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ON

THE HIGHER DEVONIAN FAUNAS

OF

ONTARIO COUNTY NEW YORK

BY

JOHN M. CLARKE

WASHINGTON

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., January 13, 1885.

SIR: I have the honor to transmit herewith a paper entitled On the Higher Devonian Faunas of Ontario County, New York, by Mr. J. M. Clarke.

Mr. Clarke has had unusual opportunities for making a critical study of the Devonian strata and faunas of the district mentioned, and I respectfully recommend the publication of his paper in the form of a bulletin as giving valuable new data.

Very respectfully,

CHAS. D. WALCOTT,
Paleontologist.

Hon. J. W. POWELL,
Director of the United States Geological Survey.

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THE HIGHER DEVONIAN FAUNAS OF ONTARIO COUNTY, NEW YORK.

By John M. Clarke.

INTRODUCTORY REMARKS.

The materials and the conclusions presented in this paper are the partial results of studies of the Devonian of Western New York, which have been of several years duration. Since the summer of 1877 much attention has been given to the finer subdivision of the Devonian on strictly paleontological evidence, the rich development of Devonian faunas within Ontario County, and in its vicinity, having afforded an unequaled opportunity for such work. What is here given concerns only the Higher Devonian strata and their contents, viz., those of the Genesee, Portage, and Chemung formations, and the materials here made use of have been derived principally from the county of Ontario, with important additions from the eastward and westward extension of these strata into the adjoining counties of Yates and Livingston.

In preparing these notes I have received many kindnesses from my companion in the field, Mr. D. D. Luther, esq., of Naples, N. Y., to whom credit belongs for many of the discoveries here detailed.

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THE PETROGRAPHIC AND PALEONTOLOGIC CHARACTERS OF THE GENESEE BEDS.

TYPICAL EXPOSURES.

1. East and west shores of Canandaigua Lake from Seneca Point and Genundewah south to Woodville.
2. The ravines on the west side of Canandaigua Lake, viz.; at Black Point, Seneca Point. and Foster's Point.
3. Cheshire in Canandaigua Township.
4. Bristol Center in "Blacksmith's," Randall's, and other gullies.
5. Hamilton Gully, Honeoye Lake.
6. Glenville, Hemlock Lake.

These shales constitute the uppermost subdivision of the rocks of the Hamilton Period, and are usually regarded as representing the uppermost Middle Devonian in New York. Since the original thorough characterization of these strata in the Geological Report of the Fourth District of New York, in 1843, their petrographical features, in a general sense, have been well known. In Ontario and the adjoining counties they are developed as a mass of bituminous shales, although varying in the amount of organic matter they contain in different horizons and localities.

Bituminous shales occur also in the overlying Naples group of strata, which are separated from the dark layers of the Genesee by a distance of only a few feet of green shales, and on this account their bituminous character does not always serve to identify their outcrops where the adjoining rocks are not exposed. The order of succession in the Genesee strata of the district under consideration is not constant, largely explained by the fact that the rocks are shales, although in the fact of their tendency to local variations these beds differ from the shales of the underlying Hamilton *proprement dit* which I have found to be quite persistent in petrographical character and paleontological contents.

Along the shores of Canandaigua Lake, where the strata have an excellent development, there are at the base of the group about 20 feet of bituminous arenaceous shale, containing rows of concretions of impure calcic carbonate, this overlaid by 40 feet of densely bituminous rock having a perfect cleavage that gives it a close resemblance to a slate. This bed is so rich in organic matters that a blow of the hammer evaporates enough of the lighter hydrocarbons to produce a very strong petroleum smell. Over limited areas it loses its schistose character, becomes compact and densely rich in bituminous matter. The freshly broken surface is of a deep black or dark coffee color, and the streak chocolate brown. On account of numerous planes of jointing which

cross these layers, and the capacity of the rock for resisting weathering, they always make a marked feature in a landscape. The exposures are generally high walls covered with projecting battlements, buttresses and parallelopipedons.

Above these strata lies a mass of black, fragile, clay shale, 100 feet thick, which passes into the overlying transition shales.

Further than this there is no variation in the rocks of the Genesee division in Ontario County, except in the case of the thin calcareous beds which are here designated as the *Styliola layer*.

In the summer of 1878 I received from Mr. Hall a small fragment of limestone quite made up of the exuviæ of the little pteropod which had already been described by him as *Tentaculites fissurella*, subsequently as *Styliola fissurella*. The specimen had been collected in the course of the geological survey of 1837–'43 from a loose block in the town of South Bristol, Ontario County. Accompanying the specimen was a request that I should make a search for the outcrop of this rock, and subsequent searches resulted in finding the layer in the midst of the dark shales of the Genesee and about 20 feet from their base, a little to east of the village of Cheshire in the township of Canandaigua. Continued searches for the distribution of the layer have discovered its outcrops in many and widely separated localities throughout the width of the district under consideration. Wherever occurring this layer is quite unique in its composition, consisting almost wholly of the shells of these minute pteropods, which are so small that they measure no more than $1\frac{1}{2}$ to 2^{mm} in length, and so abundant that I have estimated from good specimens of the limestone at least 40,000 individuals to a cubic inch of the rock. *Styliola fissurella* occurs also in great abundance in other horizons, as in the bituminous shales of the Marcellus epoch, where it is very characteristic of the blackest and most fissile layers.[2] Hall has also quoted the species as occurring in great abundance in the Black Slates of Lexington, Indiana, where it is associated with *Chonetes lepida* H. Further on in this paper I note the recurrence of the fossil in great quantities in a concretionary Goniatite-bearing stratum of the Naples shales, but nowhere else does it occur in so great abundance as at this horizon.

This *Styliola layer* varies somewhat in petrographical character in its different outcrops. On the shores of Canandaigua Lake it makes a somewhat concretionary limestone about 1 foot in thickness, and with a strong schistose tendency. In the ravines about Bristol Center and further to the west its concretionary character becomes more strongly marked, and in these places the concretionary masses are overlaid and underlaid by masses of strongly bituminous shale containing the same fossil in the same abundance. Still farther west, in the township of Richmond, and near Hemlock Lake, the layer becomes pretty well sepa-

[2] Paleontology of N. Y., Vol. V, Pt. II, p. 179.

rated into a succession of thin, very calcareous bands, which are scattered through a thickness of several feet in the dark shales; but, however it may oscillate between shale and limestone, its place in the rocks is at once marked by the predominance of the *Styliola*. Its persistence is noteworthy, as Mr. Hall states that a similar limestone 6 inches thick is to be found on Cayuga Creek, near Alden, Erie County, about 80 miles further west.

Whether the rock of the stratum be limestone or shale, it is always extremely rich in organic matter. I find that in most of the shales there is quite as great an abundance of *Styliola* shells as in the limestone, while there is a much greater quantity of organic matter, and to this may be ascribed the more perfectly developed tendency to cleavage in the shales, for the calcium carbonate of both limestone and shales is almost wholly derived from these shells. Thin sections show under the microscope that the rock has little else in it than these exuviæ, so closely crowded together that not infrequently one individual is thrust inside of another, and a third inside the second. In whatever direction of a fragment of the rock a thin slice is made, all the interspaces between the individuals which have been longitudinally cut are usually completely filled with transverse sections of other individuals, lying at varying angles to those which have happened to be longitudinally cut. Interstices too small to accommodate a *Styliola* are very often filled with bituminous matter, and it is quite common to find in the interior filling of the *Styliola* a considerable intermixture of organic matter left from the decomposition of the original tenant of the shell. The cementation of these originally loose shells has naturally been effected by percolating waters dissolving and depositing calcic carbonate. The thin sections show that this calcite has been deposited evenly on the entire inner surface of the shells, the youngest surfaces of the deposit coming together in a line, which is the longitudinal axis of the shells, giving thus to the longitudinal section the appearance of vein-infiltration. Many of the longitudinally cut individuals show also an external coating of calcite, which appears at best advantage where the original accumulation of shells has had a somewhat looser texture and plenty of room has thus been left between the shells for the deposition of such a layer. Both external and internal deposits are crystalline. Every *Styliola* shell, whether only filled with calcite or whether it has in addition to its interior filling an external coating of the mineral, shows two distinct sets of what appear at first to be twinning-lines of the rhombohedron $-\frac{1}{2}$ R. Both of these sets of lines take their origin along the central line or axis of the shell, and proceed, each obliquely backward or toward the apex of the shell, through the interior filling, the substance of the shell itself, and the external layer without interruption, and these three layers of calcite show under the polariscope perfect optical and crystalline continuity. Such twinning-lines, as they

are ordinarily developed in a crystalline limestone are seen to occur in the individual grains, one series for each grain, but the series in the adjoining grains have absolutely no relation to one another, but in the case of the *Styliola* shells and the accompanying calcite there is always a definite relation between these two sets of twinning lines; thus the angle which they make with each other is always the same, 49°, and this angle is invariably directed toward the stoma of the shell. Here may be thus an interesting example of the twinning of twinned calcites occurring about these *Styliola* shells. I have noticed, however, that the calcite of the *Styliola* shells invariably, polarizes throughout with the same color, and I have hitherto been unable to detect any difference in the colors afforded by the adjacent lamellæ. Not infrequently is to be discerned in the *Styliolæ* a second, but very indistinct, series of lines making an angle with the lines of the first set, the angle which they make with each other along the axis of the shell being 49° as in the first set, and directed towards the apex of the shell.

The transverse sections of these shells, when made at right angles to the axis show, with crossed Nicols, a radiate-crystalline structure, the radial needles extending from the center through the exterior coating of calcite. Their appearance suggests the structure apparent in a cross-section of a Belemnite, but in the longitudinal sections there is no such evidence of their existence as is found in the Belemnite. In polarized light these transverse sections show very beautifully the dark cross accompanying spherulitic structure. I recently requested of Professor Zirkel, of Leipsic, his opinion of the nature of the double series of lines meeting at the axis in the longitudinal sections of the shell, and have been pleased to learn that he does not regard the lines as lines of twinning, but as lines of cleavage. That these lines have the most evident axial angle always directed toward the stoma of the shell, he regards due to the orientation of the calcite in its deposition, which, under similar circumstances, would be the same for given surfaces. The fact, however, that these rhombohedron cleavage lines have the same relation to the *Styliola* shell and its enveloping calcite as rhombohedron lines to a scalenohedron of calcite, prompts a query whether each one of the acicular shells may not have taken its calcite as a scalenohedron, and whether the *Styliola* shell, itself an acute suggestion of a scalenohedron may not have exercised the influence of a scalenohedron in controlling the subsequent deposition of the calcite. Upon this question the recent investigations of Brongniart,[3] Sorby,[4] and Irving[5] into the character of the induration of ancient sandstones may have an interesting bearing.

[3] Graines Fossiles. 1880.

[4] Address before Geol. Soc., London. Quar. Jour. Geol. Soc., Vol. XXXVI, p. 62.

[5] Am. Jour. Science, 3d ser., Vol. XXV, No. 50.

The passage from the gray calcareous shales of the Hamilton beds *proprement dit* to the black shales of the Genesee is unusually sharply defined, a fact due evidently to the close proximity of the Tully limestone (the limit between the Hamilton and Genesee, wherever it appears). This formation is lacking in New York west of the village of Bethel, in the township of Gorham, but for a distance of 10 or 15 miles west of its last appearance its influence seems marked by the clearly defined separation between the shales of the Genesee and those of the underlying Hamilton.

But with this plane of separation very clearly marked I notice three species of brachiopoda which belong strictly to the Hamilton epoch fauna, and which cannot be regarded as an element in the proper fauna of the Genesee epoch, passing a short distance from the upper limit of the Hamilton shales into the black shales. These are *Spirifera medialis*, var. *Eatoni* H.; *S. Tullia* H.; *Orthis idonea* H.

Leaving these three fossils out of consideration, it will be seen from the table appended at the close of the discussion of the fauna of the Portage group, that there are nine species common to the faunas of the Hamilton and the Genesee epochs in this district, and it is true that with the exception of the species *Chonetes lepida* and *Chonetes setigera* none of them are in any sense characteristic or abundant in the Hamilton.

REVIEW OF THE FAUNA AND FLORA OF THE GENESEE SHALES.

PISCES.

Genus POLYGNATHUS.

1. Polygnathus dubius.

Polygnathus dubius Hinde, G. J., Quar. Jour. Geol. Soc., Vol. XXXV, p. 362, Pl. XVI, Figs. 6–18.

This "Conodont" tooth agrees well with some of the variations of the above species. It is the only species which I have noticed in this horizon. From the upper shales of the group at Glenville, Hemlock Lake. (*Vide* description of fossils of the Naples Shales for more particulars in regard to the occurrence of these fossils.)

Genus DINICTHYS.

2. Dinicthys Newberryi, n. sp.

(Plate I, Fig. 1.)

From the concretions in the black, bituminous, so called Huron Shale of Ohio, which is probably closely equivalent in age with the Genesee

and Naples shales of New York, Newberry described, in 1873,[6] the above mentioned genus with two species. These two forms have introduced to our knowledge a novel sort of monstrous fishes, and the species *D. Terrelli* and *D. Hertzeri* have gained a well-deserved reputation on account of their immense size, formidable appearance, and peculiar zoölogical relations, as well as for the beauty of the specimens obtained.

Kayser has described (Zeitsch. d. deutsch. Geol. Gesell. Vol. XXXII, p. 817) a third species under the name *Dinicthys* (?) *Eifelensis*, from Gerolstein.

From the concretions of the *Styliola layer* in Blacksmith Gully, at Bristol Center, I have a beautifully preserved specimen of the lower right mandible, with the right maxillary and portions of the cranial bones of an individual of this genus. The lower mandible, which is the best preserved of all of the parts taken, is just about one-half the size of the corresponding part of either of the Ohio species. In the possession of a sharp, even, knife-like cutting edge on the mandible instead of a finely-toothed cutting edge, it is more closely allied to *D. Terrelli* than to *D. Hertzeri*, but the jaw in its relative dimensions is much less stout than in *D. Terrelli*, approaching in these particulars much more closely to *D. Hertzeri*. To show these relative proportions clearly I give herewith the measurements in the two previously described species of what may be regarded the constants in the right lower mandible for comparison with those in this smaller form. In the diagrams, column A gives the length of the mandible; B, its width at a point half way from the posterior angle to the cutting edge; C, the width from the anterior end of the cutting edge to the base of the mandible; D, from the apex of the anterior prehensile tooth to its base.

	A.	B.	C.	D.
	cm.	*cm.*	*cm.*	*cm.*
D. Terrelli	56½	15	13¾	21½
D. Hertzeri	59	13⅜	11⅜	17 13/16
D. Newberryi	28⅛	6¼	5¼	8¼

By reducing these dimensions to the standard of the smallest species, we have these ratios:

	A.	B.	C.	D.
D. Terrelli	2	2.4	2.6	2.5
D. Hertzeri	2.1	2.1	2.1	2.1
D. Newberryi	1	1	1	1

This mandible thus is not quite one-half the size of that of either of Dr. Newberry's species, but in its relative proportions it agrees quite

[6] Geological Survey of Ohio., Pal., Vols. I and II.

closely with those of *D. Hertzeri*, while *D. Terrelli*, having a greater width in proportion to its length, has a stouter jaw. In the right maxillary we have these measurements to compare with the like in *D. Terrelli*. (I have not been able to ascertain them for *D. Hertzeri*.)

	Length.	Width.
	cm.	*cm.*
D. Terrelli	$15\frac{5}{8}$	$8\frac{1}{4}$
D. Newberryi	$6\frac{1}{4}$	$3\frac{3}{4}$

Their ratio will be:

D. Terrelli	2.5	2.3
D. Newberryi	1	1

There is thus a similar disproportion in these bones to that in the mandibles of the two species. This measurement of width for the maxillary of *D. Terrelli* does not include the triangular process on its upper posterior limb, which is wanting in *D. Newberryi*.

In the same *Styliola layer* as it outcrops on the east side of Canandaigua Lake, near Genundewah, 6 miles from the Bristol locality, I had earlier discovered a dorso-median plate belonging presumably to the same species. Its dimensions are as follows: Length, $12\frac{1}{2}$cm (broken); width, anteriorly, $13\frac{3}{4}$cm; height of carinal process, 5cm.

In the Ohio species these dimensions are in centimeters:

D. Terrelli, 65 : $57\frac{1}{2}$: 10.

D. Hertzeri, $67\frac{1}{2}$: 53 : 10.

Compared with *D. Newberryi*, their ratios are:

D. Terrelli, 5.2 : 4.2 : 2.

D. Hertzeri, 5.4 : 4 : 2.

D. Newberryi, (?) 1 : 1 : 1.

The posterior edge of this plate in *D. Newberryi* is broken and has apparently lost 3 or 4cm from its length. The smallness of the bones of *D. Newberryi* does not indicate immature growth of an individual of either of the other species. The discovery in outcrops of the same horizon, in localities separated by a distance of several miles, of bones of different individuals, all of which seem to agree with one another in their relative proportions, is at least presumptive evidence that these individuals had attained maturity and that the size of the bones given above is that of normal full growth. (Since writing the above I have received the description of A new Dinicthys from the Portage Group of Western New York, by E. N. S. Ringueberg (Am. Jour. Sci., 3d ser., Vol. XXVII, No. 162, June, 1884, p. 476.)

Mr. Ringueberg's species is from Sturgeon Point, on Lake Erie, 20 miles below Buffalo, and was found in the black shales of the Portage Group, the specimen consisting of a somewhat fragmentary dorso-median plate. This plate agrees well, in general dimensions, with that of *D. Newberryi*, but there is nothing in the latter like the strongly bifurcate crest represented by Mr. Ringueberg, and the species must be regarded as distinct.

Genus PALEONISCUS.

3. Paleoniscus devonicus, n. sp.

(Plate I, Figs. 2–6.)

(The description of this species is given with the notice of the fauna of the Naples Shales.)

A single scale of this species I have found in the shales of Glenville, Hemlock Lake, a few feet above the *Styliola layer*.

CRUSTACEA.

Genus CERATIOCARIS.

4. Ceratiocaris longicaudus.

Ceratiocaris longicaudus Hall, Sixteenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1863.

The telson spines of this species occur in the concretions of the upper arenaceous layers at Whale's Back, on Canandaigua Lake.

CEPHALOPODA.

Genus GONIATITES.

5. Goniatites complanatus.

Goniatites complanatus Hall, Geol. N. Y., Survey Fourth Geol. Dist.

To be found occasionally in the more arenaceous layers.

6. Goniatites discoideus.

Goniatites discoideus Hall, Thirteenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1860.

This species, which has usually been regarded as characteristic of the Marcellus shales, occurs in fine examples in the *Styliola layer*.

7. Goniatites Patersoni.

Goniatites Patersoni Hall, Pal. N. Y., Vol. V, Pt. II, 1879.

The concretionary portions of the *Styliola layer* on Canandaigua Lake have afforded evidence of the comparative abundance of this species, which has been hitherto regarded as diagnostic of the Portage Group.

