

REPORT

OF THE

GEOLOGICAL SURVEY OF OHIO.

VOLUME II.

GEOLOGY AND PALÆONTOLOGY.

PART II. PALÆONTOLOGY.

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A REPORT

ON SOME OF THE

INVERTEBRATE FOSSILS OF THE WAVERLY GROUP
AND COAL MEASURES OF OHIO.

BY

F. B. MEEK.

To DR. J. S. NEWBERRY, *State Geologist*:

DEAR SIR: I herewith respectfully submit a report on some of the Invertebrate fossils collected by the State Geological Survey of Ohio from the subdivisions of the Carboniferous system known as the Waverly group and Coal Measures. Preliminary notices of some of these fossils were published, without illustrations, a few years back, in the Proceedings of the Academy of Natural Sciences at Philadelphia; and the drawings of those here illustrated were subsequently prepared, and are now presented along with somewhat more extended descriptions. At the time these drawings were made, it was intended to give more full illustrations of the fossils of these formations, particularly of the *Brachiopoda* of the Waverly group, which contains numerous invertebrate remains that are not here included. As the report on these fossils, however, was not to be published until that on some of those of the older rocks was issued, work on the former was mainly suspended after the preparation of the drawings now submitted, my attention being for some time after devoted to the preparation of the published report on some of the Ohio Silurian and Devonian fossils, and preparing reports on collections of several General Government Surveys of the Western Territories.

A short time before the published report mentioned above was sent to the printer, I was prostrated by a severe and protracted attack of sickness, that not only prevented me from superintending the publication of the same, but caused an entire suspension of work on the Waverly and Coal Measure fossils. A few of the plates of the latter report, however, were already engraved; but when the others were called for I was only able to arrange such drawings as were at that time prepared, without regard to the original plan, and even without adding others necessary to the complete illustration of some of the species.* This explanation is made in order that those who use this report may understand why the plates were not more systematically arranged. The original plan was, that the space between the plates now numbered 10 and 14 was to be occupied by two or more plates of *Brachiopoda*, with numbering of the whole made to correspond, while the plate now numbered 13, and only partly occupied by Lamellibranchs, was intended to be filled out with the same, and inserted between the plates now numbered 15 and 16. As this, however, for the reasons already explained, could not be done, the intervening space had to be filled with figures of Crinoids described by other parties, which latter figures would have been more systematically placed on plates preceding all the others.

Had health permitted the completion of the original plan of a thorough study of the invertebrate fossils of the Waverly group, I had intended to prepare for this place some general remarks on the relations of this fauna to those of the Carboniferous and Devonian rocks of other parts of this country and Europe, for which purpose some notes were from time to time prepared. Nothing of this kind, however, will now be attempted here, though it may be proper to remark that I have seen no reason to change an opinion long since expressed in a joint paper with Prof. Worthen, that this rock and its equivalents in Illinois, Indiana, etc., belongs to the Carboniferous

* This is all the more to be regretted because better specimens of some of the species than those seen by me have doubtless since been found.

system.* It may also be added that, from the first, I have been impressed with the rather curious fact that many of the Waverly fossils have much more closely allied representatives in the Coal Measures of our Western States than are yet known to occur in the Lower Carboniferous limestones of the same region. Quite a list of very closely allied representative forms from these two horizons might be made out, mainly of species belonging to the *Polyzoa*, *Brachiopoda*, *Lamellibranchiata*, and *Crustacea*. By these remarks, however, it is not intended to be even intimated that I have the slightest suspicion that the Waverly should be included in the Coal Measures. It is only an interesting instance of somewhat similar physical conditions having brought into existence similar forms in particular kinds of life at different periods of time.† On the other hand, the *Crinoids* of the Waverly correspond closely in their general features to those of the the Lower Carboniferous limestones of the West, while the *Cephalopoda*, particularly the *Goniatites* and *Nautili*, nearly approach European Lower Carboniferous forms.

In preparing this report, I have been favored by Prof. Henry with the usual facilities at the Smithsonian Institution. I am also under obligation to Prof. Winchell for access to his types of the fossils described by him from the horizon of the Waverly rocks in Michigan, and for the privilege of making tracings of the drawings of his species, so far as completed. I only regret that circumstances prevented a direct comparison of specimens, especially in some doubtful cases that have come up for decision since I saw his collection. For the use of some of the fossils figured in this report I am indebted to the Rev. Mr. Hertzner, Prof. Andrews, and Mr. Klippart, of Columbus, from whose private collections they were borrowed. The drawings for the accompanying plates were made by Messrs. W. H. Holmes, I. C. McConnel, and H. W. Elliott, of Washington City, D. C.

Very respectfully, yours,

F. B. MEEK, *Palæontologist*.

* *Am. Jour. Sci. and Arts*, Vol. XXXII, page 167, 1861.

† Although the Waverly group is not a coal-bearing formation, it agrees *much* more nearly with the Coal Measures, *lithologically*, than with the Lower Carboniferous limestones further westward, and hence was apparently deposited under local conditions more nearly corresponding to the Upper than to the Lower Carboniferous, though belonging to the age of the latter.

WAVERLY GROUP SPECIES.

MOLLUSCA.

POLYZOA.

GENUS FENESTELLA, Lonsdale, 1837.

(Murchison's Sil. Syst., 676.)

FENESTELLA DELICATA, Meek.

Plate 10, figs. 2a, b, c, d.

Fenestella delicata, Meek (1871); Proceed. Acad. Nat. Sci., Philad., XXIII., 159.

Polyzoom growing in flat flabelliform, very finely reticulated expansions; branches very slender, rigid, bifurcating, and often nearly parallel, or gradually diverging, to give room for new ones formed by division; dissepiments about half as thick as the branches, alternating or opposite, and but little expanded at the ends, as seen on the non-poriferous side; fenestrules very uniform, oblong, with length usually about one-third to one-half greater than their breadth; non-poriferous side roughened by little nodes along the branches, rather more closely arranged than the fenestrules; poriferous side with a similar row of little pointed elevations along a more or less defined mesial ridge of each branch; pores comparatively large, alternating, and numbering two, or occasionally three, in each row opposite each fenestrule, and one generally nearly or exactly at one or both ends of each dissepiment.

Size of entire polyzoom unknown, but it apparently attained a length of three inches or more; number of fenestrules in 0.20 inch, measuring longitudinally, 3; do., measuring transversely, 4.

As seen on the non-poriferous side, this species closely resembles Prof. McCoy's figure of his *F. plebeja*, natural size, excepting that it forms a slightly finer network. Under a magnifier, however, it is seen to differ in having a row of little nodes along each branch, and I have not seen any longitudinal striæ on its branches, though they probably exist on perfect specimens. The magnified figures of the poriferous side of *F. plebeja* show still more important differences, its fenestrules being proportionally much longer, with four or five pores opposite each side. The

little nodes or projecting points along the mesial ridge of this side of the branches in our species do not exist in *F. plebeja*, nor does the latter usually have a pore opposite each end of each dissepiment, as in the species under consideration.

Locality and position: Lodi, Ohio. Waverly group of Lower Carboniferous.

FENESTELLA MULTIPORATA? var. LODIENSIS.

Plate 10, figs. 1a, b, c.

Fenestella multiporata, McCoy (1844); Synop. Carb. Foss. Ireland, p. 203, pl. 28, fig. 9.

Polyzoum flabelliform; stems slender, bifurcating, sometimes straight, and running nearly parallel to each other, but in other examples curving laterally to make room for new divisions, or somewhat flexuous; dissepiments very slender or scarcely half as thick as the stems, and very little or not at all expanded at the ends; fenestrules two or three times as long as wide, and not rounded at the ends; pores situated on little prominences, and alternately arranged so that from five to seven of them may be counted on each side of a stem opposite each fenestrule; mesial ridge between the rows of pores very small or apparently sometimes obsolete, occasionally with little prominences about twice as distant from each other as those bearing the pores; non-poriferous side of the stems rounded, or sometimes sub-angular, and minutely striated longitudinally.

Entire size of polyzoum unknown, but apparently sometimes not less than four or five inches in diameter. Fenestrules 7 to 9 in 0.20 inch, measuring transversely, and about 2 to 3 in the same space, measuring longitudinally; number of pores in same space on each side of a stem, 16 to 17.

This fossil agrees so exactly in the size of its branches, dissepiments and fenestrules, and so nearly in the nature and arrangement of its pores, with *F. multiporata* of McCoy, that I am inclined to believe it may possibly be a variety of the same species. The only differences I can see are, that it seems to be nearly destitute of the mesial carina so well developed along the poriferous side of the branches in Prof. McCoy's species, and the somewhat greater obliquity and prominence of its pores, which also usually number one or two less on each side, opposite each fenestrule, than in *F. multiporata*. It likewise shows some appearances of little nodes along the middle of the poriferous side of the branches not represented in the latter. It is probably a distinct species, but I prefer to

place it as a variety of *F. multiporata* until its relations to that form can be determined by a comparison of authentic specimens.

Locality and position: Lodi, Ohio. Shaly beds of the Waverly group.

BRACHIOPODA.

GENUS LINGULA, Bruguiere, 1792.

(Encyc. Meth. Tab., 250.)

LINGULA (LINGULELLA ?) MEMBRANACEA, Winchell.

Plate 14, fig. 4.

Lingula membranacea, Winchell (1863); Proceed. Acad. Nat. Sci., Philad., XV., 3.

