marginal denticles, being finely papillose. Thorax consisting of eleven segments, the axis a little less than one-third the entire width, pleuræ extended into sharp, posteriorly pointing spines. Pygidium subtriangular in outline, the posterior extremity produced into a dorsally curving, attenuate spine, a little less than one-fourth the total pygidial length. Axis depressed convex, indistinctly subangular along its median line, about one-fourth the entire width of the pygidium at its anterior margin, its sides nearly straight, gradually converging to the obtusely rounded posterior extremity, which lies a little anterior to the base of the posterior pygidial spine. Pleuræ with no conspicuous marginal border, flattened above, becoming rather strongly convex in the middle, and then sloping away to the lateral margins with a slightly convex surface. Axial segments fifteen in number; pleural segments grooved, eleven in number, curving rather abruptly backward as they approach the margin, the two or three posterior ones nearly straight. Each segment of the pygidium marked by a more or less irregular line of tubercles." Weller, 1903.

The pygidium figured has a striking resemblance to published figures and descriptions of this species in the duplicate ribs and in the tubercles on the axial lobe. But except for the width of the axis, it might with equal propriety be referred to *D. bisignatus* Clarke. It is too imperfect for accurate determination.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Evick Gap, opposite Franklin, Pendleton County, West Virginia.

Collection.—U. S. National Museum.

[Ohern.]

DALMANITES MICRURUS (Green)

Plate XCI, Figs. 10, 11

Asaphus micrurus Green, 1832, Mon. Trilobites of North America, p. 56, cast 19, fig. 3.

Dalmania micrurus Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 359, pl. lxxiv, figs. 13-20, 1861.

Description.—Hall describes this species as follows: "Pygidium triangular, convex, somewhat abruptly sloping at the sides, acute, attenuate behind. Axis very prominent, faintly subangular in the middle above, and regularly rounded towards the posterior extremity, rigid, scarcely declining below, and abruptly elevated from the posterior marginal border; a narrow angular ridge extending from the extremity of the axis into the acute spiniform caudal termination. The number of articulations in the axis is twenty or twenty-one, which are strongly defined, and some of the anterior ones slightly bent forward, and sometimes a little more prominent or almost nodose in the middle. Each of the lateral lobes is marked by fourteen or fifteen (and, in one example, sixteen) ribs; the anterior ones very regularly arching, while about four or five of the posterior ones are turned backwards, approaching the parallel of the axis. Each rib is marked by a narrow groove along its summit, continued to where the ribs coalesce in the narrow marginal rim. The direction of this suture, near the origin of the ribs, is a little below the middle, but, in its course, approaches more nearly the upper margin. Surface granulose, with a row of stronger granules or small pustules on each side of the furrow marking the ribs, and still stronger ones on the middle of the annulations of the axis." Hall, 1859.

The glabella is more truncate than in *D. pleuroptyx.* The chief and most obvious distinction as figured and described by Hall is in the sharpness of definition of the axial annulations of the pygidium, but even this is variable. This axis is also more prominent than in *D. pleuroptyx,* especially the posterior extremity.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND (?) MEMBER. Cumberland. ORISKANY FORMATION, RIDGELY MEMBER. Cumberland.

Collection.—U. S. National Museum.

[Ohern.]

Subgenus CHASMOPS McCoy

DALMANITES (CHASMOPS) ANCHIOPS (Green)

Plate XCIII, Fig. 5

Calymene anchiops Green, 1832, Mon. of Trilobites of North America, p. 35.
Asaphus laticostatus Green, 1832, *ibid.*, p. 45.
Phacops anchiops Burmeister, 1846, Die Organisation der Trilobiten, p. 90.
Dalmania anchiops Hall, 1861, Description of New Species of Fossils, etc., p. 55.
Dalmania anchiops Hall, 1862, 15th Ann. Rept. N. Y. State Cab. Nat. Hist., p. 83.
Dalmanites anchiops Hall, 1876, Illus. Devonian Fossils, pl. ix, figs. 1, 3-6, 10, 12, 13; pl. x, figs. 6-14.
Dalmanites (Chasmops) anchiops Hall and Clarke, 1888, Nat. Hist. N. Y., Pal., vol. vii, p. 59, pl. ix, figs. 1-6, 10, 12, 13; pl. x, figs. 1-14.

Description.—"General form and proportions. Body subelliptical in outline, more or less produced at the extremities. Surface depressed convex, distinctly trilobate; lateral margins deflected and subparallel. Length (including caudal spine) to width as 2 to 1. Cephalon relatively short, length about one-third the width; outline crescentic, slightly produced on the frontal margin. Surface evenly convex. Border narrow anteriorly, bearing in front of the glabella five to seven low crenulations or undulations, which become wider and thicker upon the cheeks, and produced at the genal angles into stout and rapidly tapering spines, which reach the third thoracic segment. Doublure wide and deep at the genal angles, narrowing at the lateral margins, and extending into a relatively narrow epistoma in front. Facial sutures normal.

"Glabella elongate, subpentagonal, widest anteriorly, depressed convex; bounded on all sides by low sulci. Anterior lobe large, subrhomboidal; first pair of lateral furrows long, inclined backward; second pair obsolete, except at their proximal extremities, where they appear upon the cast as two deep pits; third pair transverse or inclined slightly forward, almost obsolete at their distal extremities; first and second glabellar lobes coalescent, forming a single pair of large convex lobes, whose elevation exceeds that of the frontal lobe; third glabellar lobes narrow, depressed and relatively inconspicuous. Occipital furrow narrow on the axis, becoming broader and deeper on the cheeks, occipital ring prominent and bearing short and sharp central spine, narrowing to the axial furrows, thence rapidly widening to the genal spines.

"Eyes lunate, large and elevated considerably above the summit of the glabella, and closely appressed against its coalescent first and second lobes. Visual surface with numerous corneal lenses, the single specimen (a young individual) in which they may be enumerated, showing eighteen rows, counting diagonally from the lower posterior margin, and one hundred and ninety-two lenses. Palpebrum scarcely prominent; palpebral lobe depressed and sloping abruptly to the narrow and elevated palpebral furrow. Cheeks sloping abruptly from the ocular node to the thickened and somewhat flattened margin. A deep sinus which is stronger in old individuals, bounds the ocular node and flattens the subjacent portion of the cheek.

"Thorax subrectangular, length to width as 4 to 5. Surface depressed convex. Axis relatively narrow, widest at about the fifth segment, thence regularly tapering to the pygidium. Pleuræ relatively broad, flat for about one-half their width and thence rounded to the lateral margins. Each segment has a slight forward curve along the axial line, being sulcate on the pleuræ and having the anterior limb abbreviated by the beveled planes of articulation. Pygidium subtriangular, depressed convex or flattened. Posterior extremity produced into a stout, upwardly curved spine, usually short, but sometimes equaling the pygidium in length. Length, including the caudal spine, equal to the width.

"Axis having less than one-third the width of the shield on the anterior extremity, regularly tapering to an obtuse, broadly rounded termination, and composed of from nine to fourteen broad, flat, transverse annulations.

"Pleuræ broad and rounding more or less abruptly to the margins, bearing eight or nine wide, flattened annulations, which become obsolete just within the border. Wherever the crust is retained the annulations are seen to be faintly grooved near their distal extremities, but in the usual condition of preservation as casts of the lower surface, the tendency to duplication is not often apparent. Doublure narrow on the sides, rapidly widening toward the posterior spine, where it extends forward as far as the termination of the axis. The caudal spine is not infrequently broken away from the margin of the doublure, giving the caudal shield a semicircular outline.