8. Goniatites nodifer n. sp.

Shell umbilicate, body-whorl expanding rapidly outwards, its width at the stoma being 2½ times that at the beginning of the volution, compressed laterally, sloping gradually to the dorsum which is rounded, widest on the inner margin where it falls away abruptly to the inner whorls. The umbilicus shows five whorls which overlap one another in such a way as to leave each preceding one exposed for about one-fifth its width. Diameter of the normal full grown shell 14^{mm}, of which the the umbilicus covers 5^{mm}. *Suture:* Dorsal lobe short, lanceolate; dorsal saddles small, rounded and sloping slightly toward the umbilicus, outer lateral lobes somewhat narrower than the dorsal saddles but of the same length; lateral saddles broad, rounded, twice as long as dorsal saddles, and distinctly sloping toward the umbilicus. Inner lateral lobe short, rounded and ventral saddle small and indistinct. This suture is very similar to that of *G. planorbis* Sandb. (Versteinerungen d. Rhein. Schicht. Nass., p. 96, Pl. IX, Fig. 3), though the Nassau species is a much more umbilicate shell. The inner whorls are edged with strong nodes, which may be the protruding ends of ridges passing across the whorls. These number from 12 to 16 for each whorl, but become fainter on the younger whorls, and are hardly distinguishable on the last volution. No other marks of ornamentation are visible.

This species is a rare form occurring in the *Styliola layer* in association with *G. Patersoni* H., and as one of the Crenate goniatites stands in close sutural relations to this fossil. Its nearer allies, however, both in form, suture, and strength of umbilication, are *G. planorbis* Sandb., *G. lamellosus* Sandb., and *G. tubereulosus* d'Arch. and Verneuil.

From Genundewah, Canandaigua Lake.

It is a matter of regret to me that on account of the recent discovery of this species it has been inconvenient to prepare an illustration of it.

Genus ORTHOCERAS.

9. Orthoceras pacator.

Orthoceras pacator Hall, Pal. N. Y., Vol. V, Pt. II, 1879.

A single finely-preserved example from the *Styliola layer* is referred to this species, which has hitherto been regarded as confined to the shales of the Portage Group.

Genus GOMPHOCERAS.

10. Gomphoceras manes.

Gomphoceras Manes Hall, Pal. N. Y., Vol. V. Pt. II, 1879.

A large fragment measuring 3 inches in diameter, probably belongs to this species. From the *Styliola layer.*

PTEROPODA.

Genus COLEOLUS.

11. Coleolus aciculum.

Orthoceras aciculum Hall, Geol. N. Y., Survey Fourth Geol. Dist., 1843.
Coleolus aciculum Hall, Pal. N. Y., Vol. V, Pt. II, 1879.

Occasionally in the lower arenaceous shales on Canandaigua Lake, and not uncommon in the *Styliola layer.*

Genus TENTACULITES.

12. Tentaculites gracilistriatus.

Tentaculites gracilistriatus Hall, Pal. N. Y., Vol. V, Pt. II, 1879.

Not infrequent; associated with the following species in the calcareous layers.

Genus STYLIOLA.

13. Styliola fissurella.

Tentaculites fissurella Hall, Geol. N. Y., Survey Fourth Geol. Dist., 1879.
Styliola fissurella Hall, Pal. N. Y., Vol. V, Pt. II, 1879.

Rare, except in the calcareous layers and concretions.

GASTROPODA.

Genus PLEUROTOMARIA.

14. Pleurotomaria Itys var. **tenuispira.**

Pleurotomaria Itys var. *tenuispira* Hall, Pal. N. Y., Vol. V, Pt. II, 1879, Pl. XXX, F. 25.

The concretions of the *Styliola layer* afford in considerable abundance a species of Pleurotomaria agreeing with this variety in its strong re-

volving striæ, which are especially prominent on the upper surface of the whorls.

The original of Hall is from the Hamilton Shales of Hamburgh, N. Y.

15. Pleurotomaria rugulata.

Pleurotomaria rugulata Hall, Thirteenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1860.

This species, which is very characteristic of the Marcellus shales, I have found in a few instances in the lower shales in Bristol Center.

Genus BELLEROPHON.

16. Bellerophon striatus (?).

Bellerophon striatus Ferussac and d'Orbigny. Bronn, Lethæa Geognostica, Pl. I, Fig. 11.

The concretions of the *Styliola layer* contain a Bellerophon, which will probably be referable to this species. This shell has a width of from 16 to 18^{mm} across the stoma, is not explanate, but has the proper proportions of *B. striatus* as given in the place cited. The younger portion of the body whorl is covered by a callous, the remainder of the volution showing an ornamentation consisting of tubercles or papillate elevations, crossing which may be seen the lamellose lines of growth. The dorsum is strongly defined, is free of tubercles, and is crossed by retrally bent lines of growth. *B. Mœra* H. (Pal. N. Y., Vol. V, Pt. II, p. 119, Pl. XXV, Figs. 9–14, and Pl. XXVI, Figs. 19–24) has a similarly tubercled surface, but the dorsum is also tubercled.

From Genundewah, Canandaigua Lake.

Bellerophon striatus occurs in rocks of approximately the same age, in the Iberg formation of the Harz Mountains.

PELECYPODA.

Genus LUNULICARDIUM.

17. Lunulicardium fragile.

Avicula fragilis Hall, Geol. N. Y., Survey Fourth Geol. Dist., 1843.
Lunulicardium fragile Hall, Pal. N. Y., Vol. V, Pt. I, 1883.

Very abundant in the *Styliola layer* on Canandaigua Lake in very large and finely preserved examples. Very common also in the more sandy shales of the series, generally in a flattened condition.

Genus CARDIOLA.

18. Cardiola retrostriata.

(For the synonymy and further discussion of this species see remarks on the fauna of the Naples shales.)

This species, which reaches its culmination in the overlying Naples shales, occurs sparingly in the transition beds at the top and the arenaceous shales at the base of the Genesee.

BRACHIOPODA.

Genus LEIORHYNCHUS.

19. Leiorhynchus quadricostatus.

Orthis quadricostata Vanuxem, Geol. N. Y., Survey Third Geol. Dist., 1842.

Atrypa quadricostata Hall, Geol. N. Y., Survey Fourth Geol. Dist., 1843.

Rhynchonella quadricostata Hall, Tenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1857.

Leiorhynchus quadricostatus Hall, Thirteenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1860.

Not an uncommon species; associated with *Discina Lodensis* in the more bituminous layers.

Genus CHONETES.

20. Chonetes lepida.

Chonetes lepida Hall, Tenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1857.

Characteristic of the Marcellus shales, and occurring but sparsely at this horizon.

21. Chonetes setigera.

Strophomena setigera Hall, Geol. N. Y., Survey Fourth Geol. Dist., 1843.
Chonetes setigera Hall, Tenth Ann. Rep. N. Y. State Cab. Nat. Hist., 1857.

Not common; much more abundant in the Hamilton shales below and the Chemung group above. From the *Styliola layer.*

Genus DISCINA.

22. Discina Lodensis.

Orbicula Lodensis Vanuxem, Geol. N. Y., Survey Third Geol. Dist., 1842.
Discina Lodensis Hall, Pal. N. Y., Vol. IV, 1867.

Quite abundant in the higher, more bituminous strata at Seneca Point, on Canandaigua Lake, at Bristol Center, and at Glenville, on Hemlock Lake.

Genus LINGULA.

23. Lingula spatulata.

Lingula spatulata Vanuxem, Geol. New York, Survey Third Geol. Dist., 1842.

Extremely abundant in the *Styliola layer* in all its outcrops, passing through noticeable variation in size.

Genus CLADOCHONUS.

24. Cladochonus sp.

A member of this genus, whose specific relations have not been determined, occurs with some frequency in the *Styliola layer* on Canandaigua Lake.

CRINOIDEA.

Genus MELOCRINUS.

25. Melocrinus Clarkei.

Melocrinus Clarkei H. S. Williams, Proc. Acad. Nat. Sci., Phila., p. 31, 1882.

This species, which is the only crinoid described from the Genesee rocks, is limited, as far as my knowledge of it goes, to a very well defined horizon. The first specimens, consisting of a slab with eight individuals in a fine state of preservation, were found twelve years ago in Bell's Gully, on Canandaigua Lake, and until the summer of 1881 all efforts to find further traces of the species in the Genesee had been in vain. In that summer a single calyx was obtained from a thin calcareous layer about 10 feet above the *Styliola layer* near Seneca Point, on Canandaigua Lake, and subsequently discovered at the same distance above the *Styliola layer* in Bristol Center an exposure which showed seventeen calices in good preservation. This layer, which seems to be persistent over an area at least of some miles square, is not over an inch in thickness, and indicates that although this crinoid had encroached, apparently in great numbers, upon the bottom of the retired, quiet sea of this epoch so rich in decomposing organic matter, in a place where its environment would seem to be entirely against its successful growth, the entire plantation was soon overwhelmed, and the species did not return until the appearance of the fauna of the Naples shales.

PLANTÆ.

Genus LEPIDODENDRON.

26. Lepidodendron primævum.

Lepidodendron primævum Rogers, Geol. Survey, Penn., Vol. II, 1858.

This species is rarer at this horizon than in the fauna of the Naples

shales, but is occasionally to be found in the *Styliola layer*, and in the bituminous strata at Black Point, Canandaigua Lake.

27. Lepidodendron Gaspianum.

Lepidodendron gaspianum Dawson, Quar. Jour. Geol. Soc., Vol. XVIII, 1862.

I have no knowledge of the previous identification of this species in the rocks below the Chemung group. Dr. Dawson has identified it from the *Styliola layer*.

Genus CALAMITES.

28. Calamites inornatus.

Calamites inornatus Dawson, Quar. Jour. Geol. Soc., Vol. XVIII, 1862.

A single specimen of this species, 13 inches long and 3 inches wide, agrees well in its coarse, broad flutings with the original description of the species. From the very bituminous shales at Black Point, Canandaigua Lake.

Genus CLADOXYLON.

29. Cladoxylon mirabile.

Cladoxylon mirabile Unger, Beitrag z. Paläontologie d. Thüringer Waldes, 1856, p. 93, Pl. XII, Figs. 6, 7.

This species has been identified by Dawson (Fossil Plants of the Erian and Silurian of Canada, Pt. II, 1882, p. 126) from specimens taken from the *Styliola layer* on Canandaigua Lake. This is its first identification in America, the original having been described from the Upper Devonian at Saalfeld.

Genus CYCLOSTIGMA.

30. Cyclostigma affine.

Cyclostigma affine Dawson, Quar. Jour. Geol. Soc., Vol. XXXVII, 1881, p. 279, Pl. XII, Figs. 11, 12.

This species, described from specimens taken in the adjoining county of Yates, has been recognized by Dr. Dawson, also, in the *Styliola layer* of Canandaigua Lake.

Genus DADOXYLON.

31. Dadoxylon Clarkei.

Dadoxylon Clarkei Dawson, Fossil Plants of the Erian and Upper Silurian Formations of Canada, 1882, Pt. II, p. 124.

Described from examples from the *Styliola layer*. The specimens from which the original description has been made were comparatively small branches, measuring but an inch or two in diameter. More recently I have found examples 5 inches in diameter and nearly 3 feet in length. The abundance of this species in the *Styliola* horizon, and especially

in the large concretions in the shales immediately overlying, is very worthy of note. I have found it in every outcrop of the *Styliola layer* known to me, and at Bristol Center it occurs in great quantity and with fine preservation. It has proved itself the most abundant fossil wood of the Devonian of this district. To account for its presence we may assume the close proximity of land, perhaps wooded islands, as suggested by Dawson, or the mouth of some large continental water-course, through whose agency this drift-wood was carried out to sea. Its constant association, however, with the pelagic fossil *Styliola* leads us to believe that either it must have been carried in large quantities far out to sea, or that the little pteropods were swept in by ocean currents from deep water. The latter may be more probable, inasmuch as the character of the fauna and flora as a whole, with the lithological features of the formation, are such as to indicate a quiet, protected, and moderately shallow sea. The occurrence of the one crinoid known in the group, *Melocrinus*, has a definite bearing upon this conclusion. As far as known it appeared but at one horizon in the Genesee, and then in great numbers; migrating from its proper environment in deep waters, it encroached upon the Genesee fauna, but was soon overwhelmed by a deposit of muddy sediment, and did not appear again until toward the close of the epoch in which the Naples shales were laid down.

Genus SPORANGITES.

32. Sporangites Huronensis.

Sporangites Huronensis Dawson, Am. Jour. Sci., 1871, p. 257.

Specimens of these spores I have found in places in the more bituminous portions of the Genesee shales, but they are not commonly well preserved. It has been suggested by various authorities, most lately by Orton [7] for the Ohio Devonian and Subcarboniferous bituminous shales, that the bituminous matter contained in these rocks may be due in a large measure to these lycopodiaceous spores, from the permeation of the resinous matter contained by them through the containing rock. Whether or not this is the case, I have found these or similar macrospores in the Corniferous limestone in much greater abundance and in a more perfect state of preservation than in the Genesee, in a rock which is not black and can hardly be called bituminous. Dawson [8] has recently described from the Devonian beds of Rio Trombetos and Rio Curuá, Brazil, forms of spore-sacs which he has regarded as closely allied to the modern Rhizocarps represented by the genus *Salvinia*, and for these he has suggested the generic name *Protosalvinia*. The macrospores contained in these sporocarps are in all respects similar to the scattered macrospores of the Genesee and Corniferous. Evidence of enveloping

[7] Source of Bituminous Matter in Ohio Black Shales, Am. Jour. Sci., 1882, p. 171.
[8] On Rhizocarps in the Paleozoic Period, Proc. Am. Ass. Adv. Sci., Vol. XXXII, 1883.

membranes or sporocarps, for these North American[9] spores, such as are found in the Brazilian species, is not yet at hand, but in view of the similarity existing in the macrospores themselves of these different North and South American species, Dawson suggests the probability that all of these Devonian Sporangites were allied to the modern Rhizocarps.

In addition to these species, which constitute the known fauna and flora of the Genesee rocks of Ontario County, others have been described by other investigators from the outcrops of these rocks in other portions of the State. Hinde[10] has described a large number of species of "Conodonts" from the Hamilton and Genesee shales of North Evans, Erie County, of which the following, in addition to the one I have already mentioned, are quoted from the Genesee:

Prioniodus angulatus.	*Polygnathus nasutus.*
acicularis.	*princeps*
armatus.	*palmatres.*
spicatus.	*punctatus.*

The following species is quoted by Vanuxem:[11]

Lingula concentrica Vanuxem.

By Hall:[12]

Discina truncata Hall.

By Williams:[13]

Ambocœlia umbonata Conrad.

By Dawson:[14]

Rachiopteris pinnata Dawson.

The Pyrite Fauna.—In the more fissile bituminous strata of the Genesee, occurring in both the lower and the higher layers, there are very often to be found nodules or concretions of pyrite, usually somewhat kidney-shaped, or a little flattened from lying in the shale, often made up of masses of cubic or pyritohedral crystals and not infrequently as large as one's head. To find fossils preserved in pyrite is a very common occurrence in all the Devonian strata of New York, as it is indeed in the strata of nearly every age. But these pyrite nodules of the Genesee prove to contain a fauna almost entirely of their own, and though it is an association of fossils quite in consonance with its Devonian surroundings, all the species which I have hitherto found them to contain are to be found nowhere else.[15]

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[9] *Vide* for later investigations of these spores, Am. Jour. Sci., Vol. XXIX, April, 1885, pp. 284–289.

[10] Quar. Jour. Geo. Soc., Vol. XXXV, 1879.

[11] Geol. N. Y., Survey Third Geol. Dist., 1842.

[12] Geol. N. Y., Survey Fourth Geol. Dist., 1843; Pal. N. Y., Vol. IV, 1867.

[13] Pal. Researches, "Science," Vol. I, No. 16, 1880.

[14] Quar. Jour. Geol. Soc., Vol. XVIII, 1862.

[15] With the exception of *Chonetes lepida* H.

I describe herewith the species I have determined, and take pains to give them names suggested by their environment, which will serve to keep them distinct as a fauna. I believe there is abundant opportunity to enlarge this fauna, and I trust this suggestion may be of value to others studying the same rocks.

Genus BEYRICHIA.

33. Beyrichia Dagon, n. sp.

(Plate II, Figs. 6, 7.)

This species measures $\frac{3}{4}$ mm in length and $\frac{3}{8}$ mm in its greatest width, which is posteriorly. Hinge line straight; ventral outline semi-oval, rounding somewhat abruptly on the posterior margin, bounded by a well-marked rim on both valves. Posterior third of the shell broadly tumescent, anterior extremity less so. Medially on the dorsal margin is a prominent tubercle, extending one-half the way across each valve. Surface smooth. From Bristol Center.

Genus GONIATITES.

34. Goniatites Astarte, n. sp.

(Plate II, Figs. 9, 10.)

Width, $1\frac{1}{2}$ mm; thickness, 1 mm. The remarkable rotundity which this relatively great thickness gives to the shell gives it a peculiar form which is not represented elsewhere in the Devonian of New York. Volutions, two or three. Widely umbilicated. Septa simple, arising from the ventral suture with a low, backward curve, bending very gradually forward to a long, slightly rounded dorso-lateral saddle, and turning thence abruptly to a sharp angular dorsal lobe. Ten or twelve septa in the first volution. Whorls depressed. Surface as far as known, smooth. This is quite an abundant form in the Bristol pyrite nodules.

Genus ORTHOCERAS.

35. Orthoceras Stebos, n. sp.

(Plate II, Fig. 15.)

I have but a single individual of this species, which measures $2\frac{1}{2}$mm in length and $\frac{3}{4}$mm in width. Surface marked by strong, evenly rounded annulated elevations, which are not always the same distance apart. These annulations and the interspaces are covered with extremely minute transverse linings, equally strong on both elevations and depressions. The shell widens somewhat abruptly at the body chamber. Septa not known.

36. Orthoceras Mephisto, n. sp.

(Plate III, Fig. 2.)

Shell measuring 3mm in length and showing the body-chamber and eight air-chambers. Shell smooth and evenly tapering from the body-

chamber. Septa at equal intervals. This is quite the commonest Orthoceras in the nodules and in its proportions suggest the Hamilton species, *O. exile* H.

37. Orthoceras Asmodeus, n. sp.

(Plate III, Fig. 3.).

Length 1^{mm}. A beautiful little species, presenting a form quite different from any other known Devonian Orthoceras in its relatively strong and evenly rounded annulations, which are marked by the finest longitudinal striations. No trace of septa visible.

Genus PLATYOSTOMA.

38. Platyostoma Belial, n. sp.

Width of shell across the body whorl less than 1^{mm}. Very depressed, three volutions visible. Body whorl large, flattened, and subangulated. Aperture triangular. This minute shell is quite abundant at Bristol, and elsewhere, but so small that the drawings made of it have not been successful enough to justify publishing.

Genus LOXONEMA.

39. Loxonema (?) Moloch, n. sp.

This shell is much rarer than the foregoing; measures 3^{mm} in length, 1^{mm} in width across the body whorl. Whorls three or four. Its generic characters are not certain, as the forms thus far met with are internal casts.

Genus MODIOMORPHA.

40. Modiomorpha (?) Chemos, n. sp.

Length, 2^{mm}; width, 1½^{mm}. Beaks anterior, elevated over the hinge line, and apices appressed; anterior ligament pit short, posterior long, reaching nearly to posterior extremity of the shell. Surface marked by low, concentric ridges of growth.

Genus SPIRIFERA.

41. Spirifera Belphegor, n. sp.

(Plate III, Fig. 13.)