Shell attaining about a medium size, compressed, longitudinally oblong, with length nearly twice the breadth, and lateral margins almost straight and parallel, or but very slightly convex in outline; anterior margin rounded or sometimes faintly subtruncated; beak very obtuse, with a narrow faint ridge extending from it a short distance forward. Surface appearing smooth, but on close examination showing very obscure traces of fine concentric striae.

Length, 0.78 inch; breadth midway between the front and middle, 0.45 inch; do. at same distance from anterior end, 0.42 inch.

The specimen from which our figure and description were prepared seems to be mainly an internal cast of the dorsal valve, judging from the obtuseness of the beak. The little ridge extending forward from the beak has somewhat the appearance of being the cast of a small furrow of the cardinal margin, for the passage of the peduncle. If this appearance is not deceptive, the species would doubtless fall into Mr. Salter's group *Lingulella*. In our figure this little ridge is represented slightly too thick, and scarcely long enough, while the lateral margins of the figure are also a little too straight, and its anterior region scarcely wide enough, proportionally.

This seems to be a marked form, readily distinguished by its longitudinally oblong form, nearly straight and parallel sides, and compressed valves.

I have not had an opportunity to compare our specimens with Prof. Winchell's types, but our shell agrees so nearly with his description that I am inclined to believe it belongs to his species.

Locality and position: Prof. Winchell's type specimens came from the yellow, fine, arenaceous beds under the Burlington limestone, at Burlington, Iowa, belonging to the horizon of the Waverly group of Ohio, while that we have figured was found at about the same horizon, at Hart's Grove, Ashtabula county, Ohio.

LINGULA MELIE, Hall?

Plate 14, fig. 3.

Lingula melie, Hall (1864); 16th Report of the Regents on the State Cab. Nat. Hist. N. Y., 24; and (1867) Palæont. N. Y., IV., 14, pl. 1, figs. 3 and 4.

Shell narrow-subovate or sub-elliptic, moderately convex, widest at or a little in front of the middle, where the breadth equals about one-half to two-thirds the length; lateral margins forming semi-oval or nearly semi-elliptic curves, and rounding rather abruptly into the subtruncate or rounded front; beaks obtuse, with a flattened, slightly raised, mesial ridge extending and widening forward from them to the front. Surface marked by fine concentric striæ of growth.

Length of a rather narrow specimen, 0.66 inch; breadth, 0.34 inch.

The specimen represented by our figure is proportionally rather narrower than a majority of those in the collection, and the mesial flattened ridge is not represented tapering enough toward the beak from the front in our figure. It should be narrower, even near the middle of the valve, than the slope on either side. On some specimens, however, it seems to be nearly obsolete, while on others it is quite well defined, and rather distinctly flattened anteriorly, thus imparting a truncated outline to the front. I am not sure that I have seen specimens of *L. melie* from the original locality; but the form here described has been referred to that species by the geologists of the Survey, and was sent to me with that name attached.

Locality and position: Cuyahoga shale, a part of the Waverly group of the Lower Carboniferous, at Johnston, Trumbull county, Ohio. Prof. Hall's type specimens came from Chagrin Falls, Ohio.

LINGULA SCOTICA, Davidson?

Plate 14, fig. 9.

Lingula Scotica, Davidson (1868); Monogr. Scottish Carb. Brach., pl. 5, figs. 36 and 37; British Carb. Brach., p. 207, pl. 48, figs. 27 and 28.

?? *Lingula Scotica*, var. *Nebrascensis*, Meek (1872); Palæont. E. Nebraska, p. 158, pl. 8, figs. 3a, b.

Shell ovoid-subtrigonal, compressed; lateral margins converging with slightly convex outlines from near the front to the beaks, at an angle of about 120°, and rounding to the rounded or faintly subtruncated front;

beak narrow, and apparently rather acutely pointed in well preserved specimens; surface ornamented by distinct concentric lines and furrows.

Length, 1.06 inch; breadth, 0.80 inch.

As I have seen but one mere cast of this shell, I have no means of knowing how far it may vary in form and surface markings, nor of determining whether it is a dorsal or ventral valve, though it is more probably the latter. Although it rather closely resembles Mr. Davidson's species, I am far from being entirely satisfied that it is really the same. It is proportionally narrower than his figure, and has the concentric markings more crowded. The former difference, however, is not greater than often occurs among individuals of the same species, while the latter, as represented in our figure, is a little exaggerated.* It is probably a distinct species, but, without better means of comparison, I do not feel quite willing to separate it. It is even less like the Nebraska Coal Measure form that I have regarded provisionally as a variety of *L. Scotica*, and can hardly belong to the same species as the latter.

Locality and position: Berea grit, Berea, Ohio.

GENUS DISCINA, Lamarck, 1819.

(Hist. Nat., VI., 236.)

SUB-GENUS ORBICULOIDEA, D'Orbigny, 1847.

(Compt. Rend., XX., 269.)

DISCINA (ORBICULOIDEA) NEWBERRYI, Hall.

Plate 14, figs. 1a, b, c, d.

Discina Newberryi, Hall (1864); 16th Report of the Regents on the State Cab. Nat. Hist. N. Y., p. 30; and (1867) Palæont. N. Y., IV., 25, pl. 1, figs. 10 and 11.

Shell rather under medium size, circular, or sometimes very slightly oval, the antero-posterior diameter being in the latter cases a little greater than the transverse. Upper valve much depressed, with its apex placed about half way between the middle and the posterior margin; or slightly nearer the latter than the former. Under valve flat, with point of accretion central, and foramen very small, and situated near the margin at the outer end of a deep oval impression extending from the center nearly to the posterior edge. Surface of both valves marked by

*The concentric markings are also too strong on our figure, particularly near the beak, where they make a broad curve.

small concentric striæ, and sometimes also showing very faint traces of radiating markings.

Diameter generally about 0.53 inch in mature specimens.

The radiating markings are so obscure as not to be seen unless carefully looked for in a favorable light, consequently no attempt was made to put them in the drawings, as this could scarcely be done without giving an exaggerated impression in regard to their distinctness. Even the concentric lines are made rather too distinct in fig. 1*a*. The foraminal impression is also a little too narrow and too oblique in fig. 1*d*, where it should extend directly to the center. The specimen from which fig. 1*c* was drawn has the foraminal impression very narrow, sharp, and apparently more like the true slit of a *Discina* proper than like a mere oval impression with a minute perforation at its outer end, as in the group *Orbiculoidea*. Consequently, it may possibly belong to a different shell from that represented by fig. 1*d*.

In regard to the specific affinities of this shell little can be said, as it presents almost no characters at all to distinguish it from several species found in rocks of various ages. I have seen one in our western Coal Measures *very* closely resembling it. Our figure 1*a* shows the concentric striæ coarser than represented by the figures of *D. Newberryi*, given in the Palæontology of New York, but the specimens vary somewhat in that character.

Locality and position: The specimens represented by our figures 1*a*, 1*c*, and 1*d*, are from the Cuyahoga shale, a member of the Waverly group of the Lower Carboniferous, while that represented by fig. 1*b* is in a light-gray, fine-grained, arenaceous matrix, from the same group, at Farmington, Ohio. Prof. Hall's typical specimens were found at Cuyahoga Falls and Akron, Ohio.

DISCINA (ORBICULOIDEA ?) PLEURITES, Meek.

Plate 14, figs. 2*a*, *b*.

Shell very nearly circular, or slightly longer than wide. Upper valve much depressed; apex but little elevated, obtuse, and placed very near the posterior margin, with a backward inclination, and more depressed than the surface a little in advance of it; surface only showing fine, obscure, irregular lines, and some stronger wrinkles of growth. Internal cast showing a linear impression along the middle of the anterior slope. Under valve unknown.

Length, 0.93 inch; breadth, 0.89 inch; height a little in advance of apex, 0.16 inch; do. of apex, 0.10.

This species is remarkable for its nearly marginal apex, which is, indeed, placed almost exactly over the posterior margin, though raised about one-tenth of an inch above it. I am not sure whether it is a true *Discina* or not, as I have seen no specimens of the under valve. I suspect that it will prove to be an *Orbiculoidea*, as several of the species described under the name *Discina*, from this horizon, seem to possess the peculiarities of the foramen in the under valve distinguishing the former group. This is certainly the case with *D. Saffordi* of Winchell, and the form I have identified with *D. Newberryi*.

Locality and position: Newark, Ohio. Waverly group of Lower Carboniferous series.

GENUS STROPHOMENA, Rafinesque, 1827.

SUB-GENUS HEMIPRONITES, Pander, 1830.*

(Beitr. zur Geog. de Russ., 74.)

HEMIPRONITES CRENISTRIA, Phillips? (sp.).

Plate 10, figs. 5a, b, c, d.

Spirifer crenistria, Phillips (1836); Geol. Yorkshire, Vol. II., pl. 9, fig. 6.

Spirifer senilis, Phillips; Ib., fig. 5.

Leptena anomala, J. de C. Sowerby (1840); Min. Conch., tab. 615, fig. 16.

Orthis umbraculum, var. Portlock (1843); Geol. Londonderry, Tyrone, etc., pl. 37, fig. 5:

DeKoninck (1843); Anim. Foss. Terr. Carb. Belg., p. 222, pl. 13, figs. 4-7.

Orthis Bechei, McCoy (1844); Synop. Carb. Foss. Ireland, pl. 22, fig. 3.

Orthis cornata and *O. caduca*, McCoy (1844); Ib., figs. 5 and 6.