"Surface ornamentation. The surface of the cephalon, within the border and occipital ring, is covered by strong tubercles, which are closely disposed over the cheeks and more scattered on the glabella. In old individuals these tubercles extend to the margin, and the orbital ridge of the cheek becomes covered with fine granulations. The surface of the thorax and pygidium is smooth or finely granulose. Pygidia of young individuals show low nodes or tubercles upon the pleuræ, apparently arranged in three or four oblique rows with indications of similar ornamentation upon the axis." Hall and Clarke, 1888.

From the Oriskany comes a nearly complete pygidium which bears a close resemblance to Hall and Clarke's description and figures. This pygidium has, however, a much stronger duplication of the pleural annulations and the axial annulations are arched slightly medially. Nevertheless, the specimen must be placed here for the present, though it may ultimately be shown to belong to another species.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Locality unknown.

Collection.—Maryland Geological Survey.

[Ohern.]

Subgenus HAUSMANNIA

DALMANITES (HAUSMANNIA) PLEUROPTYX (Green)

Plate XCIII, Figs. 6-10

Asaphus pleuroptyx Green, 1832, Mon. of Trilobites of North America, p. 55.

Dalmania pleuroptyx Hall, 1859, Nat. Hist. N. Y., Pal., vol. iii, p. 356, pl. lxxiv, figs. 5 ?, 9 ? (not figs. 1-4, 6-8, 10-12); pl. lxxv, fig. 1 ?, 1861.

Dalmanites (Hausmannia) pleuroptyx Hall and Clarke, 1888, *ibidem*, vol. vii, p. 28, pl. xia, figs. 1-3.

Dalmanites pleuroptyx Weller, 1903, Pal. N. J., vol. iii, p. 295, pl. xxxii, fig. 1.

Description.—"Head semicircular, with the posterior side concave, and the posterior angles prolonged to the fifth or sixth articulation of the thorax: frontal limb slightly concave, thickened at the margin. Glabella convex in front; length from the annulation to the anterior of the frontal lobe, equal to the width of the frontal lobe, which is transversely oval:

transverse furrows strongly marked, the anterior one more deeply than the others, and passing imperceptibly into the depression which circumscribes the frontal lobe: anterior lobe expanding, and becoming prominent towards the inner angle of the eye; the central lobe a little wider than the posterior one. Occipital furrow narrow, shallow in the middle; its continuation in the posterior furrow of the cheeks being very strongly defined, and becoming wider towards the exterior margin.

"Eyes large, prominent, having an elevation of ten ranges of lenses, while laterally there are thirty-seven ranges: the entire number of lenses, in a specimen of medium size is 311. Between the lenses there is a small round granule marking each of the angles of a hexagon, which circumscribes the lens. The entire rim of the eye is much elevated above the central portion or palpebral lobe, and a deeper groove in the outer limb. Hypostoma subhastate, with scarcely perceptible inequalities on the margin.

"Thorax with the axis somewhat abruptly convex, and about three-fourths as wide as one of the lateral lobes, the articulations on each side terminated by a broad node. The articulations of the lateral lobes of the thorax marked by a deep longitudinal furrow, which leaves the elevated portion above and below nearly equal, and the extremities bending rather abruptly downwards.

"Pygidium triangular, transversely convex; the posterior extremity acute, attenuate; the axis a little depressed towards the lower extremity, which rises in strong relief above the border below. The axis is gradually attenuate, the width at the posterior extremity being about one-third as great as at the anterior extremity, which is about five-eighths as wide as the greatest width of the lateral lobe at its upper margin: its outline is curved and sometimes scarcely carinate, the latter feature more often seen in the casts. The number of articulations in the axis is seventeen; and in each of the lateral lobes are eleven to thirteen ribs which are little wider than the furrows which separate them; the whole bending downwards towards the outer extremities, and uniting in a thickened border. Each rib of the lateral lobe is marked by a longitudinal groove parallel with the margins, and a little nearer to the upper than the lower margin.

"Surface granulose, the granules being somewhat stronger on the more prominent parts of the head and in front of the eyes, while on the thorax and pygidium there is usually a stronger row of granules along the lower margins of the articulations. The granulose marking, however, is subject to considerable variation, either from accidental or other causes; and some specimens of the pygidium present a fine granulose texture, visible only under a lens." Hall, 1859.

Occurrence.—HELDERBERG FORMATION, COEYMANS MEMBER. Devil's Backbone, Dawson. NEW SCOTLAND MEMBER. Devil's Backbone, Corriganville, Dawson, Tonoloway?

Collections.—Maryland Geological Survey, U. S. National Museum.

[Ohern.]

DALMANITES BERKLEYENSIS n. sp.

Plate XCIV

Description.—Pygidium triangular, convex, large, its length 7/9 of its width. Axis consisting of 17 articulations in type specimen, its diameter at anterior end a little more than one-seventh width of pygidium, posterior extremity one-third its anterior diameter, quite convex in middle, very slightly convex, or even concave near margin; a row of pit-like depressions between articulations a short distance from margin on each side in exfoliated specimen. Pleuræ 17 in specimen observed, broad, separated by deep and narrow furrows, slightly deflected backwards at anterior end, strongly so at posterior end, where they become nearly parallel to axis. Margin distinct, depressed, convex, very broad, slightly marked by furrows between pleura, its distinctness and breadth not adequately shown by figures. Surface not observed, probably bearing tubercles.

Length of pygidium 170 mm.; width 125 mm.

This species differs from other described forms in its broad margin. It is larger than any other species of the fauna. A single specimen of this large and fine trilobite has been found.

Occurrence.—ORISKANY FORMATION, RIDGELY MEMBER. Pennsylvania Sand Quarry 3 miles north of Berkeley Springs, West Virginia.

Collection.—C. K. Swartz.

[Swartz.]

Subclass EUCRUSTACEA

Superorder OSTRACODA

Family LEPERDITIIDÆ

Genus LEPERDITIA Ronault

LEPERDITIA ALTOIDES Weller

Plate XCVII, Figs. 8, 9

Leperditia altoides Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 252, pl. xxiii, figs. 1 and 2.

Description.—" Carapace of medium size, obliquely subreniform, narrower in front, somewhat variable in proportions; valves strongly convex, gibbous in the middle. Dorsal margin straight, from three-fifths to two-thirds the total length; dorsal extremities obtusely angular, posterior margin broadly rounded, ventral margin convex, anterior margin narrower and often more sharply rounded than the posterior. Eye tubercle small, but rather prominent, situated at a point about one-third the length of the straight dorsal margin from its anterior end and about three-fourths of the height of the valve at that point from the basal margin. Surface of the valves flattened at the antero-dorsal angle, the flattening extending as a narrow, indistinct, marginal border nearly to the center of the anterior margin. Along the posterior margin there is a similar, narrow, indistinct, flattened border, which extends from the postero-dorsal angle to a point in the ventral margin directly below. Surface of valves perfectly smooth.

" The dimensions of an average specimen are: Length 7 mm.; height 4.5 mm.; convexity of one valve 1.5 mm." Weller, 1903.

The type specimens of this species which are figured are from the Decker Ferry rocks of New Jersey. In Maryland the species is quite abundant at several localities.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Devil's Backbone, Tonoloway.

Collections.—Maryland Geological Survey, U. S. National Museum.

LEPERDITIA ELONGATA Weller

Plate XCVII, Fig. 11

Leperditia elongata Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 259, pl. xxiii, fig. 13.

Description.—" Carapace large, obliquely subreniform, posterior extremity the highest. Dorsal margin straight, two-thirds of the total length of the valves, its extremities obtusely angular. Anterior margin obliquely truncate from the hinge-line, sharply rounded in front into the broadly convex ventral margin, which, in turn, curves regularly into the nearly semicircular posterior margin. Eye tubercle distinct, situated a little above the middle of the antero-dorsal quarter of the valve. Both anteriorly and posteriorly the margin is slightly flattened in a rather indistinct marginal border, extending from the extremities of the hinge-line to the middle of the valve. Surface smooth.