Ventral valve measures 6^{mm} in its greatest width and 4½^{mm} from apex to anterior margin. Beak prominent, arched and incurved over the cardinal area. Hinge line 1½^{mm} long, or one-fourth the width of the shell. From the extremities of the hinge line the margins round gradually to the lateral extremities. The surface marked by 14–16 very distinct plications, the strongest of which run almost to the apex. Medial sinus broad, measuring 1½^{mm} on the anterior margin. The cast shows that the

cardinal processes are long, extending one-third the length of the shell, and are subparallel. Dorsal valve elevated along medial fold, depressed on the lateral portions, with 10–12 elevated, radiating plications. Beak slightly elevated and closely incurved. I have only interior casts of these shells, the surface of which shows characteristic markings, which were probably also the markings of the exterior of the original test, as, wherever in any of these fossils from the pyrite the test has been preserved, it is seen to be extremely thin and delicate. Both valves are marked with the finest radiating lines, which are equally strong on the plications and sinuses. This species is the largest from these pyrite nodules, and is not common. The figure shows the ventral valve ten times enlarged, but I have not been able to obtain a satisfactory drawing of the dorsal valve.

42. Spirifera Pluto, n. sp.

(Plate III, Fig. 12.)

This is quite an abundant species, which differs from the foregoing in size and in several surface features. The ventral valve measures $3\frac{1}{2}^{mm}$ in diameter and $2\frac{1}{3}^{mm}$ from apex to anterior margin. Beak slightly arched and incurved, and the slope to the anterior margin is very gradual. Medial sinus wide, angled at the bottom and smooth, on each side being eight or nine slightly angulated plications. Cardinal area low and short, and evenly rounding on the extremities to the anterior margin. Cardinal processes long, slightly diverging, between which lies a short mesial process. Dorsal valve somewhat flatter, with a low medial fold and 5–7 radiating plications on either side of it. The surface of the shell shows no ornamentation. These shells will be discriminated from the foregoing species by their size, which varies but little.

Genus LEIORHYNCHUS.

43. Leiorhynchus (?) Hecate, n. sp.

(Plate III, Fig. 14.)

I refer to this genus the most abundant of these fossils. The shell is orbicular; width, 2^{mm}. Ventral valve marked with a broad central depression running from beak to anterior margin, the bottom of which is somewhat flattened and divided into two low ridges by a central shallow sulcus. On either side of the depression are to be counted five rounded plications, which become obsolete before reaching the beak. Beak elevated, ventricose, and arched over the hinge line. Area high. Dorsal valve more depressed, with a corresponding number of plications; beak depressed. On the ventral valve, cardinal processes prominent, diverging. On dorsal valve mesial process discernible. Surface free of sculpture.

Genus CHONETES.

Chonetes lepida.

Chonetes lepida Hall.

I have one specimen of this species from Bristol Center, the only previously described species, to my knowledge, occurring in these concretions. This specimen measures 5^{mm} wide and 3½^{mm} long, which is about the normal size of the shell as it occurs in the Marcellus shales.

Here is, thus, a fauna which is entirely in harmony with the character of the fauna of the Hamilton group, and yet entirely discordant with the fauna of the Genesee rocks which contain it. The question of its origin and the nature of the sea in which it flourished, the reasons for its occurrence only with the pyrite segregations, and the possible effects of its environment upon it, are not easily to be determined. The extreme minuteness of the fossils enhances rather than lessens the interest attaching to them. The inclination which I had at first to regard them as only young, immature individuals of known species, was soon overcome by the thought that there are no fossils known in the group which could serve as adult forms to such embryos. On account of similarities in some features with species of the Hamilton shales, as those existing between *Spirifera Belphegor* and *S. Clintoni* H.; *S. Pluto* and *S. Tullia* H.; *Orthoceras Mephisto* and *O. exile* H.; *O. Stebos* and *O. Thoas* H. and *O. nuntium* H. There is also a temptation to assume that the fauna is an abnormal and aborted survival of the fauna of those shales. It may be very probable that such was the origin of this fauna, but in assuming that the species have been in any degree aborted by their peculiar environment, it is necessary to bear in mind the coexistence of *Chonetes lepida* in its normal full size. The nodules of pyrite containing the fossils are not infrequently quite isolated, and yet where they have been found to be most abundant, namely, in the gullies at Bristol Center, they occur in such a manner that though they are generally quite disconnected from one another, they can be traced for some distance lying in the same horizon and at perhaps a distance of a foot or two above or below a similar layer. In some instances the pyrite may be seen extending for a distance of several feet as a continuous lenticular mass an inch in thickness.

These masses and nodules are not solid, compact pyrite, but are composed of little balls, strings, and twigs of pyrite, such forms as the concreting mineral is apt to assume, and among these lie the little fossils, all being cemented together by carbonate of lime and silica. On being digested in acid the parts become loosened and the fossils may be taken out.

I think we may interpret these phenomena thus: This little association of species, survivors of some old fauna, was peculiar to limited areas over the bottom of the shallow Genesee sea, where decomposition of organic matter was in progress on a large scale, by means of which the iron sulphate in the sea-water was generally deoxidized. Every

change of location of these areas of decomposition carried with it the little fauna until a considerable thickness of the mud of which the Genesee shales are built deposited over and about these spots. But with this hypothesis we would expect that these species would have occasionally strayed into contiguous sediments, or have become entangled by them, though as far as my observation has gone this does not seem to be the case. Further investigation and study, however, is desirable in this direction.

RESUMÉ.

Forty-three species constitute the described fauna and flora of the Genesee rocks of Ontario County Of these forty-three, twenty-eight have been added to the list as the result of these investigations, and there still remain in my possession a number of undetermined Pelecypoda. To this list we must add twelve species identified by other authors from the State of New York (eight of which are "Conodonts," described by Hinde), and the number of known species stands at fifty-five. Eleven of these had pre-existed in the fauna of the Hamilton shales, viz.:

1. *Polygnathus dubius* Hinde.
2. *Polygnathus princeps* Hinde.
3. *Goniatites discoideus* Hall.
4. *Goniatites complanatus* Hall.
5. *Styliola fissurella* Hall.
6. *Tentaculites gracilistriatus* Hall.
7. *Pleurotomaria rugulata* Hall.
8. *Pleurotomaria Itys* var. *tenuispira* Hall.
9. *Chonetes lepida* Hall.
10. *Chonetes setigera* Hall.
11. *Cardiola retrostriata* v. Buch.

The following sixteen pass into the Naples shales:

1. *Polygnathus dubius* Hinde.
2. *Prioniodus spicatus* Hinde.
3. *Paleoniscus Devonicus* n. sp.
4. *Goniatites discoideus* Hall.
5. *Goniatites complanatus* Hall.
6. *Goniatites Patersoni* Hall.
7. *Orthoceras pacator* Hall.
8. *Coleolus aciculum* Hall.
9. *Styliola fissurella* Hall.
10. *Tentaculites gracilistriatus* Hall.
11. *Lunulacardium fragile* Hall.
12. *Cardiola retrostriata* v. Buch.
13. *Melocrinus Clarkei* Williams.
14. *Lepidodendron primævum* Rog.
15. *Lepidodendron Gaspianum* Dn.
16. *Cyclostigma affine* Dawson.

The following eleven, making, with the "Pyrite fauna," twenty-two species, remain peculiar to it, not passing, as far as known, beyond its limits:

1. *Dinicthys Newberryi* n. sp.
2. *Ceratiocaris longicaudus* Hall.
3. *Gomphoceras manes* Hall.
4. *Bellerophon striatus* Ferussac and d'Orbigny.
5. *Leiorhynchus quadricostatus* Van.
6. *Lingula spatulata* Hall.
7. *Lingula concentrica* Vanuxem.
8. *Discina Lodensis* Vanuxem.
9. *Calamites inornatus* Dawson.
10. *Rachiopteris pinnata* Dawson.
11. *Cladoxylon mirabile* Unger.

The Transition Shales.—The shales of the Genesee, properly so called, pass upward into a narrow band of strata similar to them in clastic

structure, measuring from 30 to 60 feet in thickness, and this bed I have previously[16] designated as the Transition Shales, intending thereby only to characterize them as strata containing a fauna which shows a well-marked transition from that of the Genesee to that of the Naples shales. These passage beds have more than a merely local development in Ontario County, as they extend westward through the county of Livingston to the Genesee River, especially well developed as a mass of slightly arenaceous, dark shale at Woodville, on Canandaigua Lake and at Bristol Center. I have found the same at Hemlock Lake, and indeed wherever it has been possible to find a profile showing the junction of the Genesee and Naples shales. The fauna is quite sparse and is a commingling of species which in their best development are characteristic of both the overlying and underlying strata. *Lunulicardium fragile* H., a diagnostic fossil of the Genesee, is extremely abundant; *Coleolus aciculum* H., which occurs rarely in the Genesee, but is very abundant and characteristic of the Naples shales; *Cardiola retrostriata* v. Buch, of the Naples shales, *Goniatites complanatus* H., which culminates in the Naples shales; *Styliola fissurella* H., common from the base of the Hamilton to the base of the Chemung, but which culminates in the Genesee; *Pleurotomaria capillaria* H., of the Hamilton and Naples shales, and a *Pleurotomaria* of undescribed species, occurring in the Naples shales are all to be found, and this list, as far as known, constitutes the fauna of these beds. The small fauna is of such a mixed character that it cannot satisfactorily be referred to either the Genesee or the Naples shales, and yet on account of the predominance of *Lunulicardium fragile* and of the petrographical character of the beds it is better left under the Genesee epoch.[17]

[16] Am. Jour. Sci., Vol. XXV, p. 120, 1883.

[17] It is necessary here to emphasize the fact that these fossils which are to be found in any or all of the horizons of the lower, middle, and upper Middle-Devonian do not lose their diagnostic qualities for the horizons in which they culminate on account of this wide vertical distribution. That is to say, that although *Cardiola retrostriata* occurs in the Marcellus, Hamilton, and Genesee rocks, it is extremely rare at those horizons, and although *Goniatites complanatus* is to be found in the Hamilton shales, it is not a common or characteristic fossil as it is in the Naples shales. *Lunulicardium fragile* has been found in the Naples shales, but it is very rare and is diagnostic of the Genesee, where it culminates.

THE PETROGRAPHIC AND PALEONTOLOGIC CHARACTERS OF THE NAPLES BEDS.

TYPICAL EXPOSURES.

[Those showing the bituminous beds are in italics.]

1. In the town of Naples, the *Parrish*, Caulkins, Clarke, *Snyder*, *Hartranft*, *Grimes*, and Tannery Gullies.
2. In the town of South Bristol, the *Cook*, *Lapham*, *Maxwell*, and *Walton* Gullies.
3. In the town of Bristol, the "*Blacksmith*" and *Randall* Gullies.
4. On Honeoye Lake the *Briggs* and Hamilton Gullies.
5. In the town of Italy, Yates County, the Clark Gully and Whale's Back, on Canandaigua Lake.
6. On *Cashaqua* Creek, Livingston County, near the Shaker Settlement.
7. In the town of *Sparta*, Livingston County, on the Delaware, Lackawanna and Western Railroad.
8. On the Genesee River, below Mount Morris, Livingston County.

In the Report on the Geology of the Fourth District of New York, 1843, Mr. Hall described a series of shales, flags, and sandstones immediately overlying the Genesee shales, under the name of the Portage or Nunda Group, giving it this name on account of "its superior development along the banks of the Genesee River, in the district formerly included in the town of Nunda, now Portage." The term Nunda soon fell into disuse, and the Portage Group, as it has ever since been known, was subdivided into three parts, the first, at the base and immediately overlying the Genesee, the Cashaqua Shale, so called "from its perfect development upon the Cashaqua Creek," in Livingston County, where, according to the description, it consists of a "soft argillaceous rock of a green color, rapidly crumbling on exposure and forming a tenacious clay." At other localities the rock consisted of "a green shale, with thin flagstones and interlaminated sandy shale." The second subdivision was the Gardeau Shales and Flagstones, so called "from their great exposure along the Gardeau Reservation." The rocks here consisted of "alternations of green slaty and sandy shale with black slaty shale, and one or two thin courses of sandstone occurring in the space of 4 or 5 feet. As we ascend the arenaceous matter increases in quantity, the layers are thicker and more numerous, and the shale forms distinct alternations of black and green, often many times in succession, within the space of 50 feet. Toward the upper part the courses of sandstone become too thick for flagstones, and the shale is in thicker masses than below." The third subdivision was the Portage Sandstones, described as thick bedded sandstones, with occasional alternations of shale toward the base.

To the entire Portage group, including these three subdivisions, a thickness was ascribed of not less than 1,000 feet along the Genesee River. More recently Mr. Hall[18] has written that the black slates of the Genesee are "succeeded by a green or olive slate or shale, followed by successive alternations of black and greenish shales, and alternately shales and flagstones, and finally heavy bedded sandstones with intermediate arenaceous shaly partings. The Genesee slate has been regarded as constituting beds of passage to the next formation, known as the Portage group, and this, as well as the succeeding shale, carries a few fossils, which are likewise known in the Hamilton group. The entire formation, consisting of shales and sandstones, and having a thickness of a thousand feet or more in Central New York, diminishes like other strata in a westerly direction. On the shore of Lake Erie it has become a succession of green and black shales and sandstones, with here and there a lenticular mass of heavy-bedded sandstones, with abundant concretions and not infrequently with lenticular masses of calcareous matter."

This entire Portage group is now regarded by Hall and Dana as constituting the earlier epoch of the Chemung period.

In Ontario County the entire series of Portage strata is very perfectly developed, reaching a thickness of between 800 and 1,000 feet, with many fine exposures; and from my study of its development here and in the adjoining counties of Livingston and Yates I present in what follows my evidence for regarding the Portage group, as it is now limited, as a heterogeneous combination of faunas, the earlier of which, that contained by the Cashaqua Shales, and the Gardeau Shales and Flags, belongs with the fauna of the Genesee Shales, and the later, that of the Portage sandstones, to the beginning of the Chemung period.[19]

The order of succession of these strata in Ontario County is as follows:

1. Soft olive green and grayish shales, with occasional thin flagstones. Thickness, from 10 to 15 feet.

2. Black, very bituminous, shales, at the base easily cleavable into large slate-like fragments, higher up much more compact and like the

[18] Pal. N. Y., Vol. V, Pt. II, p. 151, 1879.

[19] The term Naples Beds or Naples Shales, by which I have here proposed to designate the Cashaqua and Gardeau series, is used advisedly and in accordance with the precedent of adopting local names for formations. My unwillingness to discard historic names led me to attempt uniting the two names Cashaqua and Gardeau into Cashaqua-Gardeau Group (inasmuch as there seems no paleontological evidence here for the separation of the two), but so uncouth and unwieldy a name was suicidal, and I have substituted for it the term Naples Beds, from the town of Naples, Ontario County, where the sections are very perfect, and where the beds have been most carefully studied. The author does not mean to assume, in the absence of complete evidence, applicability for this subdivision outside of the district here discussed.

densest layers of the Genesee. Thickness, about 40 feet. This layer I have termed the Lower Black Band.

3. Alternations of greenish and drab, soft shales, with sandy shales and occasional flagstones, and with abundant spheroidal and fantastically shaped calcareous concretions, sometimes occurring in layers, often isolated. Thickness, not less than 150 feet.

4. Black shales, in places quite bituminous; the Upper Black Band. Thickness, from 5 to 10 feet.

5. Flagstones, and at the top heavier-bedded sandstones with occasional alternations of sandy shales. Thickness, about 150 feet.

This thickness includes all the rocks, as far as it is possible to judge, which were ascribed by Mr. Hall to the Cashaqua and Gardeau subdivisions, and it is quite possible some of the strata which under his classification belonged to the Portage sandstones. It was naturally difficult to assign definite limits to these subdivisions, as they constantly vary in thickness in passing from east to west, and in a great thickness of conformable shales and sandstones it is often quite impossible to draw fixed planes of division.

This series of strata carries us to the lowest horizon of the Chemung rocks, that is, to the horizon of the first fossils which belong to the Chemung fauna. The separation of Cashaqua and Gardeau strata is not a good one petrographically, as the entire series of strata from the top of the *transition shales* to the base of the Portage Sandstones shows only a gradual, though regular, transition from the shaly sediments below to the sandstones above.

In the order of succession given, the shales included in subdivision 1 contain *Cardiola retrostriata* in great abundance, *Goniatites complanatus*, *Lunulicardium acutirostrum*, *L. ornatum*, *Cardiomorpha suborbicularis*. In subdivision 3 the softer shales contain the same species, and a large number of others. Indeed, it is here that the fossils of the group, never very abundant, have been mostly found. One may search, as Mr. Hall has said, an entire day in these rocks and find nothing or but very little, and though some species are very widely distributed and in places quite abundant, *e. g.*, those just mentioned, the entire group is to be regarded as comparatively barren of organic remains. At the beginning of these investigations only twenty-one species had been described from the Portage group, a number which is now increased to seventy-four.

The Bituminous Shales.—These beds, which occur in two fairly-well defined horizons in Ontario County, as the Lower and Upper Black Bands, retain their persistence into the county of Livingston, the Upper Band being finely developed in the township of Sparta, along a cutting on the Delaware, Lackawanna and Western Railroad, and also 1½ miles south of the Shaker Settlement on Cashaqua Creek. Further west they lose their persistency and become a series of thin beds alternating with the greenish shales and flagstones. The Lower Band has afforded but very few fossils, some undetermined ganoid scales from Snyder Gully, in Na-

ples, with *Goniatites Chemungensis* H. *var.* In the same strata, at Bristol, I have found *Spathiocaris Emersoni* Clarke, and some undetermined placoderm plates. The Upper Band is somewhat richer in organic remains, and has afforded from Naples, *S. Emersoni* Clarke, *Polygnathus dubius* Hinde, *Prioniodus spicatus* Hinde, *P. erraticus* Hinde. These species of Conodonts are comparatively abundant in Naples, at the foot of Hatch Hill, where they are associated with large quantities of vegetable remains, apparently the stipes of ferns, and accompanied with very much pyrite. They also occur at Sparta, in the same horizon. At Sparta occur also the following:

Paleoniscus Devonicus, n. sp.
Acanthodes pristis, n. sp.
Lepidodendron primævum Rogers.
L. Gaspianum Dawson.
Cyclostigma affine Dawson.
Sporangites Huronensis Dawson.
Various undetermined fish remains.

The Goniatite Concretionary Layer.