? *Orthotetes radians*, Fischer (1850); Bull. Soc., XXIII., pl. 10.

Leptena crenistria and *L. senilis*, McCoy (1855); Brit. Pal. Foss., pp. 450 and 452.

Streptorhynchus crenistria, Davidson (1860); Monogr. Scottish Carb. Brach., p. 32, pl. 1, figs. 16-22: British Carb. Brach., p. 124, pl. 26, fig. 1, pl. 27, figs. 1-5, and pl. 30, figs. 14-16: Winchell (1862); Proceed. Acad. Nat. Sci., p. 410: and of many other authors.

Shell strongly resupinate, semi-oval, or truncato-sub-circular, being wider than long, with a regularly rounded anterior outline, and lateral

* In accordance with a suggestion in Vol. I., Part II., of the Ohio Geological Reports, I retain here, provisionally, the name *Hemipronites* in a subgeneric sense under *Strophomena*, until the question in regard to the particular group for which the latter name will have to stand has been more satisfactorily settled. Whether certain allied types should be treated as representing distinct genera, or only groups bearing the relations of subgenera of one genus, is often, however, a mere matter of fancy. For the *Hemipronites* group the name *Orthotetes*, Fischer, has been recently retained; but it seems to me that this can scarcely be properly done, for the following reasons:

In the first place, Fischer, in 1829, read a communication from a Mr. Evans before

margins rounding into the front, and usually curving inward behind, so as to intersect the hinge at rather more than right angles; hinge generally a little less than the greatest breadth of the shell. Dorsal valve always distinctly convex over all the central region, and thence rounding downward to the front and lateral margins, while its posterior lateral edges are generally reflected or curved more or less upward; beak rounding over to the hinge, beyond which it projects but little. Ventral valve flattened, or more or less concave, with its lateral, and sometimes its front margins, curved a little upward, and its posterior lateral downward, to conform to the curvature of those of the opposite valve; beak moderately prominent, and directed obliquely backward and upward, but not incurved; cardinal area generally of medium height, flattened, well defined, and inclined a little backward, with its closed triangular fissure varying in its proportional breadth and height with the greater or less elevation of the beak; interior without any mesial septum; muscular impressions occupying a comparatively small, fan-shaped space, that is neither deeply excavated nor bounded by prominent dental ridges. Surface of both valves ornamented by numerous, sub-equal, or alternately larger and smaller, radiating striæ, that increase rather by the intercalation of smaller ones between the larger than by division, the smaller commencing very slender at various distances from the beaks and extending to the free margins, increasing in size, so that they often become nearly or quite as large as the others. Crossing all of these are numerous, very fine, crowded concentric striæ, and obscure, much larger, ridges of growth.

Length of a rather large, wide, adult specimen, 1.73 inches; breadth of do., 2.16 inches; convexity of the two valves at the middle, 0.65 inch; do. of the dorsal valve, measuring from its lateral margins up to the horizon of its most gibbous central region, 0.90 inch.

the Imperial Society of Moscow, containing a description of a new genus which he said was related to *Placuna* and *Pedum*, and proposed to call *Orthotetes*. He neither figured, described, nor cited any example, however, and as it is not possible to know from his description and remarks what genus he had in view, he can not be regarded as having established a genus under that name at that time. It was simply a name resting upon nothing. In 1837, however, Fischer uses the name *Orthotetes*, and figures a shell under it, without a specific name, but having almost certainly the characters of *Hemipronites*. Again, in 1850, Fischer uses the name *Orthotetes*, and figures an example with the name *O. radians* attached, which seems to be *H. crenistria*. But as the genus was thus only properly made known under the name *Orthotetes* in 1837 and 1850, while Pander had described it with illustrative examples in 1830, under the name *Hemipronites*, I think his name should be retained, whether we regard the group as a sub-genus or as a distinct genus.

I have referred this form to Phillips's species, rather because I have been unable to find any constant characters by which it can be separated from some of the European forms referred to the same by high authorities, than from being *entirely* satisfied that a careful comparison of a large series of specimens might not show it to be a closely allied but distinct species. Although varying in form, it does not, so far as I have been able to see, vary in general outline to the extent that *H. crenistria* does in Europe, judging from the published figures, nor have I seen any specimens of it with the area so much elevated, or with the beak of the ventral valve so distorted, as in some foreign examples of that shell. It also usually has its posterior lateral portions more compressed and deflected than *H. crenistria*, as illustrated from British specimens.

I see Mr. Davidson, in his very valuable Monograph of the British Carboniferous Brachiopoda, page 124, cites *Orthis Keokuk* and *O. robusta*, Hall, as synonyms of the European species *H. crenistria*. I can not quite concur with him in this, however, because these, and, I think, all of the several other allied species or varieties found in our Western Carboniferous limestones and Coal Measures differ from the published figures of *H. crenistria*, as well as from the Waverly sandstone specimens under consideration, in having a well-defined, longitudinal mesial septum in the ventral valve, extending from the beak sometimes nearly to the middle of the interior. Mr. Davidson was not acquainted with the interior of Prof. Hall's species, but on examining good specimens of the allied form *H. crassa*, M. and H., from the Coal Measures, sent by me to him some time back, he noticed this internal septum as distinguishing it from the European species *H. crenistria*.

I have, in the Palæontology of the Upper Missouri, published by the Smithsonian Institution, on pages 25 and 26, given my reasons for believing that the rules of nomenclature will compel us to retain Pander's older name, *Hemipronites*, for this group, instead of *Streptorhynchus*, King, whether we regard it as constituting a genus or sub-genus. And in the first volume of the Palæontology of Ohio, page 73, I have stated reasons for believing that when the interior of all of the Carboniferous, Devonian, and Silurian shells of this and allied groups can be thoroughly compared, it will be seen that *Hemipronites* is so closely related to *Strophomena*, Rafinesque, that it can scarcely be separated from the latter more than as a sub-genus. Prof. King's name was proposed for Permian species, with the area and beak of the ventral valve extravagantly elevated, and the beak often much distorted; but when we pass to some of the Carboniferous, Devonian, and particularly to the Silurian species, we find examples with the area nearly or quite as little developed as in some

species of *Strophomena*. Indeed, it is now well known that this character of the elevation of the beak, and the greater or less development of the area can not be, within a considerable range of limits, even relied upon as a specific distinction

Locality and position: The specimens from which our figures and description were prepared were found in the Waverly group of the Lower Carboniferous, in Medina county, Ohio. It also occurs at numerous other localities in this State at the same horizon, and I suspect that some of the Devonian forms that have been described under other names farther eastward may not be specifically distinct. According to some very high authorities, *H. crenistria* occurs both in the Carboniferous and Devonian rocks of Europe. It is certainly a very widely distributed Carboniferous species, its geographical range there being almost coëxtensive with the rocks of that age.

GENUS PRODUCTUS, Sowerby, 1814.

(Min. Conch., I., 153.)

PRODUCTUS (undetermined sp.).

Plate 10, figs. 4a, b, c, d.

At the time the figures of this and the following form were drawn, it was my intention to make a thorough study of the *Producti* and other *Brachiopoda* of the Waverly group, and to prepare full illustrations and descriptions of them all. A failure of health, however, rendered it impossible to carry out this design.

The species here under consideration attains a medium size, has a very gibbous, strongly arcuate, and produced ventral valve, faintly sinuous along the middle, with short ears extending little beyond the lateral margins, and a concave, transversely semi-oval dorsal valve. Its hinge equals about the greatest breadth of the valves, and its surface is armed with small, apparently short spines, that are moderately scattering, and regularly arranged in quincunx, on little tubercles that become more or less elongated on the ventral valve, where they sometimes even assume the character of irregular costæ. These are crossed by very fine, regular, crowded, concentric striæ, and small, generally obscure, concentric wrinkles, that are most regular and best defined over the visceral region of both valves. The costæ are very variable, being sometimes rather distinct, and in other cases quite obscure, or almost entirely obsolete, so that the surface seems nearly smooth between the little tubercles.

It is probably an undescribed species, but the difficulty of distinguishing species in this group is so great, without a good series of specimens and authentic examples of the closely allied species for comparison that I have concluded not to attempt to decide the question in regard to its

affinities in preparing the text for the press, a part of which I have had to do away from home, and with but few of the necessary facilities at hand. The fact, too, that Prof. Winchell has named and described a number of species of this genus from the same formation, none of which have yet been figured, renders it still more difficult to arrive at satisfactory conclusions whether our specimens belong to a new species or not.

Locality and position: Sciotoville, and various other localities in the Waverly group of the Lower Carboniferous series in Ohio. I think I have also seen the same shell in beds of the same age (Choteau limestone) in Missouri, and the Kinderhook group of Illinois.

PRODUCTUS (undetermined sp.).

Plate 10, fig. 3.

This is a larger, wider, and less produced form than the last, with much more distinct longitudinal costæ. It much more nearly resembles *P. semireticulatus* than the last, but has the concentric wrinkles decidedly smaller and less distinct over the visceral region, and doubtless differs in other respects from that species. The costæ of the species described above are so exceedingly variable that I am not altogether *clearly* satisfied that it may not be connected with this by specimens presenting intermediate characters, though I think it is not.

Locality and position: Same as last.

GENUS ATHYRIS, McCoy, 1844.

(Synop. Carb. Foss. Ireland, 128.)

ATHYRIS LAMELLOSA, Leveille? (sp.).

Plate 14, figs. 6a, b.

Spirifer lamellosus, Léveillé (1835); Mem. Geol. Soc. France, II., 39, figs. 21-23.