" The dimensions of an average specimen are: Length 12 mm.; height 6.5 mm.; convexity of one valve 2.5 mm." Weller, 1903.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway.

Collection.—U. S. National Museum.

LEPERDITIA GIGANTEA Weller

Plate XCVII, Fig. 10

Leperditia gigantea Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 260, pl. xxiii, fig. 14.

Description.—" Carapace very large, subreniform in outline. Dorsal margin straight, about three-fifths of the total length of the valve, its anterior extremity obtusely angular, its posterior extremity rounding into the nearly semicircular posterior margin. Ventral margin gently convex, anterior margin broadly rounded, nearly as high as the posterior margin. Eye tubercle distinct, situated at about the middle of the antero-dorsal quarter of the valves; behind the eye tubercle there is a broad, shallow, indistinct, flattened sulcus, which extends downward from the hinge-line nearly to the center of the valve. The antero-dorsal angle is distinctly compressed, and the flattened area extends around the anterior margin as a marginal border. The posterior margin is also bordered by a more or less distinct, flattened border. Surface smooth.

"The dimensions of a large specimen are: Length 22.5 mm.; height 14 mm.; convexity of one valve 6 mm." Weller, 1903.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway.

Collection.—U. S. National Museum.

Family LEPERDITELLIDAE

Genus APARCHITES Jones

APARCHITES GORDONI n. sp.

Plate XCV, Figs. 1-3

Description.—Valve rather large, elongate elliptical with an unusually long, straight hinge. Surface convex, with the greatest point of elevation in the middle of the posterior third; two obscurely defined depressions in the mid-dorsal area. Under a high magnification the surface is seen to be marked by minute, regularly arranged punctæ.

Length 1.60 mm.; height 1.0 mm.

This new species is based upon a single, well-preserved left valve, presenting, as far as it goes, all of the characters of the genus *Aparchites.* The valve is larger than the average for that genus and thus suggests *Leperditella.* The long hinge-line, elongate valve, and general convexity and marking of the surface seem to be the specific characteristics—at any rate these features will serve until the characters of both valves are known.

The specific name is in honor of the late Robert Gordon, of Cumberland, Maryland, in appreciation of his work upon the geology of western Maryland.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

Family BEYRICHIIDAE

Genus PRIMITIA Jones and Holl

PRIMITIA POSTTURGIDA n. sp.

Plate XCV, Fig. 4

Description.—Carapace small, oblong, the ratio of length to height being not quite two to one. Valves obliquely subtruncate behind, more rounded in front. Hinge straight, long, about four-fifths the greatest length of the valve. Ventral outline gently convex at the extremities, curving upward more rapidly behind than in front. Post-marginal part of valves marked by a low swelling which merges into a much fainter rim along the ventral edge, and is lacking in the posterior half. This rim becomes quite obsolete anteriorly. Within the anterior edge and about the midheight of the valve is a prominent, though compressed, ridge-like node. Sulcus strong and deep, subcentral and occupying the dorsal half of the valve, with broad though not sharply defined swellings on each side.

Length .72 mm.; height .40 mm.

None of the described American species of Primitia are close enough to *P. postturgida* to require comparison, but *P. divisa* Jones and Holl, from the Wenlock of England, is somewhat similar in shape and surface markings. In the latter species, the sulcus and the lobes surrounding it are not as well marked, in fact, the posterior lobe is almost wanting, while the place of the anterior is occupied by a small node. The swollen area enclosing the sulcus is somewhat suggestive of the horse-shoe shaped ridge of species of Bollia like *B. ungula* and *B. curta,* figured on the same plate. This possible alliance is further indicated by the marginal thickenings described.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

PRIMITIA ? CUMBERLANDICA n. sp.

Plate XCV, Fig. 5

Description.—Carapace obliquely subovate, widest in the middle third, with a straight hinge-line nearly as long as the greatest length of the valve. Post-dorsal angle obtuse, antero-dorsal angle sharper; ventral border gently convex but turning upward more gradually in front than behind, thus causing the anterior end to be narrower than the posterior. Free edge of valve with a narrow, well-defined, and slightly raised border. Sulcus short, straight, almost twice as long as wide, deep and well marked, occupying approximately the central portion and not extending to the hinge-line as in typical Primitias. Surface of valve gently convex, the pit and the border smooth, but the remainder with a neat reticular ornamentation.

Length of left valve 0.85 mm.; height 0.5 mm.

None of the American species are close enough to require comparison and the nearest form seems to be *Primitia valida* Jones and Holl, from the Silurian of the Island of Gotland, which has a similar surface ornament and central pit. On closer comparison the greater convexity of the valves of the Gotland species and their more nearly equal ends are apparent at a glance.

Both *P. ? cumberlandica* and *P. ? concentrica* belong to a group of forms at present referred to Primitia, but distinguished from the typical species of the genus by a reticulated surface, by a flattening of the dorsal median half, and, especially, by a sharply outlined, subcentrally situated pit or sulcus, all of which characters are indicative of Kirkbya rather than Primitia. This relationship is probably a genetic one and may form grounds for a generic separation from both groups to which it seems allied. Until the subject can be more thoroughly investigated, the species are provisionally referred to Primitia.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland, Maryland; Keyser, West Virginia.

Collection.—U. S. National Museum.

PRIMITIA ? CONCENTRICA n. sp.

Plate XCV, Figs. 6-8

Description.—Valves moderately convex, with a broad depression occupying the median dorsal portion. Hinge-line straight, equal to three-fifths of the greatest length of the valve. Sulcus reduced to a small, centrally situated pit. Surface reticulated, the ornament of moderate coarseness and arranged in concentric rows about the pit.

Length of right valve 0.9 mm.; height 0.7 mm.; thickness 0.2 mm.

The general outline of the valve, concentric ornament, and the small pit are characters making this species easily recognized. Its relations are discussed in the general notes under *P. ? cumberlandica,* but *P. ? concentrica* seems to be more closely allied to Kirkbya than the former species.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

Genus PRIMITIELLA Ulrich

PRIMITIELLA VARIOLATA n. sp.

Plate XCV, Figs. 9, 10

Description.—Carapace elongate, subquadrate; dorsal margin straight with both ends about equally rounded, the anterior slightly the narrower; ventral margin almost straight in the middle and but little curved toward the ends; posterior ventral end somewhat more abruptly curved than the corresponding anterior portion and each but slightly different in curvature from the dorsal ends. Middle third of dorsal half of carapace occupied by a gentle depression. Anterior and posterior ends with a narrow border. Surface marked by more or less regularly arranged small clongate depressions or spots averaging six in the length and four in the width of the valve. The anterior portion of the carapace arises abruptly from the marginal rim, but the slope to the posterior edge is gradual; highest portion of valves in posterior third.

Length .72 mm.; height .32 mm.

The elongate-subquadrate outline and the surface markings are sufficient to distinguish this from all other species of the genus.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

Genus ULRICHIA Jones

ULRICHIA ÆQUALIS n. sp.

Plate XCV, Fig. 11

Description.—This neat species is closely related to the type of the genus, *Ulrichia conradi,* described by Jones from the Hamilton shale of Canada,[1] and is probably to be regarded as the progenitor of that form.

[1] Quart. Jour. Geol. Soc. Lond., vol. xlvi, 1890, p. 544, text fig. 2.

Comparing the two forms, the following points of agreements and differences may be found. The carapace in both is about equal in size and in general outline. In each species the characteristic knobs or tubercles are two in number, are situated in the dorsal region of the carapace and divide the valves into three more or less equal portions; the posterior tubercle in *U. conradi,* however, is somewhat larger than its associate, while both tubercles are of equal size in *U. æqualis.* Both species have a distinctly raised marginal rim, equally developed in the genotype, but in the new species under discussion, thickened and most prominent at the anterior and posterior ends. A further distinction is afforded in the different surface markings of the two species. The carapaces of both are reticulated, but in *U. æqualis* the reticulation is so faint and loose meshed as to be perceived only with difficulty, thus contrasting with the more closely woven, regular reticulation of *U. conradi.*

A European species, *U. morgani* (Jones), is also closely related but differs from both in wanting the marginal rim.