This is an unusually interesting stratum, which lies at an elevation of about 150 feet above the top of the *transition shales*. It is largely calcareous, with a considerable intermixture of silica and alumina, and a freshly-broken surface shows compact, evenly-grained structure, like phthanite, gives a dark or sometimes bright red color mixed with considerable green, and passing usually at the surface into a light gray. In Parrish Gully, Naples, 60 feet above the first outcrop at its entrance, where is to be found the best exposure of the rock, the stratum which has been denuded of its overlying shales by the water of the gully-stream shows the peculiar surface of a concretionary layer, looking as though it had been kneaded, and where the shales overlie or underlie in the adjoining banks it is noticeable that they conform to this irregular surface. This concretionary tendency was so general at the time of the formation of the layer that the stratum itself is to be regarded as a concretionary mass, rather than a mass of concretions. From Parrish Gully it can be traced southward to Caulkins Gully, and on the opposite (west) side of the Naples Valley Mr. Luther has observed it in the Clarke Gully. In all of these outcrops the rock retains its characteristic color, contains considerable pyrite, but in its distribution loses somewhat of its silicious character and becomes more readily separable into the individual concretionary masses of which it is composed. The rock is extremely tough and hard to work, and plays havoc with hammers and chisels. The layer has a thickness of 8 inches or a foot, and is immediately overlain by a bed of soft shales with a thickness of 4 feet, filled with separated concretions molded into a great variety of fan-

tastic shapes, and which when broken show often the red and green tints of the layer below. These peculiarities of color and structure in these layers have not, as far as I know, been noticed elsewhere in the American Devonian, but they are very forcibly suggestive of the reddish, greenish, and grayish concretionary Kramenzelkalk of the Rhine Provinces and Westphalia. This similarity is so marked that a person familiar with both the New York and the German rocks might easily confound hand specimens without fossils, from the different countries. Especial emphasis is to be laid upon this resemblance on account of the nature of the fauna which this Naples formation contains. It is indeed insignificant in its development compared with that of the Kramenzelkalk or of the Goniatitenschichten, but nowhere above the Marcellus shales of the lower Middle-Devonian are Goniatites so abundant as here. This is an abundance in individuals and not in species, but nowhere in the Upper Devonian of America are Goniatites to be regarded as abundant fossils. Here occur the species *Goniatites Patersoni* H. (cf. *G. intumescens* Beyr.), *G. discoideus* H. (cf. *G. simplex* v. Buch), and *G. sinuosus* H., in comparatively great abundance and generally having served as nuclei for the concretionary masses. These features have a marked bearing upon the parallelism of the American and German Upper Devonian, and it seems evident that the same environment which produced in Germany the Flinz and Knotenkalk of the lower Upper-Devonion and the Kramenzelkalk of the higher Upper-Devonian produced this concretionary layer also in the upper portion of the lower Upper-Devonian in New York. Recently F. Roemer has noted (*Zeitsch. d. deutsch. geolog. Gesell.*, *Vol.* XXXI, *p.* 659) the occurrence in Lower Dunscombe, Devonshire, of a slight development of a Nierenkalk with *Goniatites intumescens* and other fossils occurring in the fauna of the Goniatitenschichten, a fact which bears out the supposition that we may have here in New York the remotest westward extension of the Goniatitenschichten.

This layer contains the following fauna:

1. *Goniatites discoideus* Hall.
2. *G. Patersoni* Hall.
3. *G. sinuosus* Hall.
4. *Orthoceras pacator* Hall.
5. *Coleolus aciculum* Hall.
6. *Styliola fissurella* Hall.
7. *Tentaculites gracili striatus* Hall.
8. *Euomphalus planodiscus* Hall.
9. *Loxonema Noe* n. sp.
10. *Platyostoma minutissima* n. sp.
11. *Cardiola retrostriata* v. Buch.

REVIEW OF THE FAUNA AND FLORA OF THE NAPLES BEDS.

PISCES.

"CONODONTS."

In the present state of our knowledge of these bodies it is not possible to assign them an exact position in a zoological classification. The original species early described by Pander from the Lower Silurian of Russia were regarded as the teeth of minute fishes, a conclusion which has been supported by Newberry, Hinde, and Nicholson. Similar bodies from the Lower Silurian have been regarded by Harley (Quar. Jour. Geol. Soc., Vol. XVII) as the spinous attachments of crustacean segments. Hinde, James, and, earlier, Grinnell have described allied forms from the Silurian and Middle Devonian as teeth of annelids. The microscopical study of the structure of these bodies by Hinde (Quar. Jour. Geol. Soc., Vol. XXXV) makes it probable that, as far as the species here mentioned are concerned, they are correctly referred to the Myxinoid fishes.

Genus POLYGNATHUS.

1. Polygnathus dubius.

Polygnathus dubius Hinde, Quar. Jour. Geol. Soc., 1879, Vol. XXXV, p. 362, Pl. XVI, Figs. 6–18.

Individuals of this species occur quite abundantly in the Upper Black Band where it outcrops on Hatch Hill, in Naples, overhanging the banks of the Naples inlet, and occasionally in the same horizon in the town of Sparta, Livingston County. They are associated with large quantities of vegetable remains, presumably the stipes of ferns, and much pyrite. My material shows forms agreeing with some of the remarkable variations of the species as figured by Hinde, but are confined to those he has designated as pectinated and fimbriated teeth. The crested variation has not as yet been observed. The individuals measure from 1 to 2^{mm} in length.

Genus PRIONIODUS.

2. Prioniodus erraticus.

Prioniodus erraticus Hinde, Quar. Jour. Geol. Soc., p. 359, Pl. XV, Fig. 14.

This species is marked by the comparatively greater distance between the cusps than in the former, and several individuals in my possession from Hatch Hill agree well with the description.

3. Prioniodus spicatus.

Prioniodus spicatus Hinde, Quar. Jour. Geol. Soc., p. 361, Pl. XVI, Figs. 1–3.

A single individual shows the strong terminal cusp extending below the base of the tooth, which characterizes the species.

These "Conodonts," although known from various horizons from the Lower Silurian to the Carboniferous, have not been before noticed from this.

Genus PALÆONISCUS.

4. Palæoniscus Devonicus, n. sp.

(Plate I, Figs. 2–6.)

Numerous specimens of individuals referable to this genus have been obtained from the railroad cutting through the bituminous layers in the town of Sparta. These are usually fragmentary, but one individual retains most of the body in place though the bones of the head have been displaced and scattered and the tail is somewhat crushed. The animal was originally about 13^{cm} in length. The cranial bones, which are found abundantly scattered through these layers, though not as yet found in juxtaposition, with the exception of those represented in Fig. 6, are characteristically marked by punctate incised lines which run along the greatest diameter of the bone, occasionally, as in Fig. 5, radiating from the most convex portion of the plate. It is quite probable that the plates in Fig. 6 represent the *parietals*, Figs. 4 and 5 the *frontals* or *squamosals*. Associated with these bones are many minute, shining, somewhat flattened, conical teeth, measuring $\frac{3}{4}$–1^{mm} in length. The scales, except those on the dorsal ridge, are 1$\frac{1}{2}^{mm}$ long and $\frac{5}{8}^{mm}$ wide, subrhomboidal in outline and very beautifully sculptured with strong elevated striæ, which take their origin at the upper forward angle and pass obliquely across the scale, the forward edge presenting the appearance of being strongly tucked. These elevated striæ become very much stronger at the posterior edge, and in this region, the upper portion of the scale being left free of striæ, shows strong punctate markings. These pittings are also to be seen in the furrows between the striæ on the anterior portions of the scale.

The median dorsal scales are large, spatulate in form, measuring 3$\frac{1}{2}^{mm}$ in width anteriorly, and narrowing backwards to 1$\frac{1}{2}^{mm}$; length 4^{mm}. Surface strongly punctate. Dorsal fin, somewhat posterior. Ventral and anal fins not well preserved.

A single scale of this species I have also from the Genesee shales at Glenville, Honeoye Lake, which brings the first appearance of this species to a still lower horizon.

Scales of *Palæoniscus* have been mentioned by Hinde[20] from the Genesee shales of North Evans, Erie County, and Dana[21] has noticed the oc-

[20] Quar. Jour. Geol. Soc., Vol. XXXV. [21] Manual of Geology, 3d ed., 1880, p. 275.

currence of *Palæoniscus* in the Black shales of Kentucky, a horizon which corresponds to the Genesee shales of New York, but I have no knowledge of the description of the species.

P. Devonicus is, I believe, the first species of this genus described from Devonian rocks.

Genus ACANTHODES.

5. Acanthodes (?) pristis n. sp.

I refer to this genus a specimen from the same locality as the preceeding, the description of which is justified, although the specimen is fragmentary, because of the extreme scarcity of icthyic remains in these rocks which are well enough preserved to allow of identification. The specimen consists of a large portion of the body of the fish, the head and tail being lost. The scales are very small, measuring 0.5^{mm} on the edge, square or slightly subrhomboidal in outline and one-fourth as thick as wide. The adjacent edges at about two-thirds the distance from the upper surface are strongly grooved by a single deep furrow. The upper surface of the scales is smooth and slightly convex. In the character of its scales the species stands in harmony with the genus *Acanthodes*, though it is impossible to determine its generic relations definitively without knowing more of its fins and head.

Genus PRISTACANTHUS.

Pristacanthus Agassiz, Poissons Fossiles, Tom. III, p. 35, Tab. VIII*a*, Figs. 11, 12, 13.

This genus was founded by Agassiz to include a peculiar spine from the Stonesfield Oolite and the Calcaire de Caen, which was described under the name *P. securis*. From the original diagnosis the following are found to be distinctive features:

1. The very thin and fragile substance of the spine.
2. Absence of any ornamentation of the surface beyond a very fine granulation.
3. The serrate character of the tooth-like lateral processes, which occur only on one side of the spine.

From the upper portion of the Naples shales, near Milo, Yates County, I have a single spine which agrees with this genus in the first two particulars, but the lateral tooth-like processes are not so evenly serrate as in the original species.

It agrees, however, as far as I am aware, with no described genus so well as with *Pristacanthus*, and, in the opinion of Dr. Newberry, to whom the specimen was submitted for examination, may be safely placed under this genus.

6. Pristacanthus vetustus, n. sp.

(Plate I, Fig. 7.)

A fragment of a spine measuring 70^{mm} in length, 8^{mm} in width at the distal extremity. The posterior edge is somewhat broken away, but it

appears from the portion that remains uninjured that the spine tapered very gradually from base to apex.

The anterior edge bears fourteen serrations, which are stronger at the proximal edge. These have a strong backward bend, the upper edge curving evenly outward and downward and meeting the lower edge at an angle of about 60°. The lower edge meets the margin of the spine at nearly a right angle. Substance of the spine exceedingly thin, measuring scarcely 0.02^{mm}, except at the extremities of the serrations, where it thickens to 0.5^{mm}. The surface of the spine is smooth and almost flat, showing under a glass fine granulations or minute pustulations. This is the only example of the species I have seen, and represents the first occurrence of this genus in Paleozoic rocks.

A large number of undetermined scales and plates of fishes from the bituminous layers at the Sparta railroad cutting are in my possession.

ANNELIDA.

Genus SCOLITHUS.

7. Scolithus verticalis.

Scolithus verticalis Hall; *Fucoides verticalis* Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 242.

Scolithus verticalis Hall, 1852, Pal. N. Y., Vol. II., p. 242.

In the upper sands of the Naples shales and also in the higher sandstones of the Portage beds this fossil is quite abundant. I regard it as the tubular boring of some annelid rather than the remnant of vegetable life, as the tubes usually show evidence of having been filled from the top by sediments which, in being carried into the *cavities*, has arranged itself in successive concave layers. Such worm borings occur in various horizons in Paleozoic rocks. Mr. Hall applied the name *Scolithus verticalis* to similar tubular borings from the Medina sandstone, and as there exists no appreciable difference in the appearance of these simple tubes I use the name for the Naples shales specimens instead of retaining the doubtfully valuable generic term *Fucoides*.

CRUSTACEA.

Genus CERATIOCARIS.

8. Ceratiocaris simplex, n. sp.

(Plate II, Fig. 2.)

The fossiliferous shales immediately underlying the concretionary limestone of Parrish Gully have afforded three specimens of this species, the most clearly defined of which is shown in the figure. The carapace is somewhat oval in outline. At its anterior extremity it shows a retral

angular notch, above which is a slight prolongation in the median axis. The dorsal and ventral edges show a well-defined margin, which is somewhat thickened, giving a noticeable rim to the carapace. Carapace convex, rising more abruptly from the dorsal margin and deflected gently to the ventral edge. No ocular node visible. Length of the carapace, figured, 30mm; greatest width, somewhat anteriorly, 10mm.

9. Ceratiocaris Beecheri, n. sp.

(Plate II, Fig. 1.)

From the shales of Cashaqua Creek, Livingston County, I have one individual showing three abdominal segments and the caudal spines. These are apparently too large to refer to the foregoing species, and as I have not as yet observed the body-segments in the layers in which *C. simplex* occurs, it is necessary to regard this form a distinct species.

Of the segments here preserved the first has been somewhat detached from its neighbor and its anterior a little broken away. What remains measures 6mm in width and 3–4mm in length. The next segment is normal in its proportions, is 8mm in length and 5 in width. The caudal plate is 4mm in length and subtriangular, from the extremity of which is prolonged the strong central caudal spine. In the specimen this spine has been flattened horizontally and been given thus an apparently greater width than the lateral spines, which have been laterally compressed. The width of this spine across the proximal end is 3mm, that of the left lateral spine 2mm, and its length 12mm. A strong medial ridge passes along the middle spine, taking its origin 1mm from the edge of the caudal plate, where it is quite strong, and continuing through the entire length of the spine as far as visible. The left lateral spine also shows evidence in the external margin of such a medial ridge. The substance of the spines is very delicate, but shows the characteristic pseudo-vascular markings of these crustacea. Of the right lateral spine but a small portion remains, and the insertion of these lateral spines upon the caudal plate is not visible. The first two segments show, on account of the flattening to which they have been subjected, no trace of ornamentation except at the angles of the segments a low inconspicuous tubercle, two on the first segment and four on the second.

I take pleasure in giving to this species the name of Mr. C. E. Beecher, of the New York Geological Survey.

Genus ECHINOCARIS.

Echinocaris Whitfield, Am. Jour. Science, 3d ser., Vol. XIX, No. 109, p. 34.

This genus was erected in 1880, in the place cited, in a paper On New Forms of Fossil Crustacea from the Upper Devonian Rocks of Ohio, and was made to include a series of forms belonging to the Ceratiocaridæ, one of which at least (*E. armatus* H.) had been previously described

as *Ceratiocaris*. These differ from *Ceratiocaris* in the peculiar pustulose, nodose, and ridged character of the ornamentation of the carapace, the number of abdominal segments (4 known in *Echinocaris*, 5 or 6 in *Ceratiocaris*), and the spinose attachments to the latter. The author of the genus has described three species from the Erie shales of Ohio, a horizon which probably parallelizes with the Naples shales.

10. Echinocaris Whitfieldi, n. sp.

(Plate II, Figs. 3 and 4.)

Carapace with a straight hinge-line extending two-thirds its length, at the posterior extremity of which the margin is abruptly deflected at almost right angles. Ventral margin with a suboval curve rounding abruptly posteriorly and less so anteriorly. Rostral region somewhat produced, posterior extremity truncated. The margin on all sides marked by an elevated rim, most prominent on the ventral and dorsal portion. The surface is marked by fine tubercles, which are principally grouped about the cephalic portion. Six or seven quite strong elongate pustules mark the position of the anterior tubercle, below and behind which lie a number smaller and indefinitely scattered, with the exception of three or four, which make a vertical row behind the anterior tubercle, as shown in Fig. 3. Near the posterior dorsal angle, on the dorsal margin and at the posterior ventral angle, are three isolated single pustules. A well-marked but short ridge is found on the anterior portion running parallel with the anterior margin, and further backwards on the carapace are a few low ridges lying in the circumference of a circle, about and within which the finer sculpture is concentric. Under a glass the surface shows very fine and delicate scaly markings. The same fragment of shale which contains the carapace affords also the specimen of the caudal plate and spines shown in Fig. 4.

The telson consists of a subtriangular caudal plate, which is prolonged into a middle spine. To the underside of the plate the two lateral spines are jointed, although the left lateral spine is lost. Of the spines the middle one is the shortest and stoutest; all are marked with a slight ridge along the center, and both they and the caudal plate are covered with comparatively strong tubercles.

The carapace measures 27^{mm} in length and 16^{mm} in width.

From the shales of Hatch Hill, Naples.

Genus SPATHIOCARIS.

Spathiocaris Clarke, 1882, Am. Jour. Sci., 3d ser., Vol. XXIII, p. 477, Plate.

This genus was founded to include some crustacean shields, allied to *Discinocaris* Woodward, characterized by their oval-elliptical outline, triangular anterior rostral opening, and lack of a dorsal suture. It is very closely similar to Woodward's genus *Cardiocaris;* indeed it differs

from it only in having the posterior margin rounded instead of very faintly notched. In a later publication[22] on these crustacea I gave my reasons for regarding the genus *Cardiocaris*, which was proposed subsequently to *Spathiocaris*, as in part at least identical with it. The committee, consisting of Mr. R. Etheridge, Dr. H. Woodward, and Professor T. Rupert Jones, appointed by the British Association for the Advancement of Science to report upon the classification of the Fossil Phyllopoda of the Paleozoic Rocks, have not admitted[23] the identity of the two genera, but have taken from each and placed elsewhere some of the original members of each genus, so that *Spathiocaris* is regarded by them as represented by two species, *S. Emersoni Clarke* and *S. ungulina Clarke.*

The differences in the genera *Discinocaris*, *Cardiocaris*, and *Spathiocaris* are so slight that I willingly concede the rearrangement by the committee of the species described by me from the Upper Devonian of Bicken, viz., *S.* (Discinocaris) *congener*, *S. ungulina*, *S.* (Cardiocaris) *Koeneni*, *Cardiocaris* (Discinocaris) *lata* H. Woodward. Objections have been made to the classification of any of these forms of the Discinocarida with the Crustacea. Among the earlier observers Keyserling and F. A. Roemer, and at the present Dames, Kayser, and perhaps others, have regarded them as a whole or in part as having had some organic connection with the Cephalopoda, with which they are sometimes associated. My description of the species occurring at Bicken called forth a vigorous reply from Professor Dames,[24] whose arguments have been sufficiently answered by subsequent writers upon the subject.[25]

11. Spathiocaris Emersoni.

Spathiocaris Emersoni Clarke, Am. Jour. Sci., 3d ser., Vol. XXIII, p. 476, Plate, Figs. 1–3.

This species is the only well defined fossil known to me from this district which passes from the fauna of the Naples shales into that of the Chemung group. I have already quoted the species from the following different horizons (Am. Jour. Sci., 3d ser., Vol. XXV, p. 120):

1. In the lower black band of Bristol.

2. About 150 feet above the transition shales of the Genesee in the town of Naples.

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[22] Ueber deutsche oberdevonische Crustaceen, Neues Jahrbuch, 1884, Vol. I, p. 178.

[23] 2d Report at the Montreal meeting, September, 1884.

[24] See also Dames in Neues Jahrbuch, 1885, Vol. I, pp. 275, 279.

[25] See von Koenen, Neues Jahrbuch, 1884, Vol. I, pp. 45, 46.

Report of the committee, consisting of Mr. R. Etheridge, Dr. H. Woodward, and Prof. T. Rupert Jones (secretary), on the Fossil Phyllopoda of the Paleozoic Rocks. 1883, pp. 2, 3.

Jones and Woodward, Geological Mag., Dec. III, Vol. I, No, 8, pp. 348–355. 1884.

Second Report of the Committee on Fossil Phyllopoda. 1884.

A. S Packard, jr., A Monograph of North American Phyllopod Crustacea. 1883, p. 451.

3. At approximately the same horizon in the town of Richmond.

4. In the upper black band, 540 feet above the transition shales, Naples.

5. At approximately the same horizon 1½ miles south of the Shaker Settlement, along Cashaqua Creek, Livingston County.

6. At approximately the same horizon in the Delaware, Lackawanna and Western Railroad cutting in Sparta.

7. In the shales immediately overlying (4).

8. In the Portage sandstones at Portageville, Wyoming County.

9. In the lowest stratum of the Chemung, Naples.

10. In the sandstones of the Lower Chemung, in the town of Canadice, Ontario County.

CRUSTACEAN TRACKS. (?)