Spirifer squamosus, Phillips (1836); Geol. Yorks., II., 220, pl. 10, fig. 21.

Terebratula lamellosa, DeKoninck (1843); An. Foss. Belg., 299, pl. 20, figs. 5a, b, c.

Compare *Spirigera Hannibalensis*, Swallow (1860); Trans. St. Louis Acad. Sci., I., 649: also *Athyris crassiscardinalis*, White (1860); Boston Jour. Nat. Hist., VII., 229.

Shell transversely sub-elliptic, being usually about two-thirds as long as wide, moderately convex; hinge line long, and often nearly or quite straight, but rounding off at the lateral extremities, and never equaling the breadth of the valves; lateral margins rather narrowly rounded; front more or less rounded, or forming a transversely semi-elliptic curve in general outline, but usually produced and sub-angular in the middle, at the termination of the mesial fold and sinus. Dorsal valve a little more convex than the other, its greatest convexity being in the central

region, in front of which it rises into a low, rounded, mesial fold, that is rarely continued very obscurely visible to the umbonal region, with sometimes the faintest possible tendency to become flattened on top; beak very short and incurved. Ventral valve having a more flattened appearance, especially anteriorly, where it is impressed into a shallow mesial sinus, which narrows rapidly backward, and is sometimes continued faintly to the umbonal region; beak a little ventricose, but only projecting slightly beyond that of the other valve, upon which it is closely incurved. Surface of each valve provided with about eight or ten strongly projecting, and sometimes slightly waved, concentric lamellæ, which rise abruptly from the surface, excepting around the front and lateral margins, where they are more crowded, and extend out horizontally to considerable distances; very fine concentric striæ, and sometimes obscure traces of radiating markings, are also seen between and upon the lamellæ.

Length of a rather transverse, mature specimen, exclusive of the extended lamellæ, 1.05 inches; breadth of do., 1.59 inches; convexity, 0.60 inch.

Internal casts of the ventral valve of this shell show that the impressions of its divaricator muscles are faintly marked, and, together, occupy a comparatively large, somewhat fan-shaped space, extending forward beyond the middle of the valve, while those of the adductor muscles extend about half the length of the divaricators between the upper ends of the latter, and, as joined together, present a neat cordate outline, very pointed below. Casts of the rostral cavity show it to be tapering, arched, rounded, or a little flattened on top, and transversely striated, while on each side of it the umbonal region shows a few granules, representing minute pits in the interior of the valve. On casts of the interior of the dorsal valve impressions of the quadruple muscles are usually well defined, the upper pair being each rhombic, connected along the straight inner edges, and sometimes unequally bilobed above, while the lower pair are longer, and occupy a somewhat larger and obovate space, that tapers below, and is a little obliquely truncated on each side above. The cast of the rostral cavity is small, much arched, and rapidly tapering to a point that looks as if it had filled a minute perforation in the point of the beak. The internal mesial ridge is very small, or merely sharply linear, and extends forward sometimes to the middle of the valve, and backward to the point of the rostral cavity. The perforation of the ventral beak seems to be small, judging from the cast of the rostral cavity.

I have not had an opportunity to compare specimens of this shell with

Prof. Swallow's types of his *Spirigera Hannibalensis*, but believe it to be the same form described by him. In regard to its relations to *Athyris lamellosa*, I can only say that a comparison of our specimens with Mr. Davidson's figures of that species shows no constant differences, though it varies much in form, and while some specimens agree quite nearly with *A. lamellosa*, others seem to have a shorter and more obtuse ventral beak than those figured by Mr. Davidson. It should also be explained here that the specimen represented by our figure on plate 14 is rather more than usually transverse, and has a longer and straighter hinge than the others. The latter character, however, is more marked than natural, in consequence of the fact that the specimen is merely an internal cast, the thick shell of the rostral region, when present, causing the hinge margin to appear shorter.

This shell seems also to be nearly related to *Athyris crassicardinalis*, White, described from near the same horizon at Burlington, Iowa, and may be the same. I regret having no opportunity to make the necessary comparisons with Prof. Swallow's and Dr. White's types, to be able to arrive at more satisfactory conclusions in regard to their relations to the form under consideration. I had expected to do this before preparing the description, and had also intended to give here much more full and complete illustrations of this and the other Waverly *Brachiopoda*, but, as elsewhere explained, a failure of health rendered this impossible, and made it necessary merely to arrange on the plates such of the figures as were already drawn at the time they were called for.

Locality and position: Sciotoville, Ohio. In the Waverly group of the Lower Carboniferous.

GENUS SPIRIFER, Sowerby, 1815.

(Min. Conch., II., 42.)

SPIRIFER CARTERI, Hall.

Plate 14, figs. 7a, b, c, (d?)

Spirifer Carteri, Hall (1857); Regents' 10th Ann. Rept. on State Cab. Nat. Hist. N. Y., 170.

Spirifer (*Cyrtia*?) *Hannibalensis*, Swallow (1860); Trans. St. Louis Acad. Sci., I., 647. Compare *Spirifer tectus*, Hall (1857); Regents' 10th State Cab. N. H. Report, 169: also *Spirifer capax*, Hall (1858); Iowa Geological Report, p. 520, pl. 7, figs. 7a, b: *Syringothyris typus* and *S. Halli*, Winchell (1863); Proceed. Acad. Nat. Sci., Philad., pp. 7 and 8: and *Spirifer cuspidatus*, Martin (sp.), as illustrated in Mr. Davidson's Monogr. Brit. Carb. Brach., pls. 8 and 9.

Shell attaining a rather large size, very thin, nearly semicircular, as seen in a direct view from above or below, and rhombic-subquadrangular in a front or posterior view, with length generally a little more than half

the breadth, and the breadth usually about twice the height of the area; hinge line about equaling the greatest breadth; front and lateral margins forming together a more or less nearly semicircular curve, or with the central part of the former sometimes a little straightened, or even very faintly sinuous in outline, and the latter meeting the hinge at rather less than right angles behind. Dorsal valve moderately convex in the central region, thence sloping laterally, and rounding more abruptly to the beak and anterior lateral margins than to the middle of the front; mesial fold depressed, smoothly rounded, equaling about two-thirds the breadth of the valves at the front, and sometimes showing on internal casts a faint linear mesial impression; beak small, and with the very narrow area incurved. Ventral valve much elevated at the beak, thence sloping laterally, with slightly convex outlines, at an angle of 100° to 125° , and more abruptly to the front and anterior lateral margins; mesial sinus smoothly rounded within, rather shallow, or moderately deep anteriorly, where it terminates in a short rounded projection fitting into a corresponding sinus in the margin of the other valve; beak elevated, obtusely angular and straight, or a little arched backwards; area high, transversely and vertically striated, ranging more or less nearly at right angles to the plane of the valves, and flattened or somewhat arched backward, with its lateral margins moderately well defined; foramen large, or about two-sevenths as wide at the hinge line as the length of the latter, and three-fifths as wide as high, showing its deep-seated transverse septum and tube to be well developed above within.

Surface of both valves ornamented on each side of the non-costate mesial fold and sinus by about eighteen to twenty simple, depressed, rounded, radiating costæ, some five or six of which, on each of the lateral extremities of both valves, are usually nearly or quite obsolete.* Crossing all of these, on well-preserved specimens, numerous fine concentric striæ and some stronger marks of growth may be seen; and over the whole a minute pitting may be observed, so crowded and arranged as to present a delicate textile appearance, as seen by the aid of a magnifier.

Breadth of a well-developed, mature specimen, 2.70 inches; length, about 1.37 inches; length of hinge line, 2.65 inches; height of area, 1.25 inches; breadth of foramen at hinge, about 0.73 inch.

This shell seems to agree almost as well with *Spirifer textus*, Hall, from the fine-grained (Carboniferous) sandstone of the Knobs, near Louis-

* The costæ are too sharply defined, and represented too small and too numerous on the ventral valve in our figures 7a and 7b. They are about right on the dorsal valve in fig. 7a; but the lateral slopes of the ventral valve in the same figure are incorrectly drawn straight, instead of somewhat convex, thus making the lateral extremities of the figure too acutely angular.

ville, Kentucky, as with *S. Carteri*, originally described from the Waverly group of Ohio. Its area is proportionally somewhat larger, flatter, and less arched, as well as more distinctly defined, than it appears to have been in the typical specimens of *S. Carteri*; but the margins of its area are still less sharply defined, and the lateral slopes of its ventral valve less flattened, and less abruptly inclined forward, than in the type for which the name *S. textus* was proposed. These, however, are usually such variable characters in shells of this kind that we may generally question the propriety of viewing them as specific differences, unless accompanied by some more constant and reliable distinguishing features.

The shell for which Prof. Swallow proposed the name *Spirifer (Cyrtia?) Hannibalensis* seems to agree in its specific characters with the Ohio form under consideration; and I even suspect that *Spirifer capax*, Hall, and *Syringothyris typus* and *S. Halli*, of Winchell, may possibly be varieties of the same species. It is true I have not seen specimens of the Ohio shell in a condition to show whether or not it possess the punctate structure seen in Prof. Winchell's types, as well as in most of the others already mentioned, but it certainly has the same deep-seated septum and internal tube as *Syringothyris* (see markings in cast at + of fig. 7c); and from this fact, and all of its other characters, it may be regarded as almost morally certain that it has the same shell structure.