Length .86 mm.; height .53 mm.

Occurrence.—Oriskany Formation, Shriver Member. 21st Bridge.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus STREPULA Jones and Holl

Strepula irregularis Jones and Holl

Plate XCV, Figs. 12-15

Strepula irregularis **Jones and Holl, 1886, Ann. and Mag. Nat. Hist. (5), vol. xvii, p. 404, pl. xiii, figs. 5, 7, 8, 9, 15.**

Description.—On the slabs and in the washings from the Keyser limestone at Cumberland, are a number of specimens of an ostracod which seem indistinguishable from the British Wenlock species described and figured by Jones and Holl as *Strepula irregularis.* As suggested by its specific name and shown in the figures on pl. xcv, the species varies considerably in shape and in the distribution of their surface crests. The variations of these features in the American form are no greater and indeed may be duplicated in the figures published by Jones and Holl, so that we have no hesitancy in referring the species as above. Compared with other American Paleozoic ostracods, there is none with which it could be confounded. The sharp, superficial crests, together with the loose and somewhat irregular reticulation of the surface, give the valves a very striking aspect.

Length of an average right valve 1.30 mm.; height of same .70 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus HALLIELLA Ulrich

HALLIELLA ? SEMINULUM VAR. LONGA n. var.

Plate XCV, Fig. 16

Description.—Carapace elongate, nearly semicircular in outline, with a long hinge-line, subequal ends, the posterior one more nearly vertical than the anterior which begins to curve backward from the prominent dorsal angle; beak deeply notched; ends and ventral side with a smooth, concave border, widest posteriorly and narrowest antero-ventrally; surface strongly convex, reticulated; notch or sulcus deep, rather abruptly impressed, centrally situated, vertical, extending from the dorsal edge more than half across the valves.

Length of entire carapace 0.96 mm.; greatest height 0.52 mm.

This American variety of *H. ? seminulum* is more elongate even than the Gotland variety of the species, which is longer than the Wenlock specimens to which Jones originally applied the name, and the German form subsequently referred to the species by Krause. Our variety differs further from the European varieties in the sulcus which is more sharply defined, or, to express it differently, more abruptly impressed.

On two previous occasions,[1] the senior author referred *Primitia seminulum* Jones to his genus Halliella, but in the second instance it was recognized that the proposed generic change was not wholly natural. The

[1] Jour. Cincinnati Soc. Nat. Hist., vol. xiii, 1891, p. 49; Geol. and Nat. Hist. Surv. Minnesota, Final Rept., vol. iii, pt. ii, 1894, p. 656.

obvious affinities of the species to the following *H. ? triplicata* tends to emphasize the relations to Kirkbya then suggested. The generic reference is, therefore, at the present time, made doubtful.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

HALLIELLA ? TRIPLICATA n. sp.

Plate XCV, Figs. 17, 18

Description.—This species has a surface ornament and sulcus almost exactly as in *H. ? seminulum* and the variety *longa* just described, but differs in the following respects: The ratio between length and height is much less in *H. ? triplicata,* as a comparison of the respective measurements will show. The most obvious difference, however, lies in the occurrence of three plications along the ventral edge of the present species.

Length of valve .76 mm.; height .57 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

Genus ÆCHMINA Jones and Holl

ÆCHMINA CUSPIDATA Jones and Holl

Plate XCV, Figs. 19-21

Æchmina cuspidata Jones and Holl, 1869, Ann. and Mag. Nat. Hist. (4), vol. iii, p. 218, text fig. 2, pl. xiv, fig. 8.

Æchmina cuspidata Jones, 1870, Monthly Microscopical Journal, vol. iv, p. 185, pl. lxi, fig. 6.

Æchmina cuspidata Jones, 1887, Ann. and Mag. Nat. Hist. (5), vol. xix, p. 411, pl. xiii, figs. 2-4, 9.

Description.—The discovery in America of this well-marked species of the Wenlock shales is not without considerable interest. The species has been known to the writers for some time as a characteristic fossil of the New Scotland beds of New York, and the extension of its range to West Virginia is in keeping with their determination.

Length of left valve .84 mm.; height .40 mm.; length of spine .97 mm

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. 21st Bridge.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus MESOMPHALUS n. gen.

Carapace of medium size, 1 mm. to 2½ mm. in length, equivalved; valves moderately convex, oblong subquadrate in outline, with a small central pit lying between two rather small rounded nodes; edge of valves rather thick, usually concealed by a flattened border which overhangs it; ventral pouch somewhat elongate, sausage-shaped, occupying nearly the full length of the ventral side.

Type *Mesomphalus hartleyi* n. sp.

This new genus is founded upon an ostracod occurring abundantly in the Keyser limestone of Maryland and West Virginia, and exhibiting features which relate it on the one hand to Beyrichia, and on the other to Primitia, with a suggestion also of Ulrichia and Hollina. The presence of a large ventral pouch recalls this persistent feature of Beyrichia, but aside from this character, there is really very little in common between the two genera. The characteristic three lobes of Beyrichia are totally wanting. The true affinities of the genus lie with the Primitiidæ, as indicated by the distinct subcentral pit, while the two nodes are suggestive of Ulrichia. From these two genera it is clearly distinguished by the presence of the ventral pouch, and in individuals not possessing this, by the subcentral instead of nearly dorsal location of both the pit and node. The Carboniferous species of Hollina, like *H. radiata* (Jones), also have two somewhat similar rounded nodes, but if they are really homologous with those on the valves of Mesomphalus, an obvious difference is apparent in the location of the lobes in that genus, only one of them being situated in the middle part of the valve, the other, the anterior, being far up near the dorsal edge.

The closely approximated nodes, their subcentral position, the central pit, and the long, sausage-shaped ventral pouch, are the distinguishing characteristics of this new genus.

MESOMPHALUS HARTLEYI n. sp.

Plate XCV, Figs. 22-24; Plate XCVI, Figs. 1-3

Description.—Carapace averaging 2.00 mm. in length, 1.30 mm. in height, and a complete example exhibiting the ventral pouch, 1.00 mm. in thickness. Valves moderately convex, rather variable in shape, but generally approaching an oblong subquadrate outline. Ventral portion of valve in specimens supposed to represent the female form occupied by an elongate sausage-shaped pouch. Central part of valve with a small pit flanked by two small rounded nodes. Surface finely reticulose, with the center of each area marked by small papillæ.

Mesomphalus hartleyi presents an aspect so different from any associated ostracod, and in fact any other described form, that there seems no necessity for comparison. The specific name is in honor of Mr. Frank Hartley, of Cumberland, Maryland, who was kind enough to collect washings for us from the Coeymans limestone at that place.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland, Maryland; Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

MESOMPHALUS SUBMARGINATA n. sp.

Plate XCVI, Figs. 4, 5

Description.—The valves of this species suggest young specimens of the associated *Mesomphalus hartleyi,* but close comparison reveals the following differences: First, the valves are smaller, less convex, more elongate, and less oblique than the average specimens of the type of the genus. Second, the surface in *M. submarginata* is more finely granulose. Third, the posterior node is almost obsolete, and, lastly, the flange seems to be incomplete, being absent on the posterior end.

Length of left valve 0.9 mm.; width 0.55 mm.; greatest height 0.22 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

Genus CTENOBOLBINA Ulrich

CTENOBOLBINA ? DENTICULA n. sp.