Twenty-five feet above the first outcrop of the Naples shales in Parrish Gully occurs a bed of sandy gray-greenish shales which are filled with peculiar impressions unassociated with any traces of organic matter. These are usually 2 or 3 inches in length, and consist of two rows lying side by side, of little concavities, each concavity measuring 2^{mm} in diameter. They suggest the Neritoides, described by Richter,[26] from the sandy shales of the Lower Devonian of the Thuringian Forest, although they are always much shorter than the European specimens. These seem to me to be the result of the wallowing of some crustacean, such as we may assume would be made by the known crustaceans of these rocks, not as they crept along over the soft mud of the sea-bottom, but in coming to a position of rest from swimming. A slight, constant vibratory motion of the appendages would produce such impressions in the mud. These markings I have found higher in these shales, as in the Tannery Gully in Naples, but they prove to be most abundant in the lower outcrops.

CEPHALOPODA.

Genus GONIATITES.

Type of **Goniatites simplex** von Buch.

12. Goniatites complanatus.

Goniatites complanatus Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., 1879. Pal. N. Y., Vol. V, Pt. II, p. 455.

This species, which is very abundant and characteristic of these shales, occurs with considerable variation of size. From the thin flagstones of the upper portion of the beds I have some large individuals measuring 10^{cm} in diameter, but the usual forms in the shales are much smaller, averaging about 25^{mm}, the smallest noticed having a diameter

[26] Beitrag z. Paläon. d. Thuring. Wald., p. 48, Taf. III, Figs. 42–44.

of 4mm. Specimens well enough preserved to show any trace of the septa are difficult to find, and I have not as yet seen any such from the soft, muddy shales. A few specimens from the sandy layers retain these septal sutures, though without showing distinctly the character of the dorsal lobe. Hall has figured one[27] example showing in part, the character of the septa, and my own specimens give this feature more perfectly. There is a marked similarity in the character of these sutures and those of *G. lamed* Sandberger,[28] of the Cypridinen-Schiefer and Goniatiten-Schichten. In the variety *rugosus* (Fig. 4) which is probably the young of some species like *G. intumenscens*, the curves of the suture are quite the same. In the var. *complanatus* (Fig. 5) the lateral saddle is somewhat stronger, and the distance between successive sutures greater than in *G. complanatus* II. In this variety, however, there is a noteworthy agreement in the form of the shell itself.

13. Goniatites discoideus.

Goniatites discoideus Hall, 1860, Thirteenth Ann. Rep. N. Y. State Cab. Nat. Hist., p. 97, Figs. 3–6, 1879; Pal. N. Y., Vol. V, Pt. II, p 441.

This species, which has hitherto been regarded as characteristic of the Marcellus shales, I have found in the concretionary limestone of Parrish Gully, Naples, and in the calcareous concretions on Honeoye Lake. It is a form in every respect comparable to *G. retrorsus* (=*G. simplex* v. Buch), as figured by Sandberger,[29] and Keyserling,[30] in the character of the sutures, the non-umbilicated shell, and the nature of the surface markings.

14. Goniatites uniangularis.

Goniatites uniangularis Conrad, 1842, Jour. Acad. Natural Science, Vol. VIII, p. 268, Pl. XVI, Fig. 4. 1879, Pal. N. Y., Vol. V, Pt. II, p. 444, Pl. LXXI, Fig. 14.

A species which presents a little variation from the foregoing in its sutures, and which is quoted by Hall from the Portage; I have, however, seen no examples of it from Ontario County.

Type of **Goniatites intumescens** Beyrich.

15. Goniatites Patersoni.

Goniatites Patersoni Hall, 1860, Thirteenth Ann. Rep. N. Y. State Cab. Nat. Hist., p. 99, Figs. 9–10; 1879, Pal. N. Y., Vol. V, Pt. II, p. 464.

A somewhat abundant species in the concretionary layer of Parrish Gully and in the immediately overlying and underlying shales. I very

[27] Pal., N. Y., Vol. V, Pt. II, Pl. X, Fig. 8.
[28] Verstein. d. Rhein. Schichten Syst. in Nassau, 1850–'56, p. 90, Pl. VIII, Figs. 4–9.
[29] *Loc. cit.* Pl. X, Fig. 15.
[30] Eine Reise in das Petschoraland, 1846, Pl. XII, Fig. 5.

much doubt the advisability of retaining this specific name, as I am unable to distinguish any differences between this species and *Goniatites intumescens* Beyr., the most abundant Goniatite in the Upper Devonian of Germany. A study of a large number of these American and European forms leads me to believe that whatever variation there may be in *G. Patersoni* from the typical forms of *G. intumescens* as figured by the brothers Sandberger,[31] which indeed is very slight, there is a far wider variation among the forms which are in Europe referred to this species.

(Cf. *loc. cit.*, Pl. VII, Fig. 3. Roemer's Lethæa Palæozoica, 1876, Pl. XXXV, Fig. 10.)

This similarity lies not alone in the character of the suture as shown above, but also in the amount of umbilication and in the caliber of the shell. The form from the Naples shales is never so carinate as in some of the European varieties, but agrees perfectly with the typical forms of the species.

16. Goniatites bicostatus.

Goniatites bicostatus Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 246; 1879, Pal. N. Y., Vol. V, Pt. II, p. 450.

This species was referred by Ferd. Roemer and De Verneuil (*vide* Sandberger, *op. cit.*, p. 101) to *G. retrorsus* v. Buch. Mr. Hall (Pal. N. Y., Vol. V, Pt. II, p. 453) has noticed the similarity between *G. bicostatus* and some of Sandberger's varieties, as follows: "In the manner of its septa it is very closely similar to the variety *lingua*" (*G. simplex* v. Buch, Kayser [32]) "and variety *typus*" (the same) "of that species, while the variety *undulatus*" (*G. undulatus* Sandb., Kays.) "represents the surface markings and the revolving carinæ." This is a rare species in the Naples shales.

17. Goniatites sinuosus.

Goniatites sinuosus Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 244; Pal. N. Y., Vol. V., Pt. II, p. 460, Pl. LXX, Figs. 13–15, Pl. LXXII, Fig. 11; Pl. LXXIV, Fig. 11.

Goniatites (*Clymenia?*) *Nundaia* Hall, 1875, Twenty-seventh Ann. Rep. N. Y. State Mus. Nat. Hist.

In the closer parallelism of its sutures and the sinuous sculpture of the surface this species differs from *G. Patersoni*. In its other features it is quite closely allied to it, and is not infrequently associated with it. Occurs not uncommonly in the concretionary layer of Parrish Gully.

[31] *Loc. cit.*, Pl. VII, Figs. 1 and 2.

[32] Zeitsch. d. deutsch geol. Gesell., Vol. XXV, p. 620, 1872.

18. Goniatites Lutheri, n. sp.

(Plate II, Fig. 8.)

Shell widely umbilicated, more so than any species with which it is associated, not excepting *G. complanatus*. Septa numerous and closely appressed, the individual figured having thirty-eight in the last whorl. The sutures are characterized by their very acute lobes and saddles. Ventral saddle very small, short and very slightly rounded, the two lateral lobes strong and acute. The lateral saddle very strong and acute, with its sides somewhat rounding. The dorsal saddle well defined and rounded, with a slight sharp carinal lobe. In the figured example the carinal portion of the shell has been somewhat folded upward, giving an abnormally thick margin to the shell. The septa are so closely crowded together that they are very nearly parallel to each other except at the apices of the lateral saddles, where the distance between them is somewhat greater than elsewhere. Surface markings are shown in some of the examples preserved in pyrite as finely incised, equidistant lines, curving gently forward over the lateral portions of the shell and more strongly forward as they near the dorsal surface. This is a very graceful species and quite distinct from any known forms belonging to the type of *G. intumescens*. Most closely allied to it is *G. forcipifer* Sandberger,[33] the closely oppressed septa of which suggest *G. Lutheri*, but there is a difference that is very marked in the acute lateral saddle and ventral lobe. This species I have seen in a few examples from the shales which overlie the concretionary limestone of Parrish Gully, and from Honeoye Lake.

19. Goniatites peracutus.

Goniatites peracutus Hall, 1879, Pal. N. Y., Vol. V, Pt. II, p. 463, Pl. LXIX, Fig. 8.

Suture characterized by the presence of but two instead of three saddles, as with other species of the group of *intumescens*-like forms. The dorsal saddle is also very acute. The species has been described from a fragment of the outer volution, and is "from the Portage or Lower Chemung, at Ithaca, N. Y." I do not know the species from Ontario County.

20. Goniatites complanatus, var. perlatus.

Goniatites complanatus, var. *perlatus*, 1874, Descriptions of New Species of Goniatitidæ, p. 1, Hall, 1879, Pal. N. Y., Vol. V, Pt. II, p. 458, Pl. LXX, Fig. 12.

This form varies from the original species in the greater distance of the septa from each other. Hall's example is "from the lower beds of the Portage group at Homer, Courtland County, New York." I am not sure that I have seen specimens referable to this variety.

[33] *Op. cit.*, p. 82, Pl. VI, Fig. 3.

Type of **Goniatites clavilobus** Sandberger.

21. Goniatites Chemungensis. Variety.

Goniatites Chemungensis Hall, 1879, Pal. N. Y., Vol. V, Pt. II.

I have a single specimen from the very bituminous layers of the lower black band, in Snyder's Gully, Naples, which is the only determinable fossil, with the exception of *Spathiocaris Emersoni*, that has been found in these rocks. In its tuberculated whorls the specimen agrees with *G. Chemungensis*, but differs from Mr. Hall's description of that species in the greater number of these marginal tuberculations on each edge of the whorls. It does not agree well with the var. *æquicostatus* Hall, and I do not attempt any further identification of it.

Genus ORTHOCERAS.

22. Orthoceras pacator.

Orthoceras pacator Hall, 1879, Pal. N. Y., Vol. V, Pt. II, p. 307, Pl. LXXXIX, Fig. 16.

The flattened condition in which this species is usually found in the fossiliferous shales has not allowed any evidence as yet of the position of its sipho. It is by no means an uncommon fossil.

23. Orthoceras aciculoides, n. sp.

(Plate II, Fig. 11.)

Shell small, sides almost parallel. The specimen from which the figure has been made is 10^{mm} long and 1^{mm} wide. It shows six septa which are remarkable for their unusual distance from one another. The first of the air-chambers measures 2^{mm} in length, the second $2\frac{1}{3}^{mm}$, the third $2\frac{1}{2}^{mm}$, the fourth 3^{mm}, the fifth $3\frac{1}{2}^{mm}$, the sixth is partially broken away. Siphuncle and surface sculpture unknown. This little species is quite distinct from any member of this genus in the Devonian fauna. Many of the individuals which had usually been referred to the species *Orthoceras aciculum* Hall, 1843, and which show very plainly such distant septa and subparallel sides, may be, since the erection of that species by its author into *Coleolus aciculum*, referred to *O. aciculoides*. The specimen figured is from the lower shales of Cashaqua Creek.

24. Orthoceras Ontario, n. sp.

(Plate III, Fig. 1.)

This is a representative of the annulated Orthocerata, in which the annulations are relatively distant and consist of very narrow, low, and acutely angled elevations. The distance between them increases with slight irregularities from apex to stoma, and the shell, which measures 14^{cm} in length, bears thirty of them. These rings slope abruptly to the surface of the shell, making the interspaces generally quite flat.

In these interspaces where the surface has been best preserved there is a fine sculpture of the test visible, consisting of minute, microscopic, longitudinal striations. Septa evenly transverse and regularly concentric. Sipho simple, central. The original of the species was taken from the concretionary shales in Parrish Gully, Naples, is preserved in crystalline calcite, and its form is thus retained without the distortion which usually occurs in the Orthocerata from these shales. As yet I know of but this specimen. The longitudinal ridge represented in the figure is a line of the attached matrix, which has been made too prominent by the artist.

25. Orthoceras filosum, n. sp.

(Plate II, Figs. 12, 13, 14.)

Conf. Orthoceras anguis Hall, Pal. N. Y., Vol. V, Pt. II, p. 312, Pl. LXXXIX, Fig. 9.

Shell tapering rapidly from stoma to apex. Test very thin and covered with finely incised lines from $\frac{3}{4}$ to $1\frac{1}{2}^{mm}$ apart. The nature of this sculpture is such that the surface of the shell is given an imbricate appearance. These lines pass about the shell in long, low undulations, which are not parallel to the outline of the stoma. The septa and sipho have not yet been noticed. This Orthoceras is interesting as the only representatives in the Devonian to my knowledge of a group after the type of *O. socium* Barrande, the forms quite characteristic of the Etage E.

The peculiarity of the entire group is the thin test, undulating and imbricating concentric lines of surface sculpture, with no longitudinal markings. I have before me several examples of this species, one from Parrish Gully, Naples, one from Hatch Hill, one from Briggs' Gully, Honeoye Lake.

GASTROPODA.

Genus BELLEROPHON.

26. Bellerophon natator.

Bellerophon expansus? Sowerby, Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 244.

Phragmostoma natator Hall, 1862, Dec. new species of Fossils (Fifteenth Ann. Rep. N. Y. State Cab. Nat. Hist.); 1876, Illustrations Dev. Fossils; not *Phragmostoma natator* Hall, 1862, Fifteenth Ann. Rep. N. Y. State Cab. Nat. Hist., explanation of plate.

Bellerophon natator Hall, 1879, Pal. N. Y., Vol. V, Pt. II, p. 108.

Much confusion exists in regard to both the synonymy and the identity of this species. The original example consisted of a portion of the outer volution of the shell from the Portage (Naples) group, which was identified by Hall in 1843 as *Bellerophon expansus?* Sowerby. Subsequently, in the Fifteenth Annual Report to the Regents on the Condition of the

State Cabinets, the species was regarded as the representative of another genus on account of the supposed evidence of a transverse septum within the body whorl, and was referred to the genus *Phragmostoma* (Hall, 1861, Fourteenth Ann. Rep. N. Y. State Cab. Nat. Hist.) as *P. natator*. To this description illustrations were accidentally appended of *P. cymbula* H., of the Hudson River group (*vide* Pal. N. Y., Vol. V. Pt. II, p. 108). In the final review and description of the species, it is removed from the genus *Phragmostoma* on account of unsatisfactory evidence of the existence of the transverse septum and relegated to the genus *Bellerophon*. In this connection Hall states that the original specimen from the Portage, upon which the species was founded, was not accessible to him, and the species as illustrated by him in the Illus. of Dev. Fossils, 1876, and in Pal. N. Y., 1879, is from a fragment out of the Hamilton shales. We infer, therefore, that examples of this species which have come into the possession of the State survey have been not only rare but very poorly preserved. I have found many individuals in a very perfect state of preservation which agree, as far as may be, with Mr. Hall's description of this species. As the description of the species has been from fragmentary specimens, it is difficult for me to pronounce definitely on the identity of the very abundant examples of my own with those of Mr. Hall, but the probabilities are quite in favor of it, as I find a close agreement between the description, as far as it goes, and my specimens. Hall, in the final report on the Devonian Gastropoda, has also described a more perfect example of the genus, very similar in its features, as shown both in the illustration, Plate XXVI, Fig. 14, and in the description to *B. natator*, which he has called *B. explanatus*. This is from an uncertain horizon, probably that of the Hamilton shales, and it may be represented among the specimens from the Naples shales, but on account of its greater size and more explanate stoma, it is necessary to regard the majority of the *Belleropha* of these shales as *B. natator*, a species common in all the outcrops of the lower fossiliferous beds.

27. Bellerophon incisus, n. sp.

Among my specimens of this genus from Parish Gully in Naples I find one which is distinctly different from the described species in these particulars: Fine, distant, incised, revolving lines appear on the shell at the beginning of the last volution, and pass outward, being nearly parallel for most of the distance, and become obsolete only near the margin of the shell. The dorsum is well marked from the stoma to the most elevated portion of the whorl, where it becomes obsolete. The dorsum is quite smooth, showing no trace of the retrally curving lines of growth. On either side of the dorsum on the most elevated portion of the shell are from thirteen to fifteen of the incised lines. Edge of stoma somewhat emarginate at the dorsum. No concentric striæ, but a few low, irregular concentric ridges. In its general proportions the species resembles *B. explanatus* H.

Genus EUOMPHALUS.

28. Euomphalus planodiscus.

Euomphalus planodiscus Hall, 1860, Thirteenth Ann. Rep. N. Y. State Cab. Nat. Hist., p. 109; 1879, Pal. N. Y., Vol. V, Pt. II, p. 57, Pl. XVI, Figs. 1–4.

This species was described from the Marcellus shales, and has hitherto been regarded as limited to that horizon. I have found it to be quite common in the calcareous concretions of Briggs' Gully.

Genus PLEUROTOMARIA.

29. Pleurotomaria capillaria.

Pleurotomaria capillaria Conrad, 1842, Jour. Acad. Nat. Sci., Vol. VIII, p. 271, Pl. XVI, Fig. 11; 1879, Pal. N. Y., Vol. V, Pt. II, p. 77, Pl. XX, Figs. 18–21.

This species constitutes a prominent member of the gastropod fauna of the Hamilton shales, and it has been found in several examples by Mr. Luther in the Naples shales. I do not know of its occurrence in the Genesee shales except in the upper portion or transition beds. Thence it ranges upward through the lower fossiliferous beds of the Naples shales and into the flag-stones of the higher strata.

Genus TROCHUS.

Subgenus PALÆOTROCHUS.

Trochus subgenus *Palæotrochus* Hall, 1879, Pal. N. Y., Vol. V, Pt. II, p. 133, Pl. XXX, Fig. 14.

"Shell conical, trochiform; spire elevated; volutions moderately convex; aperture transverse; columella?"

The above name was proposed to include a single species, *Pleurotomaria Kearneyi* Hall, from the Upper Helderberg, of which Mr. Hall has said: "I see no reasons why it should not be embraced in the Linnean genus Trochus and have proposed for it the subgeneric name."

From the shales at Naples I have several specimens which agree in all but a single particular with the species described by d'Archiac and de Verneuil as *Monodonta purpurea* (*Littorina purpurea* Sandberger) from Paffrath. In general contour, sculpture, form of the stoma, and excavation of the inner lip, they are similar, but the European species bears upon the inner lip a strong callosity which does not appear in my specimens. Although there is a wide difference in the external features of *P. Kearneyi* and my examples, there is a close agreement in all generic features. With *Ptychomphalus* and *Portlockia* of de Koninck it agrees in the form of its stoma and inner lip, but it has not in common with these genera anything that can be regarded as a Pleurotomaria band. Although agreeing well with *Paleotrochus*, it is difficult to point

out a singular particular in which it does not coincide with living representatives of the genus Trochus.

30. Trochus (Palæotrochus) præcursor, n. sp.

(Plate III, Figs. 6–9.)

Volutions, five. The last whorl making threee-fourths the height of the shell. Distance from apex to stoma, 13mm; width across the body-whorl, 13mm. Whorls ventricose, depressed at the sutures. Body-whorl depressed below, with a tubercled carina passing about it two-thirds the distance from the suture. Stoma transverse, subtriangular. Outer lip simple. Inner lip without callosity. Columella with a spirally-striated excavated band, which becomes obsolete as it passes downward. Surface marked by prominent tubercles arranged regularly in spiral lines. Of these lines of tubercles, two at or near the carina are the most strongly developed, and the interval between them greater than that between any other two lines. Of these spiral rows on the body-whorl generally eight are above and seven below the carina, and are increased by intercalation. The interspaces between the tubercles show very fine, transverse linings, only to be seen with a glass.