Again, it will be observed that all of these shells bear very close relations to the various forms or varieties referred by the highest European authorities to the common and widely distributed *Spirifer cuspidatus*, Martin. None of the specimens of the Ohio shell under consideration that I have seen have the area and beak of the ventral valve so extravagantly elevated as some of those of *S. cuspidatus* figured by Mr. Davidson and others; but this is a variable character, some of the figures of the European shell not differing materially from ours in this respect.* I have not seen any examples of internal casts of *S. cuspidatus*; but if the specimen represented by our figure 7d really belongs to the species under consideration (of which there may be some doubts), it would seem not to agree very well with Mr. Davidson's description of the interior of the corresponding valve of *S. cuspidatus*.

The only characters mentioned, by Prof. Hall as distinguishing his *S. textus* from *S. cuspidatus* were the supposed greater number of costæ, and the peculiar minutely pitted or textile appearance of the surface in the former. But he described both his *S. textus* and *S. Carteri* as having only from eighteen or nineteen to twenty costæ or plications on each side of the mesial fold and sinus, while Mr. Davidson gives thirty to forty-four

* Mr. Davidson mentions that there are all gradations from specimens with a comparatively low area to the typical forms of *S. cuspidatus*.

as the number on each valve of *S. cuspidatus*, which would make from fifteen to as many as twenty-two on each side of the fold and sinus. It is true that the published figures or descriptions of *S. cuspidatus* do not generally show or mention the minute textile markings seen on well-preserved specimens of these American shells, but Prof. King has noticed something of the kind on that shell,* and I believe I have seen unmistakable traces of them on a European specimen agreeing exactly with *S. cuspidatus* in form, and sent to this country with that name attached. I also found the punctate structure plainly visible in this shell.†

Locality and position: Prof. Hall's typical specimens of *S. Carteri* came from the Waverly group in Licking county, Ohio, and the specimens figured on our plate came from the same horizon at Sciotoville, Ohio. The same form almost certainly occurs in the equivalent beds of Michigan and Illinois, while Prof. Swallow's *Spirifer (Cyrtia) Hannibalensis*, which is almost certainly the same species, came from about the equivalent horizon at Hannibal, Missouri.

* See Geol. Mag., Vol. IV., No. 6, 1867.

† In making the first announcement of the discovery of the punctate structure, and its coincidence with the internal characters of the proposed genus *Syringothyris*, in shells of this character, I ventured the prediction that this structure really exists in the types of *Syringothyris*, which had been supposed not to be punctate, and suggested that at least some of the British forms referred to *Spirifer cuspidatus* would yet be found to possess the internal characters of *Syringothyris*, along with a punctate shell structure. (See Proceed. Acad. Nat. Sci., Philad., for December, 1865, p. 275.) Soon after the publication of these facts and suggestions, I had, through the politeness of Prof. Winchell, an opportunity to examine his type specimens of *Syringothyris*, and found them, as predicted, to be really punctate shells. At a somewhat later date Dr. Carpenter, the distinguished microscopist of London, examined a number of British specimens agreeing in all external characters with *S. cuspidatus*, and found some of them, as predicted, to possess the internal characters and punctate structure of *Syringothyris*, while in others he found neither the internal tube of *Syringothyris* nor the punctate structure. Prof. King, of Belfast, however, at a still later date, examined many British specimens of these shells, and arrived at the conclusion that, when well preserved, they are all both provided with the internal tube and punctate structure, and also all belonging to the one species *Spirifer cuspidatus*. He, therefore, accounts for the absence of the internal tube and punctate structure in some of the specimens examined by Dr. Carpenter by the accidental removal of the former, and the destruction of the latter during the process of fossilization, as certainly did take place in many punctate fossil shells. Consequently, he adopts *Syringothyris* as a distinct genus from *Spirifer*, and regards Prof. Winchell's *S. typus* as specifically identical with *Spirifer cuspidatus*, Sowerby. Although rather inclined to think he may be right in the latter conclusion, I can not agree with him in making *Syringothyris* distinct from *Spirifer*, Sowerby, because it seems to me, as stated in the Palæontology of the Upper Missouri, page 18, that the rules of nomenclature will compel us to regard *S. cuspidatus* as the type of the genus *Spirifer*, Sowerby, and, consequently, to place *Syringothyris* as a synonym of the latter.

SUB-GENUS TRIGONOTRETA, King, 1825.

SPIRIFER (TRIGONOTRETA) STRIATIFORMIS, Meek.

Plate 14, figs. 8a, b, c, d, e.

Shell attaining a full medium size, moderately gibbous, semi-oval, or sub-trigonal in outline; hinge nearly or quite equaling the greatest breadth; anterior margin more or less rounded, or sometimes a little projecting or subangular at the middle; lateral margins rounding to the front, or sometimes converging forward, with somewhat straightened outlines, and meeting the hinge behind generally at about right angles. Ventral valve more convex than the other, its greatest convexity being near or a little behind the central region, from which it rounds over a little more abruptly to the beak than to the front and anterior lateral margins; beak rather pointed, moderately prominent, and strongly incurved; cardinal area of medium size, well defined, and more or less arched and inclined backward; foramen about one-fourth to one-fifth as wide as the hinge, and apparently always wider than high; mesial sinus narrow, rather deep anteriorly, and continued much attenuated usually to the beak; interior (as shown by internal casts) with dental laminae short and diverging, and rostral cavity comparatively rather small, of moderate depth, strongly striated longitudinally, and marked by a few diverging ridges parallel to its anterior lateral margins, while the bottom of the valve on each side, in the umbonal region, is usually occupied by numerous small pits. Dorsal valve depressed convex, or sometimes rather prominent at the middle anteriorly, and rounding abruptly to the beak, and less strongly rounded or sloping to the anterior lateral margins; beak projecting little beyond the hinge, and, with the very narrow area, distinctly incurved; mesial fold narrow, rising very little above the general convexity in the umbonal region, and continued rounded, without distinctly defined margins, either much depressed or moderately elevated, to the front, where it is sometimes prominent enough to give origin to a semicircular sinus in the edge, to receive a corresponding short projection of the margin of the other valve. Surface of both valves (including sinus and fold) ornamented by numerous, rather small, depressed, rounded, more or less bifurcating, longitudinal costæ, crossed toward the front and lateral margins by distinct, sub-imbriating marks of growth, while over the whole, well-preserved specimens show a very beautiful, minute, cancellated sculpturing, formed by numerous, very sharply defined, and crowded radiating and concentric striae.

Length of a medium sized, mature specimen, 1.50 inches; breadth, 1.90 inches; convexity, about 1 inch.

This species has much the general external appearance of *Spirifer Mosquensis* of Fischer, as illustrated by Mr. Davidson from British specimens, though its marks of growth show that the young shell was proportionally wider, and its lateral angles more acute, than any of Mr. Davidson's figures would indicate, while neither he, MM. DeVerneuil, DeKoninck, nor any of the other authors who have figured and described that shell, so far as I have seen, either mention or illustrate the beautiful fine cancellated sculpturing seen on the species under consideration. The most marked and decided difference, however, at least from the original typical Russian examples of *S. Mosquensis*, is the very much greater development and anterior extension of the dental laminae of the latter species.

It also resembles, though less nearly, the common *S. striatus* of Sowerby, but may be readily distinguished by its proportionally less transverse and more gibbous form, as well as by its less acute lateral angles, than we generally see in that species, while its rostral cavity has a different form. The minute cancellated sculpturing of its surface is also more delicate than that of *S. striatus*, var. *clathratus* (as illustrated by Mr. Davidson), which is the only European form referred to *S. striatus* on which markings of that nature have yet been illustrated by any of the authors I have had an opportunity to consult.

Prof. Swallow has described several species that seem to be more or less similar to this, from about the same horizon in Missouri, with which forms it ought to be compared. I have no authentic examples of these Missouri shells for comparison, however, but so far as can be determined from the published descriptions, none of them seem to agree exactly with this shell.

Locality and position: Waverly group of the Lower Carboniferous at Sciotoville and many other localities in Ohio.

SPIRIFER (TRIGONOTRETA) BIPLICATUS, Hall??

Plate 14, fig. 5.

Spirifer buplicatus, Hall (1858); Iowa Geological Report, I., part Palæont., 519.

Compare *Spirifer Osagensis*, Swallow (1860); Trans. St. Louis Acad. Sci., I., 641.

Shell rather under medium size, trigonal-subsemicircular, with breadth twice to twice and a half the length, moderately convex; hinge line much longer than the breadth of the valves at any other point, and

sometimes abruptly produced in the form of slender, long, very sharp, spine-like extensions; lateral margins converging, with more or less convex outlines forward to the front, which is narrowly rounded or sub-angular at the middle. Dorsal valve depressed convex in the central region, and compressed near the posterior lateral angles; beak projecting little beyond the hinge line, and, with the narrow area, rather strongly incurved; mesial fold narrow, rounded, and depressed, or scarcely rising above the general convexity of the central and umbonal regions, but usually becoming somewhat more elevated at the front, defined on each side by a little larger and deeper furrow than those between the larger costæ. Ventral valve of nearly the same general form as the other; mesial sinus moderate, and narrowly extended to the beak; area rather narrow; beak moderately prominent and incurved. Surface of each valve ornamented by about thirty to thirty-six rather small radiating costæ, some six to eight of which usually occupy the mesial fold at the front in mature specimens, and five to seven the mesial sinus, those of the fold and sinus, as well as one or two of the larger ones on each side, bifurcating, while the others are generally all simple; crossing the whole, numerous fine concentric striæ and an occasional stronger mark of growth may be seen on well-preserved specimens.