Plate XCVI, Figs. 6-9

Description.—Carapace elongate, subovate, tapering anteriorly; hinge long and straight; surface gently convex, thickest anteriorly and sloping somewhat abruptly toward this extremity, granulose, and in some specimens with punctæ between the granules; median sulcus moderately developed, slightly curved and dividing the shell along the median line; immediately behind the sulcus a rounded node of considerable size, though no great prominence, is observable; the rest of the body of the valve rather evenly convex. Occasionally a small spine in the posterior half of the dorsal edge; flange or frill narrow, but developed rather uniformly along the entire length of the free edge of the valve; edge of frill bearing a row of small spines which are most conspicuous in the posterior edges. On the anterior end the contact edge beneath the flange bears denticles.

Length of right valve 1.45 mm.; height .82 mm.

One of the type specimens has a granulose surface, while the surface of the second, in addition to the granules, presents rather regularly placed punctæ. Whether the latter condition is a specific character or is due to weathering cannot be determined from the material at hand. The position of this specimen is somewhat questionable. If it really belongs to Ctenobolbina, then it must be classed with the *subcrassa* section of the genus, but the post-median node is longer than in any other known species of the genus. The shape of valve, size, character and granulose marking of flange and contact edges, is as in typical Ctenobolbina. Considering the large size of the node, it is possible that the species is nearer Klœdenia, but for reasons mentioned, also the absence of a sulcus behind the node, this relation seems more questionable than the one given the species.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

CTENOBOLBINA ? DUBIA n. sp.

Plate XCVI, Figs. 10-12

Description.—Carapace subovate except that the dorsal edge is nearly straight. As oriented, the posterior end is the narrower, but considerably the thicker. An undefined broad median sulcus confined to the dorsal half; otherwise the valve is without furrows. Posterior half of dorsal edge somewhat excavated, forming a straight shoulder descending abruptly; ventral edge thick, with a rather narrow flange around the ends and ventral portion. Surface smooth.

Length 1.00 mm.; height .62 mm.

The position of this species is altogether doubtful. There is a general resemblance to Ctenobolbina, but the sulcus is so shallow and limited in its extent, and the shape of the valve so different from the average of that genus, that the species really belongs here. In general expression again, as also in the thick ventral edge, considerable agreement is noted with certain similarly thick-edged Primitias. Finally, it is not altogether improbable that the species is nearer the type of Halliella than any other. However, until all of these various Primitian genera shall have been revised, the position assigned the species will serve the purpose of classification provisionally.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus BOLLIA Jones and Holl

BOLLIA AMERICANA n. sp.[1]

Plate XCVI, Figs. 13-15

Description.—This well-marked Bollia is closely related to the type of the genus, *B. uniflexa* Jones and Holl, and also to the somewhat similar

[1] Compare *Bollia bicollina* Jones and Holl, 1886, Ann. and Mag. Nat. Hist. (5), vol. xvii, p. 361, pl. xii, figs. 14-16, and *B. uniflexa*, *ibid.*, figs. 17*a*, 17*b*.

B. bicollina, noted in the bibliography above, but from each it can be separated by slight although important differences.

Length of left valve 1.24 mm.; height of same .9 mm.

The outline of the valves in *B. uniflexa* and *B. americana* is practically identical, but the former has a reticulate surface and a slightly developed marginal ridge. In *B. bicollina* the valves are more equal ended than in the American species, while further differences may be noted, especially in the marginal ridges of the two species. There are sharp protuberances or crests in *B. bicollina* closely paralleling the edge of the valve and continuing to the dorsal border. The marginal ridge in *B. americana,* however, is more rounded and like the inner ridge, thickens slightly into terminal knobs before the hinge is reached.

Bollia americana, B. uniflexa, and *B. bicollina* are three well-marked members of the typical section of Bollia, namely that division of the genus in which the outer ridge is not strongly developed while the inner ridge has bulbous ends connected by a narrow bent portion. No American species is known closely resembling it to make comparisons necessary.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge, Cash Valley.

Collections.—Maryland Geological Survey, U. S. National Museum.

BOLLIA CURTA n. sp.

Plate XCVI, Figs. 16, 17

Description.—Carapace subcircular except along the short, straight hinge, with ends strongly and almost equally curved; dorsal angle obtuse, hinge straight and rather short; outer ridge thin, inconspicuous, paralleling and closely following the margin and reaching the dorsal edge with its ventral part showing a neat row of papillæ; inner ridge thick, equally developed throughout, occupying the greater portion of the valve, but not extending to the hinge margin; the included sulcus narrow; surface of valves papillose.

Length of valve .76 mm.; width .60 mm.

The subcircular outline, unusual development of the inner ridge, and the insignificant outer rim, cause this species of Bollia to be easily recognized.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

BOLLIA IRREGULARIS n. sp.

Plate XCVI, Fig. 18

Description.—Carapace elongate, subelliptical, the length about one and two-thirds times the height, hinge-line approximately straight, anterior and posterior ends about equally rounded, ventral margin gently curved with a slight backward swing of the anterior outline; edges of valves thick, forming the marginal ridge which extends practically to the dorsal line at each end; marginal ridge along posterior end thinner than the corresponding anterior portion and slightly constricted in the lower third; inner ridge irregularly U-shaped with the posterior arm reflexed and slightly bulbous; spaces between ridges narrow, sharply depressed.

Length of right valve .60 mm.; height .36 mm.

Bollia irregularis is probably most closely related to the common Cincinnatian form *B. persulcata* (Ulrich),[1] with which it agrees in size, general outline, and distribution of the ridges. Minor differences such as the more pronounced development of the ventral portion of the marginal ridge, and the less bulbous character of the inner ridge, will readily distinguish the Helderberg species.

Occurrence.—HELDERBERG FORMATION, NEW SCOTLAND MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

BOLLIA JUGALIS n. sp.

Plate XCVI, Fig. 19

Description.—Carapace obliquely subovate, the anterior end narrower and more abruptly truncate of the two; ventral margin curved, with the

[1] Jour. Cincinnati Soc. Nat. Hist., vol. ii, 1879, p. 12, pl. vii, fig. 6.

greatest amount of curvature in the posterior portion; dorsal margin straight. Inner ridge thick, regularly U-shaped, with the ends slightly bulbous and reaching the dorsal margin; outer ridge imperfectly developed and coalescing with the inner ridge along the ventral side; dorsal ends of outer ridge free, but reaching little more than halfway across the valve; anterior arm of outer ridge narrow and drawn out; posterior end thick and bluntly rounded; edge of valves marked by a somewhat obscure marginal rim.

Length 1.40 mm.; height .94 mm.

The union of the inner and marginal ridges along the ventral portion, suggesting the specific name, is the distinguishing and characteristic feature of this species. The associated *B. americana* is of similar shape and size, but the surface configuration of each is sufficiently distinct to admit of no confusion in identification. A similar union of the inner and outer ridges along the ventral side is unknown to us in any other species of the genus, so that in this respect *B. jugalis* seems to be unique.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

BOLLIA UNGULA Jones

Plate XCVI, Figs. 20-22

Bollia ungula **(Claypole MS) Jones, 1889, Amer. Geol., vol. iv, p. 338.**
Bollia ungula **Ulrich, 1891, Jour. Cincinnati Soc. Nat. Hist., vol. xiii, p. 188, pl. xiv, figs. *6a*, *6b*.**

Description.—The geologic range of this widespread Bollia has been considerably extended by the discovery of specimens in the siliceous dark shales of Lower Oriskany age at 21st Bridge. Hitherto the species has been known only from strata of Middle Devonian age in the various parts of the eastern half of the United States. With the exception of a slight variation in the marginal rim, these Oriskany specimens differ but little from examples in the type horizon.