Genus PLATYOSTOMA.

31. Platyostoma (?) minutissimum, n. sp.

I find in the concretionary layers in Parrish Gully and along Honeoye Lake a remarkable abundance of a minute shell which I temporarily refer to this genus. These measure across the body-whorl from $\frac{1}{2}$ to 1mm and are $\frac{3}{4}$mm high. The volutions are three in number, the last very large and ventricose; surface without any visible ornamentation. That this is the young of some gastropod is quite possible, but as there is no species of gastropod that I know from this horizon of which this could be the young form, I venture to regard it as a new species. The individuals are so abundant in places that one may count scores over a single square inch of the surface of the rock. The sections of the rock for the microscope usually give abundant evidence of them.

Genus LOXONEMA.

32. Loxonema Noe, n. sp.

(Plate III. Fig. 10.)

Among the specimens from the concretions of Briggs' Gully and Parrish Gully and occasionally from the soft underlying shales, is a small *Loxonema* measuring from 5 to 8mm in length. This is the only representative of the genus I know from this horizon, and it is quite distinct from the *Loxonemas* of the Hamilton and Chemung faunas in the proportionally large and few ribs on the whorls.

PTEROPODA.

Genus HYOLITHES.

33. Hyolithes Neapolis, n. sp.

(Plate III, Figs. 4 and 5.)

Length of the shell on dorsal side, 23mm; width across stoma, 8mm; ventral side, ½ to 1mm longer than the dorsal, projecting above the dorsal margin of the stoma; dorsal side often showing two depressed furrows passing from apex to stoma, which are usually much increased in strength by compression. Also marked by strong transverse striations, which are especially prominent on the central, most convex portion of the shell, where they become strong *rugæ*. Toward the margins these markings become obsolete. No longitudinal sculpture. The ventral margin of the stoma is rounded, and the surface of the ventral side is marked by concentric transverse lines of growth all running parallel to the stoma. No longitudinal markings. This is a very handsome species, distinct from the species of *Hyolithes* in the adjoining faunas of the Chemung and Hamilton in the character of its sculpture. It occurs, as far as known only in the softer, lower shales. From the black shales of the upper black band in Parrish Gully I have two fragments, which bear, one a dorsal valve and one a ventral valve of a very small individual, measuring 4½mm in length, which lack the characteristic sculpture of *H. Neapolis* and belong probably to another species, although the condition of their preservation is not such as to allow their description.

Genus COLEOLUS.

34. Coleolus aciculum.

Orthoceras aciculum Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 243.

Coleolus aciculum Hall, 1879, Pal. N. Y., Vol. V, Pt. II, p. 187.

Abundant everywhere throughout the lower shales, associated with *Goniatites complanatus* and *Cardiola retrostriata*. I have had occasion to doubt somewhat the value of Hall's reference of this, originally regarded as an *Orthoceras*, to this genus. I have not infrequently collected specimens showing evidence of septa, these especially common in the concretions of Honeoye Lake, and which in external peculiarities agree very perfectly with the description of *Coleolus aciculum*. I have not seen the siphuncle to any of these individuals, and it may be pos-

sible that this genus includes septiferous forms. Though this does not appear from the diagnosis of it, the original figure of *Orthoceras aciculum* in the Report on the Fourth District of New York shows the presence of septa, and, as the genus stands now, may be regarded as representing a specimen of my species *O. aciculoides*. As I have already remarked, under the description of that species, many of the forms occurring in the Naples shales which have usually been referred to *O. aciculum* may have to be referred to *O. aciculoides*, and other septa-bearing forms must remain for the present without definite reference, as material is not at hand for study.

Genus STYLIOLA.

35. Styliola (Styliolina) fissurella.

Tentaculites fissurella Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist.; not *T. fissurella* Hall, Ills. Dev. Fossils, Pl. XXV, Figs. 12–14.
Styliola fissurella Hall, 1879, Pal. N. Y., Vol. V, Pt. II.

As already noticed, this minute pteropod is very abundant in the Naples shales, making a very large element of the calcareous matter of the Parrish Gully concretionary layer. In the shaly layers it is much less abundant, but will be found in many of the higher sandy shales and flagstones.

Karpinsky (Die fossilen Pteropoden am Ostabhange des Urals—Mém. de l'Acad. St. Petersburg, 7th ser., T. XXXII, No. 1, 1884) has suggested the probability that the paleozoic Styliolæ are generically different from the living members of the genus, and proposes the name *Styliolina* for the former. *Styliolina* is distinguished from *Styliola* by the form of the embryonal bulb, the lack of longitudinal furrows and thorn-like processes about the stoma, and the presence of longitudinal incised lines.

Genus TENTACULITES.

36. Tentaculites gracilistriatus.

Tentaculites fissurella Hall, 1876, Illus. Devonian Fossils; not *T. fissurella* Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist.
Tentaculites gracilistriatus Hall, 1879, Pal. N. Y., Vol. V, Pt. II, p. 173, Pl. XXXI, Fgs. 12, 13; Pl. XXXI A, Figs. 37–47.

This species, quoted by its author from the Marcellus and Hamilton shales, I have found not uncommonly associated with the foregoing.

Tentaculites gracilistriatus is regarded by Karpinsky in the work cited above as a synonym for *T. acuarius* Richter.

PELECYPODA.

Genus CARDIOLA.

37. Cardiola retrostriata.

Cardiola retrostriata von Buch.
Venericardium retrostriatum von Buch. Ueber die Ammoniten, p. 50.
Cardium palmatum Goldfuss, Petrefacta-Germaniæ, p. 270, Pl. XXXIII, Figs. 8–10.
Cardiola retrostriata Keyserling, 1846, Eine Reise in das Petschoraland, p. 254, Pl. XI, Fig. 3.
Avicula speciosa Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist.
Cardiola speciosa Hall, Miller, 1877, Am. Pal. Fossils, p. 186.
Cardiola speciosa Hall, 1883, Pal. N. Y., Vol. V, Pt. I; Plates and Explanations, Pl. LXX, Figs. 2–9.

Mr. Hall described and figured in 1843 (*loc. cit.*) the species *Avicula speciosa*, and has more fully illustrated the same under the name *Cardiola speciosa* in his late work, Plates and Explanations of the Devonian Lamellibranchs of the State of New York, the entire text of which has not appeared at the present writing. There is much variation in the form of this species, as it occurs in the Naples shales. It is here the most abundant fossil in the group (excepting *Styliola fissurella*), and the hundreds of specimens which have passed through my hands show the nature of the variation to be thus: The outline of the shell is most commonly approximately circular, sometimes becoming transverse. In the circular forms the shell is more elevated at the beak than in the more transverse individuals. The variation in this respect is, however, slight, and only to be perceived in specimens from the calcareous concretions, where the form has been well preserved. The variation in size is from 2 to 8^{mm} in length in the commonly occurring individuals, averaging about 5^{mm}. The surface is marked in the normal form by eight or nine ribs, between which lie comparatively deep *sulci*. Rarely the ribs become as many as twelve or fifteen. They are crossed by closely oppressed, retrally-bent lines, in which the retral bend is sometimes an even arc, and sometimes sharply angulated at the middle. Not infrequently each of these ribs is bordered by a fine elevated margin, which limits the ends of the retral striæ. Many of these features are very well brought out in Hall's illustrations of *Cardiola speciosa* in the place cited, but he has not noticed the forms with the elevated margin to the ribs. I have compared *C. speciosa* Hall, with specimens of *C. retrostriata*, v. Buch, from the Middle and Upper Devonian of Altenau, Bicken, Adorf, Bredelar, and elsewhere, and to my mind there is *absolutely* no specific difference in the American and European species.

The European species varies within even wider limits than the American, as is well shown in the illustrations given by the Sandbergers,[34] where the three varieties represented do not any of them compare favorably with the most common American forms. By an error (*op. cit.*, p. 270) the variety there mentioned as *Cardiola retrostriata* var. *typus*, represents var. *augulifera*, and no illustration of the typical form is given. This *typical* form, that is, the one most usually occurring in the Upper Devonian horizons, is well illustrated by Goldfuss (*loc. cit.*), Keyserling (*loc. cit.*), and Roemer.[35] This form bears from eight to ten, sometimes twelve, ribs, and its sculpture is the same as in *C. speciosa*. F. A. Roemer[36] has given a figure of *Cardium palmatum* Goldfuss, which is rather more transverse than the usual American forms, and bears twelve ribs; this transverse form is, however to be found in the Naples shales associated with the others. *Cardiola retrostriata* v. Buch is a shell of very wide distribution throughout the Upper and Middle Devonian of Europe. Keyserling[37] has described it from the Domanik Schiefer of Petschora Land; F. A. Roemer[38] from the same horizon (Mittel Oberdevon, "Domanik Schiefer" Credner, 1883) of Altenau in the Ober Harz. It is everywhere abundant in the same horizon throughout Westphalia, in the Fichtel Gebirge, etc. In the north of France and on the Belgian frontier the "Schistes à Cardium palmatum" are a member of the Upper Devonian, and are assigned the following position by Gosselet[39] in the classification of the Upper Devonian beds.

Psammites du Condroz, Calcaire d'Œtræungt Psammites.

Schistes de Famenne { Schistes de Famenne, proprement dits. / Schistes à Cardium palmatum. / Calcaires de Trelon. / Cuboides Beds.

The relation of this horizon for *Cardiola retrostriata* and its American horizon will be well seen in the following list of the most characteristic fossils of the formations lying in immediate juxtaposition to the "Schistes à Cardium palmatum." This is quoted from a section between Marienbourg and Frasnes, given by Gosselet. (*Loc. cit.*)

1. *Schistes de Famenne:*
   Rhynchonella cuboides: Hamilton group.
   R. pugnus: Chemung sandstones.
   Spirigera concentrica: Hamilton group.
   Spirifera disjuncta: Chemung sandstones.
   S. euryglossus.
   S. Murchisoniana.
   Productus subaculeatus: Chemung sandstones.

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[34] Verstein. des Rhein. Schichten-Syst., Pl. XXVIII, Figs. 8, 9, 10.
[35] Lethæa Palæozoica, Taf. XXXV, Fig. 16.
[36] Beitr. zur Kenntn. d. Nordw. Harz, Taf. IV, Fig. 11.
[37] *Loc. cit.*
[38] Beitr. z. geol. Kennt. d. Nordw. Harz, Taf. IV, Fig. 11.
[39] Annales d. Mines, Ser. 6, Tom. XII, p. 595, 1867.

2. *Schistes à Cardium palmatum: (Cardiola retrostriata); Naples shales.*
   Goniatites retrorsus: Naples shales.
   Rhynchonella bijugata.
3. *Schistes à nodules argilo-calcaires (Calcaires de Trelon):*
   Rhynchonella cuboides: Hamilton group.
   Atrypa reticularis: Hamilton group.
   Rhynchonella bijugata.
   Spirifera euryglossus.

The species of these higher Devonian beds have been subject to much greater *recurrence* in Europe than in America, as was early noticed by Bigsby.[40] *Rhynchonella cuboides* Sowerby, is fairly diagnostic of the lower Upper-Devonian and the American species after its type, *R. venustula* Hall, originally identified as *R. cuboides* by Conrad, which occurs only, as far as known, in the Tully limestone, at the base of the Genesee shales, is strong evidence of approximate parallelism of the Tully limestone and the European beds containing *R. cuboides*, viz., the Eifel cuboides kalk, the Aix-la-Chapelle cuboides schichten, the Iberger kalk of the Harz Mountains, etc.

Rhynchonella pugnus Sowerby, which ranges into lower horizons in Great Britain and Europe than America, is to be regarded as an Upper Devonian or Lower Carboniferous type, and in the section given it occurs in its normal position in association with *Spirifera disjuncta* Sowerby (*S. Verneuili*), a brachiopod distinctly upper Upper-Devonian in its type and in America *exclusively* so in its species, but which in Belgium, France, and the Rhineland ranges below its normal horizon into the cuboides beds. *Productus subaculeatus* Murchison is in Europe an Upper Devonian fossil, ranging occasionally into the Middle Devonian. In New York, Hall has identified it from the Corniferous limestone or Lower Devonian, but, according to Bigsby, de Verneuil has mentioned two species very similar to *P. subaculeatus*, collected by Lyell from Tioga. If by this Tioga County, New York, is meant, it would be within a district of Chemung outcrops. The "Schistes à *Cardium palmatum*" are described by Gosselet as black or violet-black, fissile shales, and are very like the bituminous beds of the Genesee and Naples shales.

Cardiola retrostriata is also quoted[41] from the shales of Torbay, in Devonshire, with *Goniatites retrorsus*, *Bactrites Schlotheimii*, and *Pleurotomaria turbinea*, which Lee regards an Upper Devonian horizon. Leonhard[42] has mentioned the species from Novaja Semlia. But the species is not confined to Upper Devonian horizons. Bigsby[43] quotes it from the Middle Devonian "*Calcaire de Givet.*" Maurer[44] refers to this species a form from the *Wissenbach slates* of the Ruppbachthal, Lower Devonian. Von Seebach has mentioned it from the *Wissenbach* (*Goslar*)

[40] Quar. Jour. Geol. Soc., Vol. XIV, 1858.
[41] Lee, Geol. Mag. new ser., Vol. IV, p. 100, 1877.
[42] Ueb. paläoz: Gebilde im Nord-Deutschl. u. Belg., 1844, p. 139.
[43] Thesaurus Devonico-Carboniferus, p. 166.
[44] Neues Jahrbuch, 1876, p. 808.

shales of the Harz, that is, lower Upper Devonian. Barrois[45] has found Sandberger's var. *angulifera* in the "Schistes de Porsguen" of La Rade de Brest, which he refers to the Lower Devonian. It also occurs in the Bohemian Upper Silurian, *Étages E.* and *H.* In America its vertical range is much more limited. I have the species from the Hamilton shales of Hopewell, Ontario County, and a single specimen from the bituminous Marcellus shales, giving thus the species a range from the base of the Middle Devonian to the base of the Chemung group proper.

Genus CARDIOLA.

38. Cardiola Doris.

Cardiola Doris Hall, 1883, Pal. N. Y., Vol. V, Pt. I. Plates and Explanations, Pl. LXX, Figs. 10, 11.

A rather rare species, associated with *Lunulicardium ornatum* and *L. acutirostrum.* From Parrish Gully.

Genus CARDIOMORPHA.

39. Cardiomorpha suborbicularis.

Myalina suborbicularis Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 243.

Cardiomorpha suborbicularis Hall, 1877, Miller, Am. Pal. Foss., p. 186. 1883, Hall, Pal. N. Y., Vol. V, Pt. I. Plates and Explanations, Pl. LXIII, Figs. 9, 10. Not C. *suborbicularis* Sandberger.

This is a very abundant species in the lower shales, and very strongly suggests *Cardiola concentrica* v. Buch, of the lower Upper-Devonian of Westphalia and the Harz.

Genus LUNULICARDIUM.

40. Lunulicardium ornatum.

Lunulicardium ornatum Hall. *Pinnopsis ornata* Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 244.

Lunulicardium ornatum Hall, 1877, Miller, Am. Pal. Foss., p. 193. 1883, Hall, Pal. N. Y., Vol. V, Pt. I. Plates and Explanations, Pl. LXXI, Figs. 25–29.

A characteristic species, occurring first in the lowest green shales of the group at Cook's Point, on Canandaigua Lake, and in the beds immediately underlying the lower black band in Snyder's Gully, south from Woodville.

[45] Annales de la Soc. Geol. du Nord., Tom. IV, p. 89, 1877.

41. Lunulicardium acutirostrum.

Pinnopsis acutirostra Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 244.

Lunulicardium acutirostrum Hall, 1877, Miller, Am. Pal. Fossils, p. 193. 1883, Hall, Pal. N. Y., Vol. V, Pt. I. Plates and Explanations, Pl. LXXI, Figs. 30–32.

Not uncommon in the soft shales of Parrish Gully, Briggs' Gully, and elsewhere.

42. Lunulicardium fragile.

Avicula fragilis Hall, 1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 222.

Aviculopecten fragilis Hall, 1877, Miller, Am. Pal. Fossils, p. 184.

Lunulicardium fragilis Hall, Am. Pal. Fossils, p. 193.

L. fragile Hall, 1883, Pal. N. Y., Vol. V, Pt. I. Plates and Explanations, Pl. LXXI, Figs. 1–14.

A characteristic and abundant fossil in the Genesee shales, losing its abundance with the close of the "transition shales," and to be found but sparingly in the Naples beds. My specimens are from Parrish Gully.

BRACHIOPODA.

Genus LINGULA.

43. Lingula ligea.

Lingula ligea Hall, 1860, Thirteenth Ann. Rep. N. Y. State Cab. Nat. Hist.

L. ligea var. Hall, 1867, Pal. N. Y., Vol. IV, Pl. II, Fig. 8, p. 8.

I have of this species but two individuals, one from the soft shales of Cashaqua Creek, Livingston County, and the other from the higher sandy shales at Naples. Mr. Hall's specimens are quoted from the arenaceous layers of the group.

44. Lingula triquetra, n. sp.

(Plate III, Fig. 11.)

Shell comparatively large, broadly spatulate, the sides sloping away very evenly from the apex at an angle of about 50 degrees, and rounding somewhat abruptly to the anterior margin, which is very transverse. In the ventral valve the apical angle is more acute than in the dorsal, projecting slightly over the dorsal apex; the width of the shell on the anterior margin nearly equal to three-fourths the length of dorsal valve. The surface is ornamented by concentric ridge-like lines of growth, which are not all of the same size. No evidence of radiating, decussating lines. Length of dorsal valve, 18^{mm}; greatest width, 13^{mm}; length of ventral valve, 19½^{mm}. This species resembles somewhat *L. læna* H.

and *L. palæformis* H. of the Hamilton shales, but differs from the former in being shorter, more transverse on the anterior margin, and with straighter sides, and from the latter in its relatively less width anteriorly, more abrupt anterior marginal angles, and the absence of radiating striæ.

BRYOZOA.

Genus AULOPORA.

45. Aulopora annectens, n. sp.

(Plate III, Fig. 15.)

A single specimen of this species attached to a valve of *Lunulicardium ornatum* has a creeping polyzoarium, polyp-cells scattered at nearly equal intervals along it. The sclerenchyma is flattened and the polyp-cells evenly sessile, opening directly from the base of the polyzoarium. Polyp-cells shallow, and with a number of deep striations on the inner surface, making pseudosepta. This is from the sandy layers in the lower beds of the group on Whale's Back, Canandaigua Lake.

CRINOIDEA.

Genus MELOCRINUS.

46. Melocrinus Clarkei.

Melocrinus Clarkei H. S. Williams, 1882, New Crinoids from Rocks of Chemung Period., Proc. Acad. Nat. Sci., Phila., p. 31.

This species has been found by Mr. Luther in the shales of Hatch Hill, Naples, occurring in the same manner as in the Genesee strata, a single thin layer, which is a mass of calices and columns. It is the only crinoid yet known from this group in Ontario County.

PLANTÆ.

Genus LEPIDODENDRON.

47. Lepidodendron primævum.

Lepidodendron primævum Rogers, 1858, Geol. Survey of Pennsylvania, Vol. II, Pt. II, p. 828.