Greatest breadth of a mature specimen with lateral extremities produced as mucronate extensions (measuring to the points of the latter), 1.75 inches; do., exclusive of the spines, 1.20 inches; length, 0.59 inch.

The lateral extremities of this shell seems to be always acutely angular, and often mucronate; but the individual figured has them *unusually* produced and pointed, as well as remarkably abruptly projecting from the posterior lateral margins, which generally curve outward a little into the bases of the spines, instead of meeting them at obtuse angles.* The costæ on the mesial fold usually commence at or very near the beak, as two very small, obscure divisions, which soon bifurcate so as to form four, the lateral two of which subdivide at some point farther forward, and sometimes the middle two bifurcate toward the front so as to make eight altogether. The furrow between the middle two costæ of the mesial fold, as well as those between the lateral margins of the fold and the costæ on each side, are usually a little larger and deeper than the others. This character, and the bifurcations of the costæ on the fold, and one or two of the lateral ones on each, are not well shown in our figure.

Although I believe this to be the species described by Prof. Hall under

* This angularity at the connection of the posterior lateral spines and the lateral margins, however, is slightly exaggerated in figure 5.

the name *S. biplicatus*, the identification has not been made from direct comparison with authentic specimens of that shell. I also think it very possible that *S. Osagensis*, Swallow, is only a more gibbous form of this shell, with less extended lateral angles. At any rate, there are specimens among the Ohio collections agreeing pretty nearly with the description of *S. Osagensis*, that seem to be connected with the form figured on our plate by intermediate varieties. I much regret that the circumstances elsewhere explained prevented me from giving full illustrations of both valves, as well as of the different varieties of this shell.

Locality and position: Upper members of the Waverly group, at Richfield, Ohio, at the same horizon in Iowa, and probably in Missouri and Illinois.

LAMELLIBRANCHIATA.

GENUS ENTOLIUM, Meek.

(Cal. Geol. Rept., II., 479.)

ENTOLIUM SHUMARDIANUM, Winchell? (sp.)

Plate 15, figs. 4a, b.

Pernopecten Shumardianus, Winchell (1865); Proceed. Acad. Nat. Sci., Philad., XVII., 126.

Compare *P. limatus*, Winchell (1865), Ib., and *Avicula Cooperensis*, Shumard (1855), Missouri Geol. Report.

Shell compressed-lenticular, thin, nearly equivalve, suborbicular exclusive of the ears; basal margin rounded; lateral margins rounded or with the posterior one sometimes slightly truncated or straightened on the upper slope, both apparently a little gaping above the middle; umbonal slopes straight and converging to the beaks at an angle of about 115°; hinge margin very short, or scarcely equaling two-fifths of the greatest breadth of the valves below, in the left valve sloping very slightly inward from the extremities of the ears to the beak at the middle, but in the right valve straight; ears small, flat, triangular, equal, or very nearly so, and obtusely angular at the extremities, without any traces of a byssal sinus under them on either side;* beaks small, equal,

*The ears are not represented quite obtuse enough in our figure 4a. If their lateral margins were continued up from below *straight* (but obliquely), so as to intersect the hinge margin above at an angle of about 100°, instead of being a little sinuous, they would be correct. The same objection also applies, though in a less marked degree, to figure 4b.

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compressed, and not projecting above the hinge margin or showing the slightest obliquity; superior lateral regions compressed and separated from the more convex central portion by shallow undefined impressions that diverge from each side of the beaks at an angle of about 90° , the one on the posterior side being usually longer than the other. Surface appearing nearly smooth, but showing under a magnifier very fine, regular, crowded, and obscure concentric striæ, with a few finely marked, irregular furrows of growth, and sometimes the slightest possible traces of radiating striæ, that are generally entirely obsolete.

Height, 1.04 inches; breadth, 1.08 inches.

The foregoing description was mainly drawn up from the specimen represented by our figure 4a. This I believe to be a left valve. Other specimens in the collection, however, present the form shown by our figure 4b. These are believed to be the right valve of the same species, and will be seen to have the hinge line straight, and the superior lateral margins more protuberant in outline, so as to give a different form to the whole valve. I have observed precisely the same differences between what we have every reason to believe to be the opposite valves of a scarcely distinguishable species found in the Coal Measures, as may be seen by figures given on plate 9 of Palæontology of Eastern Nebraska, published in Hayden's Nebraska Report of 1872, and on plate 26 of the fifth volume of the Illinois Geological Reports.

I am in considerable doubt in regard to the specific name that ought to be retained for this shell. It perhaps agrees most nearly with Prof. Winchell's description of his *Pernopecten Shumardianus*. But after seeing how these shells vary in the slight details of form and their obscure surface markings, it seems to me quite as probable that it may belong to his *P. limatus*, or rather that the latter and *P. Shumardianus* may both belong to one species, also including our shell. Prof. Winchell did not see the hinge in either of these forms, but merely referred them to his genus *Pernopecten* from their general external resemblance to the type of that group. I feel well assured, however, that at least the specimens here under consideration have not the crenate hinge characterizing *Pernopecten*, and can not be properly referred to that group.

Again, it certainly bears *very* close relations to *Avicula Cooperensis*, Shumard, from rocks of the same age in Missouri. In making comparisons with the latter, however, it should be kept in mind that the figure of Shumard's species, given in the Missouri report, was drawn from a very aberrant specimen, which also had its ears partly hidden by the rock, so as to cause a misapprehension in regard to their form. The

radiating costæ seen on Shumard's figure, as I have elsewhere explained, are also made *much* too strong by the engraver, even for the individual specimen there represented, while in a great majority of specimens *no traces of them whatever are to be seen*. In looking over a large collection of specimens of *P. Cooperensis*, sent by Dr. Williams, of Booneville, Missouri, to the Smithsonian Institution, from the same locality and bed from which Dr. Shumard's original typical specimens were obtained, I could only discover faint traces of radiating costæ on two or three of them, while all of the others were as completely destitute of any such costæ as the specimen from which our figure 4a was drawn.

At one time I strongly suspected that *Aviculopecten limiformis* of White and Whitfield, the type of *Pernopecten*, Winchell, might also be the same species as *Avicula Cooperensis*, Shumard; but on examining the specimens of the latter mentioned above, I was unable to discover any traces whatever, in any of them, of the crenate character of the hinge seen in the type of *Pernopecten*.

Some years back, Prof. Winchell did me the favor to loan me the type specimens of his genus *Pernopecten*, and I made careful drawings of two of them, one of which shows the crenate character of its hinge very clearly, while the other gives as satisfactory a view of the exterior. They are both, I think, right valves, and the one showing the hinge agrees almost *exactly*, in all *specific* characters, with the form represented by our figure 4b, though it is proportionally not quite so broad, and has slightly more obtuse ears, while the other agrees even more closely in form with our figure 4a, excepting in having its hinge straight, which, I think, is due to the fact of it being a right valve. Again, Prof. Winchell's type actually seems to agree exactly, in all constant *specific* characters, with *Entolium aviculatum* (= *Pecten aviculatus*, Swallow), already mentioned, from the Coal Measures. So we have here a remarkable case of shells presenting extremely little or *no* constant *specific* difference, and yet differing in a character of the hinge that seems to be of *generic* importance.

Locality and position: The specimen from which our figure 4a was drawn came from the Cuyahoga shale of the Waverly group at Richmond, Ohio, and that represented by figure 4b came from the Waverly group at Lodi, Ohio. Prof. Winchell's type specimens of *E. Shumardianus* and *E. limatus* came from the yellow arenaceous beds at Burlington, Iowa, and I believe he has identified the same forms at this horizon in Michigan.

GENUS AVICULOPECTEN, McCoy, 1851.

(An. and Mag. N. H., VII., 171.)

AVICULOPECTEN CRENISTRIATUS, Meek.

Plate 15, figs. 7a, b.

Aviculopecten crenistria, Meek (1871); Proceed. Acad. Nat. Sci., Philad., XXIII., 4.

Shell thin, attaining a moderately large size, plano-convex, with a truncato-suborbicular outline; height and breadth nearly equal; basal margin more or less regularly rounded; posterior margin rounding from the posterior ear into the base, sometimes a little straightened above; anterior side rounded so as to make a shorter curve than the other; hinge less than the breadth of the valves in length, but rather long. Left valve moderately convex; beak rising a little above the hinge margin, nearly or quite central, and not oblique; posterior ear small, with a marginal ridge, flat, without being separated from the swell of the umbo by a sulcus, rather acutely angular at the extremity, and distinctly shorter than the margin below, from which it is separated by a nearly rectangular notch; anterior ear larger, or sometimes nearly as long as the margin below, rather acutely angular at the extremity, convex, and separated by a rounded impression from the umbo, defined by a rather deep subangular marginal sinus. Surface ornamented by numerous, very slender, radiating costæ or raised lines, separated by rather wide, flat spaces, in each of which a still smaller line is sometimes intercalated; crossing all of these are smaller, regularly arranged, sharply elevated, concentric lines, that seem to form little projections at the points of crossing, so as to give a rough appearance to the surface; costæ becoming more closely crowded, but not smaller on the ears. Right valve flat or a little concave, with beak obsolete; ears flat, and of nearly the same size and form as in the other valve, excepting that the anterior one is broader and defined by a more shallow and more rounded sinus than appears to exist in the left valve; surface cancellated by regular, rather closely arranged, radiating and concentric lines, the latter being very sharply elevated, and minutely and regularly waved, crenate, or somewhat vaulted; radiating costæ somewhat larger and more distant on the ears.