Length .77 mm.; height .47 mm.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

Genus KLŒDENIA Jones and Holl

Klœdenia centricornis Ulrich and Bassler

Plate XCVII, Figs. 1-4

Klœdenia centricornis Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, pl. xxxviii, fig. 23.

Description.—Valves very slightly oblique, elongate, subelliptical, the relation of length to height being a little less than two to one; hinge-line long and straight, though shorter than length of the shell; cardinal angles subequal, generally rather obtuse; ends nearly equal, curving broadly into the bowed ventral part of the outline. Surface of valves rather coarsely reticulated or pitted and with the usual two furrows. The conical, sometimes spine-like form of the median node is the most peculiar feature of the species. The contour of the remainder of the surface is about as usual except that the ventral slope is uncommonly abrupt and the flattened border a little wider than usual.

Left valve, fig. 1, length 1.83 mm.; height 0.92 mm.; left valve, fig. 2, length 1.47 mm.; height .76 mm.

Both of the figured and only known specimens from Maryland are provided with a ventral pouch. This is situated rather far back and gives the female valves a more oblique form than pertains to the male. Good specimens of the latter from equivalent beds in the New York are contained in the Ulrich collection at the U. S. National Museum. The unusual length of the valve, spine-like central node, and coarse pitting, are features which will cause its easy identification and differentiation from other species of the genus.

Occurrence.—Helderberg Formation, Keyser Member. Cumberland.

Collection.—U. S. National Museum.

Klœdenia fimbriata Ulrich and Bassler

Plate XCVII, Figs. 5-7

Klœdenia fimbriata Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, pl. xxxviii, fig. 22.

Description.—This fine species will be recognized at once by its spinose margin. This spiney frill, together with the reticular surface ornament and the general neatness of form, imparts a striking elegance to the shell. The depth of the anterior sulcus, which, however, is located very near the middle of the valve, is somewhat suggestive of Primitiidæ like *Eurychilina*. But the size and form of the median lobe—indeed every feature that experience has shown to be essential—is too thoroughly in accord with *Klœdenia* to have any doubt as to the generic position of the species. Only a few specimens have been seen and none of these have a ventral pouch.

Length of left valve, including marginal spines, 2.5 mm.; width 1.3 mm.; height 0.5 mm.

This species was described from the Coeymans limestone of Herkimer County, New York, and fragments of apparently the same form have been noted at Cumberland, Maryland.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

KLŒDENIA NEARPASSI (Weller)

Plate XCVII, Figs. 12, 13

Beyrichia nearpassi Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 255, pl. xxiii, figs. 7, 8.

Klœdenia nearpassi Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 301 (gen. ref.).

Description.—"Carapace subelliptical in outline, the posterior extremity equaling or a little narrower than the anterior; the hinge-line straight, about four-fifths of the total length of the valves. Free margin, with a flattened, marginal border. Valves divided into three lobes by two rather broad and deeply impressed, nearly equal furrows, which start from the dorsal margin and extend vertically downward to about the middle of the valve. A shallower and less sharply defined furrow extends vertically upward from the ventral margin, directly beneath the anterior furrow from the dorsal margin, the two being indefinitely connected across the middle of the valve by a slight depression. The posterior lobe is strongly convex and is the largest of the three, occupying about one-half of the total length of the valve; medial lobe subglobular, about as high as the posterior one; anterior lobe about the same width as the median one, but less strongly convex. Entire surface of the valves smooth." Weller, 1903.

The dimensions of an average specimen are: Length 1.75 mm.; height 1 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway.

Collection.—U. S. National Museum.

KLŒDENIA KÜMMELI (Weller)

Plate XCVII, Fig. 16

Beyrichia kümmeli Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 266, pl. xxiv, fig. 21.

Klœdenia kümmeli Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 301 (gen. ref.).

Description.—"Carapace subelliptical in outline, a little narrower in front, hinge-line straight, about three-fifths of the total length. Free margin with a depressed, concave border, whose outer edge is slightly elevated in a rounded, marginal ridge, outside of which the surface drops abruptly to the edge of the valve. Valve divided into three lobes by two furrows, which extend ventrally downward from the hinge-line to about the middle of the valve; the anterior furrow a little shorter than the other, with its lower extremity slightly curved backward. Posterior lobe the largest, including nearly one-half of the valve, with a small, but distinct, tubercle a little in front of its middle point. Middle lobe subglobular in form, more highly convex than either of the others, with a slight, concave excavation at its base. Anterior lobe more depressed convex than either of the others. Surface finely pitted, except on the marginal border and in the furrows; the pits appearing to be angular depressions, with narrow, dividing ridges.

"The dimensions of the type specimen are: Length 4 mm.; height 2.5 mm." Weller, 1903.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway.

Collection.—U. S. National Museum.

KLŒDENIA SUSSEXENSIS (Weller)

Plate XCVII, Figs. 14, 15

Beyrichia sussexensis Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 253, pl. xxiii, figs. 3 and 4.

Klœdenia sussexensis Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 301, pl. xxxviii, figs. 19, 20.

Description.—"Carapace subelliptical in outline; the dorsal margin straight, its length about nine-tenths of the total length of the valves, its extremities angular. Ventral margin gently convex; the anterior and posterior margins both broadly rounded, the posterior extremity being a little higher than the anterior and its margin being nearly straight for a short distance below the postero-dorsal angle. The entire free margin of the valves with a distinct, flattened, marginal border, which is abruptly separated from the body of the valve. The dorsal half of the surface of each valve is divided into three lobes by two deep furrows, which reach to about the middle of the valve. The posterior furrow divides the valve at about the middle of its length and is nearly straight; the anterior furrow lies about halfway between the posterior one and the anterior extremity; it is a little shorter than the other and its lower extremity is slightly bent backward. The two furrows are connected below by an indistinct depression in the valve, partially isolating the middle lobe. The anterior and posterior lobes are connected ventrally. The middle lobe is subglobose and is the most prominent of the three; the posterior lobe is a little more prominent than the anterior. The entire surface, except in the furrows and on the marginal border, is finely papillose.

"The dimensions of the type specimen are: Length 3 mm.; height 1.8 mm." Weller, 1903.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway.

Collection.—U. S. National Museum.

KLŒDENIA BARRETTI (Weller)

Plate XCVII, Fig. 17

Beyrichia barretti Weller, 1903, Geol. Surv. N. J., Pal., vol. iii, p. 254, pl. xxiii, fig. 9.

Klœdenia barretti Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 301 (gen. ref.).

Description.—"This species resembles the last [*K. sussexensis*] but is smaller, with the anterior furrow narrower and with the posterior one produced further toward the ventral margin, giving to the median lobe a more elliptical outline.

"The surface is also very differently marked, it being covered with rather large, irregular pits. The ventral margin is nearly straight in the central portion, the anterior and posterior extremities of the valve being of nearly equal height.

"The dimensions of the type specimen are: Length 2.3 mm.; height 1.5 mm." Weller, 1903.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway.

Collection.—U. S. National Museum.

Genus KLŒDENELLA Ulrich and Bassler

KLŒDENELLA PENNSYLVANICA (Jones)

Plate XCVII, Figs. 18-21

Klœdenia pennsylvanica Jones, 1889, Amer. Geol., vol. iv, p. 341, pl. figs. 5*a-d*, 6 (not 7*a*, *b*, 8, 9).

Klœdenella pennsylvanica Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 304, fig. 54, p. 318, pl. xliii, figs. 1-3.

Description.—As noted in the remarks under *Klœdenella turgida* several distinct species were referred to *Klœdenia pennsylvanica* by Jones in his original description. The present writers have restricted this species to Jones's figs. 5 and 6. The differences between these several species are indicated in the remarks under *Klœdenella turgida* and *Klœdenella turgida ventrosa.*

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Tonoloway, and other localities in Maryland. The species occurs also in the lower beds of the Helderberg in Pennsylvania and other states.