Specimens referable to this species occur commonly in the upper bituminous layers in Naples and in the township of Sparta, Livingston County. Usually they are in a poorly preserved, decorticated "Knorria" condition. Outside of these bituminous strata the species is of rare occurrence. A specimen very remarkable for its size and beauty of preservation has been found by Mr. Luther in the upper sandy shales of the group at the

opening of Grimes's Gully, in Naples. This is a long trunk, measuring along the flattened edge 70^{mm} in width. When found only this transverse edge was exposed, and the trunk ran directly back into a thick bed of compact shales, so that it became necessary to remove several hundred cubic feet of this rock in order to expose it. Already a length of 225^{cm} has been worked out, the diameter of the flattened trunk constantly increasing the further the rock has been penetrated, and it measured 130^{mm} in section at the spot where it was necessary to break it off on account of the enormous mass of rock overlying. I trust that soon the remainder of this remarkable specimen may be uncovered, and believe that we may eventually find the root attached.

48. Lepidodendron gaspianum.

Lepidodendron gaspianum Dawson, 1860, Canadian Naturalist and Geologist, Vol. V.

Good specimens referable to this species are to be found in the higher sandy shales of the Tannery Gully, in Naples.

Genus CYCLOSTIGMA.

49. Cyclostigma affine.

Cyclostigma affine Dawson, 1881, Quar. Jour. Geol. Soc., Vol. XXXVII.

This species, which was founded on specimens taken from the horizon of the Naples shales in the adjoining county of Yates, I have found in the bituminous beds in Sparta. The specimens have been identified by Dr. Dawson as belonging to this species.

Genus FUCOIDES.

50. Fucoides graphica.

Fucoides graphica Vanuxem, 1842. Geol. N. Y., Survey Third Geol. Dist., p. 172.

This paradoxical fossil occurs very widely distributed throughout the flagstones of the group, always as long, low, oval elevations on the under surfaces of the slabs, a fact which proves that whatever the nature of the fossil may be it represents only the fillings of depressions on the originally muddy sea-bottom. These may have been formed by the wallowing of some animal, or by the decomposition of sea-weed over the bottom, but it is impossible yet to decide their true origin, as they have not been sufficiently investigated.

A number of other species have been described from the rocks of this age in New York State by Conrad, Hall, Dawson, and Williams, which I have not as yet been able to find in the district under consideration. Some of these cannot be identified on account of lack of completeness in the original definition of the species. This is especially true of the Pelecypoda, of which I have a large number of unidentified forms, any

description of which I feel obliged to defer, as Mr. Hall's study of these fossils is just issuing from the press, and probably any descriptions of mine would increase the unfortunate confusion which has hitherto existed in regard to the New York Devonian Pelecypoda.

The following species must be added to complete the list of the known fauna of these rocks:

Gomphoceras Ajax Hall.
1879, Pal. N. Y., Vol. V, Pt. II, p. 350, Pl. XCIV, Fig. 8.

This species was described from the shales of the Portage group, at Penn Yan, N. Y.

Orthoceras Thyestes Hall.
1879, Pal. N. Y., Vol. V, p. 306., Pl. LXXXVIII, Fig. 2.

An exceptionally large and robust species "from the soft shales of the Portage group, near Watkins," Yates County.

Orthoceras Atreus Hall.
1879, Pal. N. Y., Vol. V, p. 305, Pl. LXXXVIII, Fig. 1, and Pl. LXXXIX, Figs. 10, 11.

Another extremely robust species quoted from the "Calcareous layers of the Portage group, at Penn Yan," Yates County, and from near Portageville on the Genesee River.

Conularia congregata Hall.
1876, Illus. of Devonian Fossils, Pl. XXVIII, Fig. 1.
1879, Pal. N. Y., Vol. V, Pt. II, p. 214, Pl. XXXIV, Fig. 1; Pl. XXXIV*a*, Figs. 9, 10, 11.

This is cited "from the shales of the Portage group, near Ithaca, N. Y."

Avicula triradiata Conrad.
1842, Vanuxem, Geol. N. Y., Survey Third Geol. Dist.

Not mentioned by Hall in his final report on the Aviculidæ, 1884.

Lucina retusa Hall.
Nucula lineolata Hall.
Astarte subtextilis Hall.
1343, Geol. N. Y., Survey Fourth Geol. Dist., p. 245.

These species, early described by Hall, do not appear in his recent monograph of the Devonian Pelecypoda.

Cardiomorpha undulata Hall.
1883, Pal. N. Y., Vol V, Pt. I. Plates and Explanations, Pl. LXIII, Fig. 16.

Cardiomorpha textilis Hall.
1883, Pal. N. Y., Vol. V, Pt. I. Plates and Explanations Pl. LXIII, Figs. 11–15.

Præcardium vetustum Hall.
1883, Pal. N. Y., Vol. V, Pt. I. Plates and Explanations, Pl. LXX, Figs. 18–20.

I have not had opportunity of comparing these figures with my specimens.

Orthis tenuistriata Hall.
1882, Geol. N. Y., Survey Fourth Geol. Dist., p. 246.

No mention has been made of this fossil in Hall's monograph of the New York Devonian Brachiopoda, and it is hardly to be regarded as a member of this fauna.

Spirifera lævis Hall.
Delthyris lævis Hall.
1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 245.

Spirifera lævis Hall.
1867, Pal. N. Y., Vol. IV, Pl. XXXIX, p. 239.

This species, which is not uncommon in localities east of Ontario County, seems limited to those beds. I do not know of its occurrence west of Tompkins County.

Crania centralis Hall.
1879, Pal. N. Y., Vol. V, Pt. II, Pl. LXXXVIII, Fig. 2, under explanation of the figure of *Orthoceras Thyestes*.

Cyathocrinus ornatissimus Hall.
1843, Geol. N. Y., Survey Fourth Geol. Dist., p. 247.

The individuals upon which this species was founded were taken from the Portage shales at Portland, on Lake Erie. I have no knowledge of its having been found in any other locality, and the species has never as yet been carefully diagnosed.

Poteriocrinus (Decadocrinus) Zethus Williams.
Taxocrinus Ithacensis Williams.
Taxocrinus curtus Williams.
1882, New Crinoids from the Chemung group of New York.

These three species, described by Dr. Williams, from the vicinity of Ithaca, I have not as yet found.

Ormoxylon Erianum Dawson.
1871, Fossil Plants of Silur. and Dev. of Canada.

Asteropteris Novoboracensis Dawson.
1881, Quar. Jour. Geol. Soc., Vol. XXXVII, p. 299, Pl. XII, Figs. 1-9.

Equisetides Wrightiana[46] Dawson.
1881, Quar. Jour. Geol. Soc., Vol. XXXVII, p. 301, Pl. XII, Fig. 10; Pl. XIII, Fg. 20.

The last two of these species were described from specimens found in the adjoining county of Yates.

[46] In the Geological Magazine for September, 1884, T. R. Jones and H. Woodward, regarding the original of this species as the abdominal segments of a Phyllopod crustacean, have thus described it, under the name *Echinocaris Wrightiana*. If this is correctly referred the original animal must have been of colossal dimensions.

THE PETROGRAPHIC AND PALEONTOLOGIC CHARACTERS OF THE PORTAGE BEDS.

TYPICAL EXPOSURES.

1. In the town of Naples, the Grimes and Tannery Gullies; on Hatch Hill; on the Garlinghouse road, and at Ingleside.
2. In the town of Italy, Yates County, the Clark Gully.
3. At Dansville, Livingston County.
4. On the Genesee River at Portageville.

From the highest horizon referred to the preceding group of shales, rise about 600 feet of heavy bedded gray and greenish sandstones, with some flagstones near their base, and occasional interlaminations of arenaceous shales. These were originally grouped with the Cashaqua and Gardeau divisions of Hall, as has already been noticed, under the name Portage group, and it may be that this was done more on negative than positive evidence, as these sandy layers are very barren of all organic remains. The paleontological connection between these Portage sandstones and the underlying Naples shales is very slight, and between the two must be drawn the line which separates the fauna of the Hamilton period from that of the Chemung. The original description of Hall characterized these sandstones by the abundance of the worm-borings *Scolithus* (*Fucoides*) *verticalis*, and these I have found to be quite abundant, especially at the top of the series and immediately underlying the beds bearing the important High Point Fauna presently to be noticed more at length. At Ingleside, in the township of Naples, I have found in these sandstones *Dictyophyton tuberosum* H., a fossil referred to the Hexactinellid sponges by Hall,[47] Whitfield,[48] Barrois,[49] and to the Algæ by Roemer;[50] also, *Ambocœlia umbonata* Conrad; these about 500 feet below the summit of the group on High Point, 3 miles west of the village of Naples. *Dictyophyton tuberosum* I have also found within 300 feet of the upper limit mentioned. This fossil must be regarded as characteristic of the Chemung fauna, as it is not known to occur outside of Chemung horizons.

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[47] Thirty-fifth Ann. Rep. N. Y. State Mus. Nat. Hist., 1883.

[48] Am. Jour. Sci., Vol. XXII, July and Aug., 1881.

[49] "Dictyospongidæ des Psammites du Condroz," Annales de l. Soc. Geol. du Nord, Tom. XI, 1883.

[50] "Bemerk. ueb. Hall's Gattung *Dictyophyton*." Sitzungsber. der schlesisch. Gesell. für vaterländ. Cultur, 1883.

Ambocœlia umbonata is also a characteristic and abundant Chemung fossil, though it occurs as a member of the Hamilton fauna, 1,000 feet below. In the sandstones and flags of Grimes's Gully, in Naples, at a distance of about 600 feet below the High Point horizon, I have found the Chemung fossils *Leiorhynchus mesacostalis* H. and (?) *Discina leoni* H. Besides these, Mr. Luther has more lately detected *Ambocœlia umbonata* Con., *Atrypa aspera* H., *Stenochisma eximium* H., and some unidentified species of *Productella*. Below this fossiliferous stratum and within 10 feet of it are beds containing the characteristic species of the Naples shales, viz., *Cardiola retrostriata*, *Goniatites complanatus*, *Coleolus aciculum*. Further than the six species mentioned, all of which are characteristic of the typical fauna of the Chemung, I know of no other fossils from these Portage sandstones, with the exception of the crustacean species described by myself, viz., *Spathiocaris Emersoni*, *Dipterocaris Procne*, *D. pennæ-Dædali*, from the beds in the town of Canadice, and *D. pes-cervæ* from Dansville, Livingston County. There are thus ten well-defined fossils (exclusive of *Fucoides graphica* and *Scolithus verticalis*) which constitute the known fauna of the Portage sandstones, two of which, namely *D. pennæ-Dædali* and *D. pes-cervæ* may be peculiar to it; seven belong to the Chemung fauna above, namely, *Dipterocaris Procne*, *Ambocœlia umbonata*, *Atrypa aspera*, *Leiorhynchus mesacostalis*, *Stenochisma eximium*, (?) *Discina Leoni*, *Dictyophyton tuberosum*, and one comes over from the Naples fauna below, namely, *Spathiocaris Emersoni*.

The following table gives a list of all the fossils now known to occur in the Genesee and Naples beds in New York, and shows what portion of these faunas and floras have been derived from the rocks below of the Hamilton Period and what members pass upwards into the rocks of the Chemung Period. It therefore affords the evidence upon which the Naples shales and the Portage beds must be assigned to their appropriate horizons.

As a result of these investigations the fauna and flora of the old Cashaqua and Gardeau beds, *i. e.*, the Naples shales, are increased by 32 species or 50 per cent. (for Ontario and adjoining counties, 66 per cent.), and of the Genesee shales the list is increased by 27 species or 48 per cent. of the known fossils of these rocks occurring in the State, and 60 per cent. of the known contents of the rocks in Ontario County and vicinity.

A list of the fossils occurring in the Genesee, Naples, and Portage beds of Ontario County, with the names of species heretofore identified from these horizons elsewhere in the State of New York, but not as yet known within this district.

Species.	Hamilton shales.	Genesee shales.	Naples shales.	Portage beds.	Chemung beds.
Polygnathus dubius Hinde	*	*	*		
nasutus Hinde		*			
princeps Hinde	*	*			
palmatus Hinde		*			
punctatus Hinde		*			
Prioniodus erraticus Hinde	*		*		
spicatus Hinde			*		
angulatus Hinde		*			
armatus Hinde		*			
aciocularis Hinde		*			
Dinicthys Newberryi Clarke			*		
Pristacanthus vetustus Clarke		*	*		
Palæoniscus devonicus Clarke			*		
Acanthodes pristis Clarke			*		
Scolithus verticalis Hall		*		*	
Ceratiocaris longicaudus Hall			*		
simplex Clarke			*		
Beecheri Clarke			*		
Echinocaris Whitfieldi Clarke			*		
Wrightiana Dawson			*		
Spathiocaris Emersoni Clarke			*		
Dipterocaris pennæ-Dædali Clarke				*	
pes-cervæ Clarke				*	
Procne Clarke				*	*
Beyrichia Dagon Clarke		*			
Goniatites complanatus Hall	*	*	*		
var. perlatus Hall			*		
discoideus Hall	*	*	*		
uniangularis Hall			*		
Patersoni Hall		*	*		
bicostatus Hall			*		
sinuosus Hall			*		
Lutheri Clarke			*		
nodifer Clarke		*			
peracutus Hall			*		
Chemungensis Hall *var*			*		
Astarte Clarke		*			
Orthoceras pacator Hall		*	*		
aciculoides Clarke			*		
Ontario Clarke			*		
filosum Clarke			*		
Stebos Clarke		*			
Mephisto Clarke		*			
Asmodeus Clarke		*			
Thyestes Hall			*		
Atreus Hall			*		
Gomphoceras Ajax Hall			*?		
Manes Hall		*			
Conularia congregata Hall			*?		
Hyolithes Neapolis Clarke			*		
Coleolus aciculum Hall		*	*		
Tentaculites gracilistriatus Hall	*	*	*		
Styliola fissurella Hall	*	*	*		
Bellerophon natator Hall	*		*		
incisus Clarke	*		*		
striatus Ferussac and d'Orbigny		*			
Euomphalus planodiscus Hall			*		
Loxonema Noe Clarke			*		
Palæotrochus præcursor Clarke			*		
Platyostoma minutissimum Clarke			*		
Belial Clarke		*			
Macrocheilus (?) *Moloch* Clarke		*			
Pleurotomaria capillaria Conrad	*		*		
rugulata Hall	*	*			
Itys var. tenuispira Hall		*			
Cardiola retrostriata v. Buch		*	*		
Doris Hall			*		
Cardiomorpha suborbicularis Hall			*		
undulata Hall			*?		
textilis Hall			*?		
Praecardium vetustum Hall			*?		
Lunulicardium fragile Hall		*	*		
acutirostrum Hall			*		
ornatum Hall			*		
Modiomorpha (?) *Chemos* Clarke		*			

A list of the fossils occurring in the Genesee, Naples, and Portage beds, etc.—Continued.

Species.	Hamilton shales.	Genesee shales.	Naples shales.	Portage beds.	Chemung beds.
Spirifera lævis Hall			*?		
Belphegor Clarke		*			
Pluto Clarke		*			
Ambocœlia umbonata Conrad	*	*		*	*
Atrypa aspera Hall				*	*
Chonetes setigera Hall	*	*			*
lepida Hall	*	*			
Leiorhynchus quadricostatus Hall		*			
mesacostalis Hall				*	*
(?) *Hecate* Clarke		*			
Stenochisma eximium Hall				*	*
Crania centralis Hall			*?		
Discina truncata Hall		*			
Lodensis Hall		*			
Leoni Hall (?)				*	*
Lingula ligea Hall			*		
spatulata Hall		*			
concentrica Vanuxem		*			
triquetra Clarke			*		
Cyathocrinus ornatissimus Hall			*?		
Melocrinus Clarkei Williams		*	*		
Poteriocrinus Zethus Williams			*?		
Taxocrinus Ithacensis Williams			*?		
curtus Williams			*?		
Aulopora annectens Clarke			*		
Cladochonus sp		*			
Dictyophyton tuberosum Hall				*	*
Cyclostigma affine Dawson		*	*		
Asteropteris noveboracensis Dawson			*		
Ormoxylon Erianum Dawson			*		
Dadoxylon Clarkei Dawson		*			*
Cladoxylon mirabile Dawson		*			
Lepidodendron primævum Rogers		*	*		
Gaspianum Dawson		*	*		
Calamites inornatus Dawson		*			
Rachiopteris (Rhodea) pinnata Dawson		*?			
Fucoides graphica Vanuxem			*	*	
Sporangites Huronensis Dawson		*			

Thus of 47 species occurring in the Naples shales of this district, 15 species or 34 per cent. occur also in the fauna of the Genesee; 1 species (3 including *Fucoides graphica* and *Scolithus verticalis*) or 2.1 per cent. in the fauna of the Portage; 9 species or 19 per cent. in the fauna of the Hamilton proper.

Of 32 species (not including 11 species belonging to the pyrite fauna) here noted as occurring in the Genesee shales of the district, 16 species or 50 per cent. occur also in the fauna of the Naples shales; 11 species or 34 per cent. in the fauna of the Hamilton proper.

Of 12 species which here occur in the Portage beds, 1 (3 ?) species or 8.5 per cent. is found also in the Naples shales; 7 species or 60 per cent. occur in the overlying Chemung beds.

There are two conclusions to be drawn from these tables, namely, (1) that the Naples shales have no such paleontological relation to the rocks of the Chemung Period as to justify the union of them with these rocks; (2) that their fauna and flora is more closely allied to those of the Hamilton shales, and that therefore these beds are to be regarded either as constituting the uppermost member of the Hamilton Period, or,

together with the Genesee shales, representing a distinct geological epoch.

From the facts (1) that only 10 of the 66 species which may be referred to the horizon of the Naples shales in New York, and 15 of the 56 species in the Genesee shales occur in the fauna of the Hamilton epoch, and (2) that as far as it is possible to trace a correspondence between these and transoceanic faunas they appear to belong to a lower Upper-Devonian horizon, and (3) that the transition from the Genesee to the Naples beds is so gradual petrographically and paleontologically that a very strong line of division between them is not possible, the more probable conclusion is that these two groups of strata represent the epoch of the lower Upper-Devonian in Western New York.

FAUNA OF CHEMUNG BEDS AT HIGH POINT.

Overlying the thick-bedded "sandstone with vertical fucoids," which was described by Mr. Hall as composing the terminal mass of the Portage sandstones, is a stratum 5 feet in thickness which contains a fauna of much interest. This was discovered in 1878 by Mr. D. D. Luther, on the summit of "High Point," a mountain standing 1,900 feet above the sea, and situated about 3 miles northwest of the village of Naples. The exposure of the stratum is quite limited, and, as it is *in situ* only on the sheer face of a high cliff, has been studied mostly from the fragments which have fallen into the talus below. I know as yet of no other outcrop of the stratum, although I have reason to believe that it will be found among the high hills lying to the south. The containing rock is a sandy limestone, or a sandstone, with a large intermixture of calcic carbonate brought in by the fossils it contains, and is in places largely composed of fragments of crinoid columns. It has afforded me the following fauna:

Rhynchonella pugnus Martin.
Atrypa aspera Hall.
A. reticularis Linnæus.
A. hystrix Hall.
Streptorhynchus Chemungensis Hall.
Spirifera disjuncta Sowerby.
S. subattenuata Hall.
S. mesacostalis Hall.
S. bimesialis Hall.
Ambocœlia umbonata Conrad.
Strophodonta Cayuta Hall.
S. variabilis Calvin.
S. exilis Calvin.
Productella speciosa Hall.
Orthis infera Calvin.
Chonetes setigera Hall.
Crania sp.
Pterinea sp.
Polypora sp.
Fenestella sp.
Zaphrentis sp.
Receptaculites sp.
Dadoxylon Clarkei Dawson.
Rhynchodus sp.
Cladodus sp., and other undetermined fish remains.