Height, 2.50 inches; breadth, 2.78 inches; convexity, 0.40 inch.

The specimens of this species are not very well preserved, being mainly casts with some portions of the surface. It is rather remarkable in having only a comparatively shallow rounded sinus under the an-

terior ear of the flat right valve, where it is usually deep and angular in species of this genus, while in the left it is deeper and more angular, though none of the specimens are in a condition to show clearly its exact form. One cast shows a little of the cardinal plate, which is rather coarsely striated longitudinally. None of the specimens of the left valve have the surface well enough preserved to show whether the sharply elevated concentric lines or laminae are minutely waved, as in the other valve, but they probably are so when the surface has not been worn or exfoliated.

I am not acquainted with any described species so nearly allied to this as to render a comparison necessary.

Locality and position: Sciotoville, Ohio. Upper part of the Waverly series of the Lower Carboniferous.

AVICULOPECTEN WINCHELLI, Meek.

Plate 15, figs. 5a and 5b?

Shell attaining about a medium size; left valve compressed convex, exclusive of the ears, presenting a slightly oblique, irregularly subtrigonal or subcircular outline; hinge equaling two-thirds to three-fourths the greatest breadth below; basal outline forming a more or less oblique semicircular curve; posterior margin most prominent near the middle, where it is usually subangular, and thence rounding into the base below, while above it is straightened or even slightly concave in outline obliquely forward and upward into the sinus under the ear; anterior margin most prominent above the middle, where it is somewhat abruptly rounded, and thence descending and curving nearly vertically into the base, and rounding, with a slightly straightened outline, obliquely upward and backward into the sinus above; ears subequal, or with the posterior one about one-fourth larger than the other, both abruptly flattened from the umbonal slopes, triangular in form, and shorter than the margins below, the posterior one being generally rather acutely angular, and defined by a deep, wide, rounded or subangular sinus, while the anterior is a little more obtuse than the other, and defined by a somewhat narrower and more angular sinus; beak rather compressed, abruptly pointed, with apex subcentral, and extending to, or very slightly above, the hinge margin. Surface of both disc and ears ornamented by numerous small radiating linear costæ or raised striæ, about every third, fourth, or fifth one of which is usually slightly larger than others, the smaller

ones generally dying out at various distances between the free margins and the beak; crossing all of these radiating costæ, numerous, much finer, more crowded, and more regular concentric striæ, and a few very obscure ridges and furrows of growth, may be seen.

Breadth of largest specimen of this valve seen, 1.88 inches; height, 1.53 inches; convexity, about 0.24 inch; length of hinge, 1.10 inches.

The foregoing description and measurements are, as stated, made out entirely from left valves. There are, however, in the collection, from the same beds and locality, casts of some smaller right valves, that almost certainly belong to the same species. (See fig. 5*b*.) These are very nearly, or, sometimes, quite flat, have the ears proportionally larger, so as to make the hinge line as long as the breadth of the disc below, while the sinuses under their ears are deeper and narrower (particularly the anterior one*) than in the other valve. They also differ in having the flattened disc smooth, or only showing minute, crowded, concentric striæ, with sometimes very faint traces of radiating lines. On the ears, however, this valve has the radiating costæ nearly or quite as strong as those of the other valve.

The specimens of the left valve vary somewhat in form, some of the smaller being proportionally narrower across the disc, and having the ears more nearly equal (the anterior one being also more acutely angular) than that represented by our figure 5*a*. In other large specimens, however, the proportional breadth is even somewhat greater than in that we have figured.

This species has *very* nearly the outline and surface markings of *A. Coxanus*, Meek and Worthen, from the Coal Measures of Illinois and Nebraska.† The right valve of the *A. Coxanus* is unknown, but its left valve is so nearly like that of certain varieties of the form under consideration, that there is little, excepting the much larger size and more robust appearance of the Waverly shell, by which the two can be distinguished. Yet I have no doubts in regard to their belonging to distinct species, not only from the great difference of size, but also on account of the rather widely separated horizons at which they occur, the species of this type of lamellibranchiate shells being usually more restricted in their vertical range. In size, it agrees more nearly with *Aviculopecten rectilaterarius*, Cox; but it differs from that species in having a deep

* This anterior sinus is not represented quite angular enough in our figure 5*b*.

† See Palæontology Eastern Nebraska, published in Hayden's Nebraska Report of 1872, pl. 9, fig. 2*a*.

sinus under the posterior ear, as well as in some of its less important details.

Locality and position: The specimens figured on our plate are from the Waverly group of the Lower Carboniferous, at Newark, Ohio. Through the politeness of Prof. A. Winchell, I was permitted to make tracings for comparison from drawings he has prepared of this shell from the same horizon in Michigan.

GENUS PALÆONEILO, Hall, 1870 ?

(Prelim. Notice Lamellib. Upper Held., etc., 6.*)

PALÆONEILO BEDFORDENSIS, Meek.

Plate 15, figs. 3a, b, c.

Shell subovate, compressed, or moderately convex, height more than three-fourths the length, the highest point being in front of the middle; basal margin semiovate, most prominent antero-centrally, from near which it ascends with a slightly straightened, oblique outline behind, and rounds up oblique to the front; posterior margin narrowly rounded, and somewhat compressed; anterior side shorter and more broadly rounded; dorsal margin arcuate, declining more abruptly in front of the beaks, which are moderately prominent, and situated a little more than one-third the length of the valves from the anterior margin. Surface ornamented by very fine, regular, closely arranged concentric striæ, that become obsolete on the posterior third of the valves. Oblique posterior sulcus very faintly indicated, or entirely wanting.

Length, 0.57 inch; height, 0.42 inch; convexity, about 0.14 inch.

This species seems to be most nearly allied to *P. brevis*, from the New York Chemung, but differs in not being "very ventricose," and in having its lines of growth very regular, instead of "irregular." Like that species, its oblique posterior sulcus or constriction is quite nearly obsolete. I have not seen its hinge clearly enough to be *entirely* sure that it belongs to the group *Palæoneillo*; but from its crenate hinge margin, and general form, it probably belongs to that genus.

Locality and position: Bedford, Ohio. Bedford shale of the Waverly group.

* I cite this paper here and elsewhere, with the above date, not because I *know* it to have been properly *published* at the time, but because I have heard of a few copies being sent out during the year 1870, one of which I have seen. Neither this copy, nor, so far as I can learn, any of the others, had any title page or author's name attached; but it has been attributed to Prof. Hall in a notice published in the American Journal of Science and Arts.

GENUS SCHIZODUS, King, 1844.*

(Ann. and Mag. Nat. Hist., XIV., 313.)

SCHIZODUS MEDINAENSIS, Meek.

Plate 15, figs. 1a, b, c.

Schizodus Medinaensis, Meek (1871); Proceed. Acad. Nat. Sci., Philad., XXIII., 165.

Shell of medium size, subtrigonal, moderately convex above the middle and cuneate below, somewhat longer than high; anterior side rounded; basal margin somewhat straightened or slightly convex in outline along the middle, rounded up regularly in front and more abruptly behind; dorsal outline sloping nearly at right angles from the beaks toward the extremities, the anterior slope being more abrupt than the other; posterior side longer than the anterior, sloping with a more or less convex or subtruncate outline above, and very narrowly rounded at the extremity below; beaks rather prominent, abruptly pointed, located a little in advance of the middle; posterior umbonal slopes rather prominently rounded or subangular from the beaks obliquely to the posterior basal extremity. Surface nearly smooth, or only showing fine lines of growth.

Length, 1 inch; height, 0.82 inch; convexity, 0.44 inch.

This species has been supposed to be identical with, or nearly related to, a New York Chemung form, which was, I believe, described by Mr. Conrad under the name *Nuculites Chemungensis*. It certainly differs, however, materially in form from that shell as figured and described by Mr. Conrad in Vol. VIII. of the Journ. Acad. Nat. Sci., Philad., and might with about as much propriety be identified with Western Coal Measure species, ranging even up into beds referred by some to the Permian. One of these, described by Prof. Swallow under the name *Cypriocardia? Wheeleri* (Trans. St. Louis Acad. Sci., Vol. II., p. 96, 1862), and figured by Prof. Geinitz under the name *Schizodus obscurus*, in his "Carbonformation und Dyas in Nebraska," agrees more nearly in form, but differs in being decidedly more depressed, with less elevated beaks, and a more truncated posterior outline. It also differs from the shell under

* Mr. Tate has proposed (Geol. Mag., 1868, p. 412) to change the name of this genus to *Axinopsis*, because *Schizodon* had been used, in 1842, by Waterhouse, for a genus of Mammals. This, however, seems entirely unnecessary, the two names, *Schizodus* and *Schizodon*, although identical in meaning, are sufficiently distinct in sound and to the eye to prevent confusion. Other instances of names as nearly alike being both retained in Natural History, might be cited.

consideration, in being sometimes a little sinuous on the posterior basal margin. Another Coal Measure form figured by Prof. Geinitz, under the name *Schizodus Rossicus*, is in some respects still more nearly like our shell, but differs in other characters.

As difficult as it certainly sometimes is to separate closely allied species of this genus, I can not think that we ought to refer to the same species forms found occupying such widely different horizons as the Chemung group of the Devonian, and the Waverly group and Coal Measure of the Carboniferous; on the contrary, it seems to me that we ought generally, under such circumstances, to regard them as distinct species, although it may not be easy, in all cases, to point out well-defined distinctions in the fossilized shells.