Collection.—U. S. National Museum.

KLŒDENELLA CLARKEI (Jones)

Plate XCVII, Fig. 21

Beyrichia clarkei Jones, 1890, Quart. Journ. Geol. Soc. Lond., vol. xlvi, p. 17, text fig. 2.

Bollia clarkei Ulrich, 1894, Geol. and Nat. Hist. Surv. Minnesota, Final Rept., vol. iii, pt. ii, p. 669.

Klœdenella clarkei Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 319.

Description.—This well-marked species which was originally described from the Lower Helderberg of Herkimer County, New York, may be readily distinguished from associated forms of Klœdenella by its less elongate shape and more conspicuous sulci.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

KLŒDENELLA CLARKEI VAR. PAUPERA Ulrich and Bassler

Plate XCVIII, Figs. 1-3

Klœdenella clarkei paupera Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, pl. xliii, fig. 5.

Description.—The specimens referred to under the above name are obviously close allies of *Klœdenella clarkei* (Jones). This species, together with *K. halli* constitutes a readily distinguishable group of the genus in the sharp definition of the lobes and the unusual depth and length of the sulci. The lobation of the valves ordinarily appears to consist of four ridges joining ventrally. The typical form of the species is a common fossil in the underlying Silurian formation. The variety here figured is distinguishable by characters of only minor value. Its valves and the ridges especially are thinner, giving the whole a somewhat emaciated appearance. It is noted further that the furrows present somewhat irregularly distributed papillæ which have not been observed in the earlier phases of the species. The figures on pl. ii afford a sufficiently accurate representation of the species to render its recognition easy.

Length .75 mm.; height .45 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

KLŒDENELLA TURGIDA Ulrich and Bassler

Plate XCVIII, Figs. 4-6

Klœdenia pennsylvanica Jones, 1889 (part), Amer. Geol., vol. iv, p. 341, figs. 8, 9 (not figs. 5-7).
Klœdenella turgida Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, p. 318, pl. xliii, figs. 6, 7.

Description.—Upon comparison of the species of *Klœdenella* with the figures referred to *K. pennsylvanica* by Jones (*loc. cit.*), it appears that three distinct forms have been included under that name. Two of these belong in the Keyser limestone, while the form to which it is proposed to restrict *K. pennsylvanica* is very abundant in the underlying Manlius. *K. turgida* is distinguished from *K. pennsylvanica,* as here restricted, by the strong development of the anterior sulcus. This sulcus delimits a well-marked anterior lobe and produces a somewhat concentric arrangement of the lobes behind it, the effect being quite different from the usual appearance of *K. pennsylvanica.*

Length of a normal right valve 1.10 mm.; height .64 mm.; length of a short left valve .97 mm.; height .60 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland, Maryland; Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

KLŒDENELLA TURGIDA VAR. VENTROSA Ulrich and Bassler

Plate XCVIII, Fig. 7

Klœdenia pennsylvanica Jones, 1889 (part), Amer. Geol., vol. iv, p. 341, figs. 7*a*, 7*b* (not figs. 5, 6, 8, 9).
Klœdenella turgida ventrosa Ulrich and Bassler, 1908, Proc. U. S. Nat. Mus., vol. xxxv, pl. xliii, fig. 8.

Description.—As noted in the remarks on *K. turgida* Jones's figures of *K. pennsylvanica* are thought to include specimens of three distinct species. The form now under consideration is more like *K. pennsylvanica* s. s. in lobation of the valves than *K. turgida,* being without a well-marked anterior sulcus, but in the less elongate form and general aspect it is so like the latter that it has been placed as a variety of this species. Its main peculiarity lies in a ventral swelling which causes an apparent break in the antero-median lobe. The ventral flange is unusually well developed and the series of granules along the antero-ventral edge has not been observed in any other species of the genus.

Length 1.05 mm.; height .65 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

Family THLIPSURIDAE

Genus THLIPSURA Jones and Holl

THLIPSURA MULTIPUNCTATA n. sp.

Plate XCVIII, Fig. 8

Description.—Valve subovate, tapering posteriorly, the ventral side straight, the dorsal side strongly convex, the curvature of same semicircular in the anterior half, but growing less posteriorly; surface moderately convex, marked in the anterior half of the shell by a group of four subquadrangular pits and with two, or rather three, elongated depressions paralleling the post-dorsal half.

Length of right valve 1.0 mm.; width 0.6 mm.

There is no described American species with which this need be compared, indeed, this is the first recognition of the genus Thlipsura in America. However, eleven or more species and varieties have been described from the Silurian of Europe, and of these, *T. multipunctata* is most closely allied to *Thlipsura plicata* var. *bipunctata* Jones and Holl. In the latter form the anterior pits are only two in number while the posterior marking consists of a single sulcus. In other respects the valves are quite similar and in future study with abundance of material, our American species may prove to be only a variety or form of *T. plicata.*

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge.

Collection.—U. S. National Museum.

Genus OCTONARIA Jones

OCTONARIA ? ANGULATA n. sp.

Plate XCVIII, Figs. 9-11

Description.—Valve semicircular, the anterior and dorsal sides regularly curved, the ventral edge straight, the post-ventral angle clearly defined and approximately rectangular, the antero-ventral region blunt and somewhat obliquely truncated. Surface of valves depressed, convex, with a thin rim-like marginal ridge; within the latter a similar ridge essentially paralleling the outer one; finally a straight or curved thin ridge divides the median space longitudinally into subequal parts. The depressed spaces between the ridges show obscure, irregularly distributed papillæ.

Length of an average left valve .75 mm.; height .50 mm.

Of this singular species, nothing but the separated valves have been observed. Their reference to Octonaria is of course somewhat provisional, none of the hitherto described species being at all close. It is possible also that the hinge has been misinterpreted and that the straight edge may be the cardinal instead of the ventral side. The very slight convexity of the surface is somewhat foreign to the conception of Octonaria, as is also the marginal ridge. The latter feature and also the inner ridge are somewhat suggestive of Strepula, but after careful comparison, it was decided that there was really no relationship to that genus. Considering the straight edge as dorsal, another relationship which may be suggested is to certain species of Kirkbya. However, pending further information respecting the hingement and relation of the valves to each other, the above designation will serve provisionally.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland, Maryland; Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

OCTONARIA INÆQUALIS n. sp.

Plate XCVIII, Figs. 12-18

Description.—Valve ovoid to subrhomboidal; left valve larger and overlapping the right on all sides; ornament of left valve consisting of two parallel curved depressions in the dorsal portion, the outer the less conspicuous, and of two or more smaller depressions with their corresponding ridges just within the anterior half and a little beneath the crater of the shell; the right valve of the same carapace shows a similar arrangement of the grooves in the dorsal half, but the anterior and ventral depressions are in part unrecognizable or absent and so arranged that the general aspect is very different from that of the opposite (left) side of the shell.

Length of a complete carapace 0.7 mm.; width 0.50 mm.; thickness 0.37 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

OCTONARIA SIMPLEX (Krause)

Plate XCVIII, Fig. 19

Thlipsura simplex Krause, 1891, Zeits. deutsch. geol. Gesell., vol. xliii, p. 508, pl. xxxii, fig. 16.

Description.—Among the numerous specimens of Ostracoda from the Keyser limestone is the single presumbably right valve figured, which agrees essentially with the figures of *Octonaria simplex* (Krause), from the Silurian drift of northern Germany. The subcentral pit or sulcus at first recalls Primitia, but the convex cardinal margin is indicative of overlapping valves as in Octonaria and Thlipsura. More material is necessary to determine the true genetic relations of this form, and until this is forthcoming, it seems best to regard the species as above.

Length of right valve 0.80 mm.; width 0.57 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

Genus CRATERELLINA n. gen.