In the summer of 1882 I made Dr. H. S. Williams, of Ithaca, acquainted with the locality, and he has identified the following additional species:[51]

Productella dissimilis Hall.
Orthis Iowensis Hall.
Strophodonta arcuata Hall.
S. (*Strophonella*) *reversa* Hall.
S. Canace Hall and Whitfield.
Spirifera Orestes Hall and Whitfield.
Stenochisma contractum Hall.
Fistulipora occidens Hall and Whitfield.

Of this fauna only the following species had been previously recognized from the Chemung group of New York State:

Atrypa aspera Hall.
A. reticularis Linnæus.
A. hystrix Hall.
Streptorhynchus Chemungensis Hall.
Strophodonta Cayuta Hall.
Spirifera mesacostalis Hall.
S. disjuncta Sowerby.
Productella speciosa Hall.
Chonetes setigera Hall.
Ambocœlia umbonata Conrad.
Stenochisma contractum Hall.

Rhynchonellæ very closely allied to *pugnus* Mart. have already been recognized in America by Meek[52] in the subcarboniferous rocks of Rockford, Indiana, and Chouteau Springs, Missouri, in forms which are closely comparable to the English and Irish carboniferous forms. These have been referred to the species *R. Missouriensis* Shumard.[53] Marcou, in 1858, and McChesney, in 1860, described species of quite the same type as *R. pugnus*, the former under the name *R. Rockymontana*, the latter with the name *R. eatoniaeformis*, from the carboniferous of Utah and Illinois respectively. Although *R. pugnus* belongs to a carboniferous type, and occurs abundantly in the English and Irish carboniferous rocks, it is also in the same countries a member of the fauna of the Middle Devonian.[54] It isa well-known fossil in the Rhenish Devonian[55] throughout

[51] Am. Jour. Sci., Vol. XXV, Feb., 1883.
Dr. Williams has somewhat forestalled my work upon this fauna by the publication of this article upon A remarkable Fauna at the base of the Chemung Group in New York, but my observations here indorse and materially strengthen the *essential* views there set forth.

[52] Geol. Survey of Illinois, 1866, Vol. II, p. 154.

[53] Geol. of Missouri, 2d Ann. Rep. 1855, p. 204, and Meek, Geol. Survey of Illinois, Vol. II, p. 153.

[54] Davidson, Mon. British Dev. Brach., p. 60.

[55] Maurer, Neues Jahrbuch, 1875; Kayser, Zeitschr. d. d. Geol. Gesell., Band XXIII,

the Stringocephalen Kalk and the Upper Calceola Schichten, but here it is not to be regarded as a diagnostic fossil, inasmuch as its more usual occurrence is at a higher horizon. Kayser,[56] Roemer, and Schlönbach quote it from the vicinity of Eschweiler and Aachen, where it is associated with *Spirifera disjuncta* at a horizon which parallellizes with the Lower Chemung of America. In Belgium and the north of France it is quoted by Bureau[57] from the Cop-Choux limestone, associated with *Rhynchonella cuboides*, and by Gosselet[58] from the "Schistes de Famenne," in association with *S. disjuncta* and *R. cuboides*, both of which horizons agree, as nearly as we can expect agreement in so widely separated formations, with the Chemung group of New York.

The forms of this species occurring in the Rhenish and Harz Devonian show a variation from the typical forms of *R. pugnus* figured by Davidson, and this author has referred the examples figured by the brothers Sandberger to *R. acuminata* Martin. Nowhere, to my knowledge, does this species in any one Devonian fauna present so considerable a variation as the specimens from High Point. Certain individuals with only a medium elevation of the mesial fold and with lateral plications acute at the margin, becoming obsolete over the visceral regions, represent the type of *R. pugnus*. Others, with extremely acute and elevated anterior margin and only traces of one or two lateral plications, represent the varieties of *R. acuminata*, *mesogonia*, or *plicata* Phill.[59] *R. pugnus* is one of several Devonian species of cosmopolitan range, and it has from the time of its first appearance in the Middle Devonian of Germany to its disappearance in the Lower Carboniferous, adapted itself to the change in the probable westward migration of the Devonian fauna of Europe, and has as a specific type outlived, without much variation, most of its earlier associates.

Dr. Williams has compared the fauna represented in the second of the lists given above with a peculiar and interesting fauna originally described by Hall[60] from Lime Creek, near Rockford, Iowa, and subsequently reviewed by Dr. C. A. White.[61] By these two authors this fauna was regarded as belonging to the Hamilton group. Later Messrs. Hall and Whitfield[62] published a study of the same fauna, describing some additional species, and referred it to the Chemung group, and more lately Mr. S. Calvin[63] has reviewed the fauna and given a complete list of its members as known to date. Calvin had also previously described[64]

[56] Kayser, Zeitschr, d. d. Geol. Gesell, Band XXII, p. 841.
[57] Bull. Soc. Geol. de France, 2me ser., T. XVII.
[58] Bull. Soc. Geol. de France, 2me ser., T. XVIII, p. 18.
[59] Mon. British Dev. Brach., Pl. XIII.
[60] Geology of Iowa, Vol. I, Pt. II, 1858.
[61] Geology of Iowa, Vol. I, p. 187, 1870.
[62] Twenty-third Ann. Rep. N. Y. State Cab. Nat. Hist., 1873.
[63] Am. Jour. Sci., Vol. XXV, June, 1883.
[64] Bull. U. S. Geol. Survey, Vol. IV, No. 3, 1878.

an interesting fauna from a bed of black shales at Independence, Iowa, which *underlies* the main beds of the Devonian strata in that State, known as the Devonian limestones. The Rockford shales, containing the Lime Creek fauna, *overlie* these Devonian limestones, and several of the species occurring in the higher horizon are also found in these lower Independence shales. For the purpose of bringing out clearly the correspondence between the High Point fauna of Ontario County, and the fauna of the Lime Creek and Independence beds as given by Calvin, leaving aside the Cœlenterate fauna of the Lime Creek beds, the following table will suffice:

Species.	Independence shales.	Devonian limestones.	Lime Creek beds.	High Point beds.
Naticopsis gigantea H. and Whitfield			*	
Paracyclas Sabini White			*	
Cryptonella Calvini H. and Whitf			*	
Terebratula navicella H			*	
Gypidula occidentalis H			*	
Gyp. munda Calvin	*			
Leiorhynchus Iris H			*	
Stenoschisma contractum, var. *saxatile* H			*	*
Rynchonella ambigua Calvin	*			
R. pugnus Martin				*
Atrypa reticularis Linnæus	*	*	*	*
Atrypa hystrix H	*		*	*
Atrypa aspera H				*
Cyrtina Hamiltoniæ, var. *recta*			*	
Spirifera MacBridei Calvin			*	
S. fimbriata Conrad			*	
S. cyrtinaeformis H. and Whitf			*	
S. Whitneyi H			*	
S. subumbona H	*			
S. Orestes H. and Whitf			*	*
S. Hungerfordi H			*	*
S. disjuncta Sowerby				*
S. mesacostalis H				*
S. bimesialis H		*		*
S. subattenuata H		*		*
Ambocoelia umbonata Con				*
Productella truncata H			*	
P. dissimilis H	*		*	*
P. speciosa H				*
Chonetes setigera H				*
Orthis impressa, var. *Iowensis* H			*	*
O. infera Calvin	*			*
Streptorhynchus Chemungensis Con			*	*
Strophonella hybrida H. and Whitf			*	
S. reversa H	*		*	*
Strophodonta exilis Calvin	*		*	*
S. variabilis Calvin	*		*	*
S. Canace H. and Whitf	*		*	*
S. arcuata H	*		*	*
S. Cayuta H				*
Crania famelica H. and Whitf			*	
Fistulipora occidens H. and W			*	*
Dadoxylon Clarkei Dawson				*

This fauna in Ontario County consists of twenty-six described species, indisputably of the age of the Chemung Period, as it contains eleven species previously recognized from the Chemung group of New York, and lies 600 feet above the last stratum known to contain fossils of the Naples shales. But it embraces a large intermixture of species that are totally unlike those of the Chemung of New York, and which find their counterpart only at a distance of nearly 1,000 miles to the west. Fourteen species are common to the High Point strata and the Lime

Creek beds overlying the Devonian limestones. Of twelve species occurring in the Independence shales, which underlie these Devonian limestones, nine occur also on High Point. Two species of the intervening Devonian limestones, viz., *Spirifer bimesialis* H., and *S. subattenuata* H., occur likewise at High Point. With the occurrence of these Chemung fossils abundantly at the base at the top of the Devonian series in Iowa, it becomes difficult to assign any definite horizon to the members of that series which will give them a correspondence with series in New York. The character of the fauna of the Independence shales leads us to the belief that the first Devonian fauna to appear in Iowa included an important representation from the Chemung fauna of New York in its probable migration westward from New York, to be succeeded in the limestones and shales above by a mingling of the Middle and Lower Devonian faunas of the east, and again by a return of the Chemung fauna with a more perfect development at the time of the deposition of the Lime Creek beds. That is, in the matter of relative age, all of these Iowa Devonian beds must be later in time of deposition than the Devonian of New York lying below the horizon of the High Point strata, and the age which saw the deposition of the Chemung sediments in New York was probably well toward its close at the time of the inception of the conditions in Iowa necessary for the deposition of the Independence shales.

List of the new species described in this paper.

Species.	Genesee shales.	Naples shales.
PISCES.		
1. Dinicthys Newberryi	*	
2. Pristacanthus vetustus		*
3. Palæoniscus Devonicus		*
4. Acanthodes pristis		*
CRUSTACEA.		
5. Ceratiocaris simplex		*
6. C. Beecheri		*
7. Echinocaris Whitfieldi		*
8. Beyrichia Dagon	*	
CEPHALOPODA.		
9. Goniatites Lutheri		*
10. G. Astarte	*	
11. Goniatites nodifer		
12. Orthoceras aciculoides		*
13. O. Ontario		*
14. O. filosum		*
15. O. Stebos	*	
16. O. Mephisto	*	
17. O. Asmodeus	*	
PTEROPODA.		
18. Hyolithes Neapolis		*
GASTEROPODA.		
19. Bellerophon incisus		*
20. Loxonema Noe		*
21. Platyostoma minutissimum		*
22. Pl. Belial	*	
23. Palæotrochus præcursor		*
24. Macrocheilus (?) Moloch	*	
PELECYPODA.		
25. Modiomorpha Chemos	*	
BRACHIOPODA.		
26. Spirifera Belphegor	*	
27. Sp. Pluto	*	
28. Leiorhynchus Hecate	*	
29. Lingula triquetra		*
CŒLENTERATA.		
30. Aulopora annectens		*

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[Figures in heavy-faced type indicate the page on which the description or a special reference is given.]

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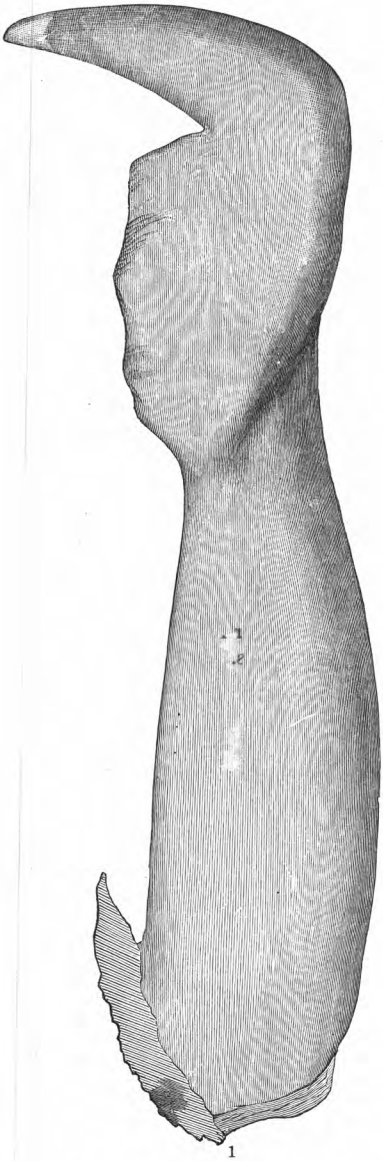
EXPLANATION OF PLATE I.

FIG. 1. *Dinichthys Newberryi* Clarke. Right lower mandible. $\times \frac{1}{2}$.
FIGS. 2, 3. *Palæoniscus Devonicus* Clarke. Scales. Fig. 2, $\times 2$; Fig. 3, $\times 10$.
FIGS. 4, 5, 6. The same. Cranial plates. $\times 2$.
FIG. 7. *Pristacanthus vetustus* Clarke. Spine. *Ad nat.*



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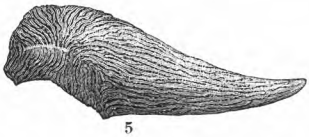

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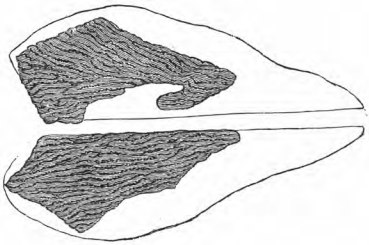

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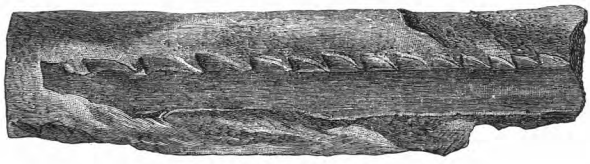

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DEVONIAN FOSSILS.

EXPLANATION OF PLATE II.

FIG. 1. *Ceratiocaris Beecheri* Clarke. Showing three abdominal segments and the telson spines. *Ad nat.*

FIG. 2. *Ceratiocaris simplex* Clarke. Carapace. *Ad nat.*

FIG. 3. *Echinocaris Whitfieldi* Clarke. Carapace. *Ad nat.*

FIG. 4. The same. Caudal plate with two telson spines. *Ad nat.*

FIG. 5. *Beyrichia Dagon* Clarke. Side view. × 20.

FIG. 6. The same. Dorsal view. × 20.

FIG. 7. The same. Ventral view. × 20.

FIG. 8. *Goniatites Lutheri* Clarke. *Ad nat.*

FIG. 9. *Goniatites Astarte* Clarke. Side view. × 12.

FIG. 10. The same. Front view. × 12.

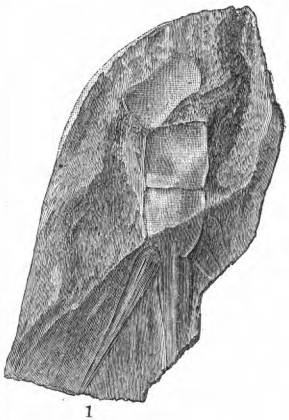
FIG. 11. *Orthoceras aciculoides* Clarke. × 2.

FIG. 12. *Orthoceras filosum* Clarke. *Ad nat.*

FIG. 13. The same. Opposite side of the same individual.

FIG. 14. The same. A younger example. *Ad nat.*

FIG. 15. *Orthoceras Stebos* Clarke. × 12.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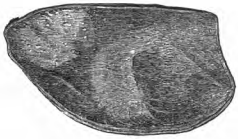
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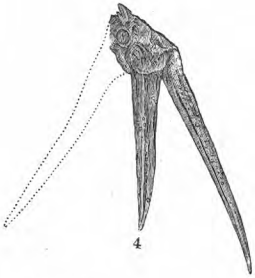
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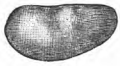
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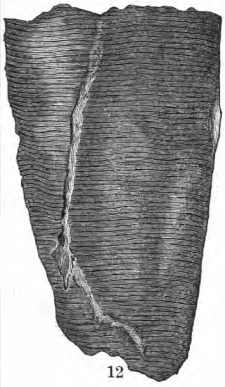
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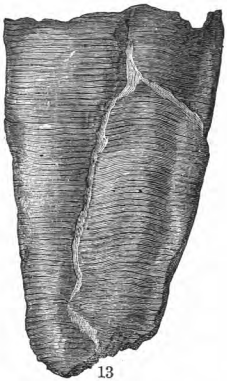
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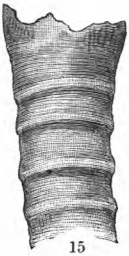
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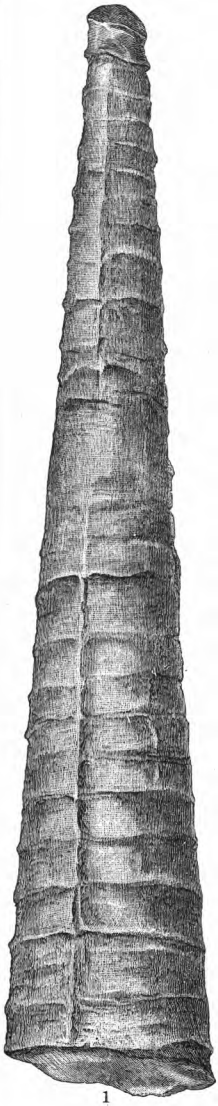
DEVONIAN FOSSILS.

EXPLANATION OF PLATE III.

FIG. 1. *Orthoceras Ontario* Clarke. *Ad nat.*
FIG. 2. *Orthoceras Mephisto* Clarke. × 12.
FIG. 3. *Orthoceras Asmodeus* Clarke. × 30.
FIG. 4. *Hyolithes Neapolis* Clarke. Dorsal surface. *Ad nat.*
FIG. 5. The same. Ventral surface. *Ad nat.*
FIG. 6. *Palæotrochus præcursor* Clarke. *Ad nat.*
FIG. 7. The same. × 2.
FIG. 8. The same. Showing the stoma. × 2.
FIG. 9. The same. View from above. × 2.
FIG. 10. *Loxonema Noe* Clarke. × 3.
FIG. 11. *Lingula triquetra* Clarke. *Ad nat.*
FIG. 12. *Spirifera Pluto* Clarke. × 10.
FIG. 13. *Spirifera Belphegor* Clarke. × 4.
FIG. 14. *Leiorhynchus* (?) *Hecate* Clarke. × 10.
FIG. 15. *Aulopora annectens* Clarke. *Ad nat.*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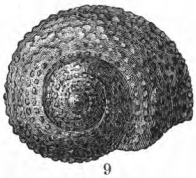
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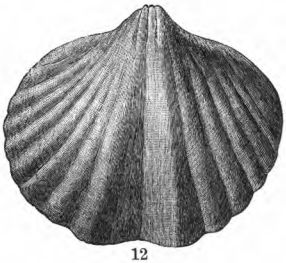
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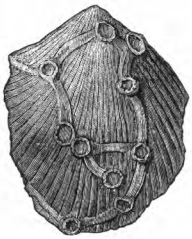
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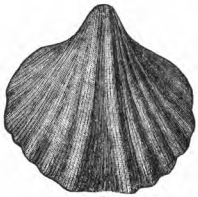
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DEVONIAN FOSSILS.