This genus is erected for a small group of early Devonian Ostracoda, two of which are illustrated in this work. One of these is found in great numbers upon the surface of dark siliceous shales of Lower Oriskany age at 21st Bridge. Although the preservation of this material is not of the best, still a sufficiently large number of individuals were found to indicate that the original of pl. xcviii, fig. 21, is a normal example, and that its surface characters are as indicated. The second form is a larger but less abundant species in the same formation. Both species occur in comparative abundance in the Lower Oriskany cherts at Cash Valley, Maryland, and other forms are known in rocks of similar and earlier age elsewhere.

The most obvious characteristic of the genus is the presence of a crater-like depression bordered by a more or less distinctly elevated rim occupying the anterior third or half of each valve. Otherwise the general shape and relation of the valves, and other characteristics, ally the new genus Craterellina to Thlipsura and Octonaria. However, the absence of the posterior sulci of the former and the proportionally great size of the single large round excavation in the anterior part of the valve impart a sufficiently peculiar aspect to the five or six species which it is proposed to refer here to justify their generic separation from all established genera.

Type *Craterellina robusta* n. sp.

CRATERELLINA ROBUSTA n. sp.

Plate XCVIII, Fig. 21

Description.—Valves rather broadly subovate, the ventral edge considerably less curved than the dorsal, and the posterior end much narrower than the anterior. The crater-like depression in the anterior half extends practically to the edge of the valve. An extension or projection into the depression from the posterior side of the surrounding rim tends to divide the cavity into two more or less equal halves, each of which is marked by a node-like prominence. A rather distinct rim borders the posterior half. Remainder of surface broadly convex, and exhibiting occasional punctæ.

Length of right valve 1.25 mm.; height 0.9 mm.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge, Cash Valley.

Collections.—Maryland Geological Survey, U. S. National Museum.

CRATERELLINA OBLONGA n. sp.

Plate XCVIII, Fig. 20

Description.—Carapace suboblong or somewhat irregularly subovate; posterior end slightly narrower and more rounded than the blunt anterior end; anterior half of valve with a ring-like ridge enclosing a depression from the center of which a small, rounded, cone-like prominence arises. Otherwise the surface is simply convex, with occasional scattered punctæ, or smooth.

This species is readily distinguished from its associate *C. robusta* by its smaller size, more elongate shape and proportionately smaller "crater."

Length of right valve 0.8 mm.; height 0.5 mm.

Occurrence.—ORISKANY FORMATION, SHRIVER MEMBER. 21st Bridge, Cash Valley.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family CYPRIDAE

Genus BYTHOCYPRIS Brady

BYTHOCYPRIS PUNCTULATA VAR. ARCTATUM n. var.

Plate XCVIII, Fig. 22

Description.—The specimen upon which this new variety is founded agrees apparently fairly well with the Middle Devonian *Bythocypris punctulata* Ulrich, but close comparison will show the following differences: The new variety is smaller, more elongate and narrower at the anterior end, but a more striking difference is observed in the close arrangement of the punctæ. In *B. punctata,* the punctæ are several times their own diameter apart, but in the variety this distance is reduced to one diameter or even less.

Length of left valve 1.10 mm.; height .60 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland, Maryland; Keyser, West Virginia.

Collections.—Maryland Geological Survey, U. S. National Museum.

Genus PONTOCYPRIS Sars

PONTOCYPRIS ARCUATA n. sp.

Plate XCVIII, Figs. 23-25

Description.—Carapace moderately convex, subreniform, the dorsal outline almost regularly arcuate, the ventral edge long, very slightly sinuate; ends somewhat unequal, the posterior rounding sharply into the ventral margin and very gradually into the dorsum, the anterior blunter; left valve overlapping the central part of the ventral edge of the right, while the dorsal edge of the right similarly overlaps the left valve. In edge views the outline is lenticular, tapering regularly and equally to each extremity. In an end view the greatest thickness lies above the center. Surface smooth.

Length 1.0 mm.; greatest height 0.56 mm.; greatest thickness 0.38 mm.

This species is related to *P. smithi* and *P. mawi,* two Wenlock species described by Jones. It is shorter than either of the British species and the slight convexity of the ventral outline and the less acuminate posterior end afford sufficient difference to distinguish it readily enough from *P. mawi.* Critically compared with *P. smithi,* which is the nearer of the two, the present species is distinguished by its shorter form, more regularly arcuate dorsum, straighter ventral edge, and in having the anterior and posterior halves of the carapace less equal.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collection.—U. S. National Museum.

PONTOCYPRIS MAWII VAR. BREVIATA Jones

Plate XCVIII, Figs. 26-28

Pontocypris mawii var. *breviata* Jones, 1889, Ann. and Mag. Nat. Hist. (6), vol. iv, p. 269, pl. xv, fig. 4.

Description.—The specimens figured agree so well with the variety *breviata* of this well-known European Silurian species that the writers have no hesitancy in so referring the American form. The shortening of the anterior portion of the shell, thus producing a more equal ended effect, is the most noticeable feature of the variety. The more accurate outline of the associated *P. arcuata* will distinguish the two forms at sight.

Length of left valve 1.2 mm.; height .65 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

Family CYTHERELLIDAE

Genus PACHYDOMELLA Ulrich

PACHYDOMELLA LONGULA n. sp.

Plate XCVIII, Figs. 29-31

Description.—Carapace somewhat elongate subelliptical, the ventral side less curved than the dorsal, the ends nearly equal, the posterior a trifle wider and very slightly truncated in the dorsal part; valves thick and very convex, the left overlapping the right all around, the overlapping edge thickened and slightly prominent along the antero-dorsal and ventral edges. Point of greatest thickness of left valve in the ventral half, in the right valve, in the dorsal half, the resulting appearance in an end view being one of oblique compression. In a ventral view, the greatest thickness is near the middle of the posterior half, where it exceeds in amount the height of the carapace. Surface of valves smooth, apparently without markings of any kind.

As near as can be determined from the character of the specimens, this species conforms in every respect with the type of the genus *Pachydomella tumida*, the only difference of consequence being that in *P. longula* the shape of the carapace is more elongate. Jones and other authors have referred somewhat similar highly inflated species to Polycope, but in these forms the shell is evidently not so thick, the overlapping rim of the larger valve being much less conspicuous.

Length of complete carapace 1.15 mm.; height .60 mm.; thickness .70 mm.

Occurrence.—HELDERBERG FORMATION, KEYSER MEMBER. Cumberland.

Collections.—Maryland Geological Survey, U. S. National Museum.

GENERAL INDEX

PALEONTOLOGICAL INDEX

Figures in **bold face** indicate principal discussion.

D

E

F

COLUMNAR SECTIONS OF THE LOWER DEVONIAN
OF MARYLAND

By CHARLES K. SWARTZ

MARYLAND GEOLOGICAL SURVEY

WILLIAM BULLOCK CLARK, State Geologist

SCALE: HORIZONTAL (IN EAST-WEST DIRECTION) 1 INCH 2 MILES
VERTICAL 1 INCH 50 FEET

The numbers beside the columnar sections refer to the subzones of the Keyser Member of the Helderberg, as follows:

Favosites helderbergiae var. praecedens zone.
14. Leperditia subzone
13. Corriganville Stromatopora reef subzone
12. Tentaculites gyracanthus subzone
11. Corriganville lower Stromatopora reef subzone
10. Rensselaeria mutabilis subzone
9. Keyser coral reef subzone

Chonetes jerseyensis zone
8. Bryozoan subzone
7. Gypidula coeymanensis var. prognostica subzone
6. Cystid-Spirifer subzone
5. Rawlings Stromatopora reef subzone
4. Cladopora rectilineata subzone
3. Rhynchospira formosa subzone
2. Rhynchospira globosa subzone
1. Warrior Mountain coral subzone