Locality and position : Medina, Ohio. Waverly group of the Lower Carboniferous.

GENUS GRAMMYSIA, DeVerneuil, 1847.

(Bull. Soc. Geol. Fr., IV., 2d ser., 696.)

GRAMMYSIA? HANNIBALENSIS, Shumard (sp.).

Plate 16, figs. 5a, b, c.

Allorisma Hannibalensis, Shumard (1855); Missouri Geological Report, Vol. I., Part II., p. 206, pl. C, fig. 19.

Grammysia Hannibalensis, Hall (1870?); Prelim. Notice Lamellibr. Upper Helderberg, etc., p. 62.

Shell small, transversely subovate or subtrapezoidal, with anterior and umbonal regions gibbous, and the height at the beaks equaling about three-fifths the length; anterior end sloping abruptly from the beaks above, with a straight or slightly concave outline, to the lower end of the lunule, where it narrowly rounds into the base, or is sometimes subangular; base forming a broad semi-elliptic or semi-ovate curve; posterior extremity more compressed, apparently sometimes a little gaping, usually narrowly rounded in outline at the middle, and thence truncated obliquely forward and upward above, to the posterior extremity of the hinge; cardinal margin more or less nearly horizontal, straight, or a little concave in outline, and inflected along its entire length so as to form a well-defined escutcheon; lunule generally distinctly defined, rather deep, and presenting an obovate outline; beaks prominent, strongly incurved at right angles to the hinge, so as to bring their points nearly or quite in contact; posterior umbonal slopes prominently rounded; posterior dorsal region abruptly compressed, and sometimes separated from the

swell of the umbonal slopes by a faint undefined sulcus extending from immediately behind each beak, obliquely backward and downward to the truncated edges of the posterior ends of the valves. Surface ornamented by usually well-defined concentric ridges and furrows, that are small and very regular on the umbones and strongest anteriorly, but generally become obsolete on the posterior dorsal region; crossing these a small, very obscure sulcus may often be seen extending from each beak nearly directly downward to the base.

Length of a well-developed adult specimen, 1.35 inches; height of do., 0.81 inch; convexity, 0.71 inch.

Although always presenting peculiarities of general physiognomy by which it can be readily recognized, this shell varies much in form, as well as in the size and regularity of its concentric ridges and furrows. The furrow extending down each valve from the beaks, is generally obsolete, or so faintly defined as scarcely to attract attention, though it is quite distinct on some specimens. On some individuals, like that represented by our figure 5a, the concentric ridges and furrows are very strongly defined, and comparatively large, while on others they are smaller, as seen in figure 5c, and on still others they fade away and become so irregular as not to be readily distinguished, on the lower and posterior parts of the valves, from the marks of growth.

As may be seen by the synonymy, this shell was originally referred by Dr. Shumard to the genus *Allorisma*, King, and more recently it has been referred by others to *Grammysia*, DeVerneuil, with which latter it certainly seems to be rather closely connected through other species. Still it appears to me to be quite as nearly related to Prof. McCoy's genus *Sedgwickia*, as originally founded by him in 1844, on his *S. attenuata*, *S. bellata*, *S. corrugata*, etc., though it is widely distinct from the original typical forms of the group (*Leptodomus*) to which he refers such shells in 1855.

Locality and position: The specimens we have figured are from the Waverly sandstone of the Lower Carboniferous, at Medina, Ohio. It also occurs at Cuyahoga Falls, and various other localities at the same horizon in Ohio, as well as in the yellow arenaceous beds at Burlington, Iowa; also at Hannibal, Missouri, where the specimens described by Dr. Shumard were obtained. It is likewise found at this horizon in Illinois, and is said to occur in the Chemung group (Devonian) in New York and Pennsylvania.

GRAMMYSIA ? RHOMBOIDES, Meek.

Plate 16, figs. 7a, b.

Grammysia rhomboides, Meek (1871); Proceed. Acad. Nat. Sci., Philad., XXIII., 72.

Shell attaining a moderately large size, rhombic-suboval in outline, with height equaling about three-fourths the length, not very convex, the greatest convexity a little before and above the middle; valves without an oblique mesial ridge or fold, closed, or nearly so, all around; basal margin most prominent just behind the middle, from near which it ascends with a nearly straight outline obliquely forward, and more abruptly with a convex outline behind; anterior side truncated oblique forward from the beaks above, and very narrowly rounded near the middle; posterior side less narrowly rounded at the middle, with its upper edge probably sometimes obliquely truncated; cardinal margin equaling about one-third the length of the valves, and inflected so as to form the usual well-defined escutcheon, which narrows backward from the beaks; lunule rather deep, well defined, lance-ovate in form, and as long as the truncated anterior dorsal slope; beaks moderately prominent, not very gibbous or very strongly incurved, and situated a little nearer the middle than the anterior margin; posterior umbonal slopes forming a very obscure rounded ridge, between which and the dorsal and posterior dorsal margins there is a rather narrow, slightly concave, or flattened space on each valve. Surface with only small marks or lines of growth, which are gathered into very small obscure wrinkles along the margins of the lunule.

Length, 2.90 inches; height, measuring vertically from the most prominent part of the base to the horizon of the tops of the beaks, 2.15 inches; do., to cardinal margin behind the beaks, 1.93 inches; convexity, 1.40 inches.

I only know this shell from casts which show neither the nature of the hinge nor the muscular or pallial impressions. It presents no traces of the characteristic oblique mesial fold or ridge seen in the typical forms of *Grammysia*, and might, when its cardinal margin and lunule are concealed in the matrix, be mistaken for a large *Schizodus*. Its well-defined lunule and escutcheon, however, and obsolete muscular impressions, show that it can not be even nearly related to that group. As the casts show no indications of the characteristic internal cartilage process of *Edmondia*, and it does not seem to have the habit of *Cardiomorpha*, I know of no genus to which it appears to be more nearly related than to

Grammysia, and have concluded to place it provisionally in that group, until its relations can be more precisely determined from the study of better specimens.

Locality and position: Same as last.

GRAMMYSIA VENTRICOSA, Meek.

Plate 16, figs. 6a, b (and pl. 13, figs. 5a, b, var.)

Grammysia ventricosa, Meek (1871); Proceed. Acad. Nat. Sci., Philad., XXIII., 73.

Shell attaining a moderate size, extremely ventricose, the convexity being greater than the height, with the greatest gibbosity a little in front of and above the middle; height equaling about half the length; posterior side comparatively long, a little gaping and narrowly rounded in outline at or a little above the middle; pallial margin usually slightly sinuous near the middle, or in front of it; anterior side very short, concave just under the beaks to the base of the lunule, where the margin is subangular, or very abruptly rounded and most prominent, while below this it curves obliquely backward into the base; cardinal margins scarcely more than equaling half the entire length of the valves, and inflected so as to form the usual shallow escutcheon; beaks very gibbous, moderately elevated, oblique, strongly incurved, and placed almost over the anterior margin; lunule deep, ovate or obovate, and well defined; posterior umbonal slopes prominently rounded; flanks without any oblique ridge or sulcus. Surface marked on the anterior side of the valves, near the lunule, by small wrinkles, which pass into mere lines and linear furrows of growth farther back, while even the latter become nearly or quite obsolete over the more gibbous parts of the valve.

Length of largest specimen seen, 2.50 inches; height, 1.30 inches; convexity, 1.55 inches.

I know nothing of the hinge or muscular and pallial impressions of this shell, and refer it, like the last, to *Grammysia*, from its form and general appearance. It shows no traces of the oblique ridge and furrows seen on the typical species of that genus, but it is well known that this character is not constant in the group.

Locality and position Same as foregoing.

GENUS EDMONDIA, DeKoninck, 1844.

(Anim. Foss. Carb. Belg., 66.)

EDMONDIA? TAPESIFORMIS, Meek.

Plate 13, fig. 6.

Shell longitudinally suboblong-oval, about once and a half as long as high, rather compressed; posterior side rather obliquely rounded; anterior side very short, rounded, or subtruncate; basal margin forming a long nearly elliptic curve; dorsal very straight, and but very slightly declining posteriorly; beaks anterior, oblique, and scarcely rising above the cardinal margin; umbonal slopes not angular or even prominent. Surface ornamented by regularly arranged, raised concentric lines or small ridges, separated from each other by wider furrows.

Length, 1.81 inches; height, 1.10 inches; convexity, about 0.46 inch.

This species is only referred to the above mentioned genus with great doubt, as nothing is known in regard to the nature of its hinge or other internal characters. It seems to be a thin shell, but does not present the general aspect of *Allorisma*, *Sanguinolites*, *Sedgwickia*, or any of the allied groups, being much more compressed, and apparently closed all around. So far as can be determined from the only specimen yet seen, the cardinal margin does not appear to be inflected as in the most of the palæozoic types believed to belong to the *Anatinidæ*. In a side view it presents somewhat the appearance of a shell figured by Prof. McCoy, under the name *Maetra ovata*, in his Synop. Carb. Fossils of Ireland, pl. 2, fig. 4, excepting that it is proportionally about one-third longer and more compressed. In its proportional length and height it agrees more nearly with another form figured in the same work under the name *Pul-lastra ovalis*, but its extremities are more regularly rounded.

Locality and position: Richfield, Summit county, Ohio. Waverly series of the Lower Carboniferous series.

GENUS CARDIOMORPHA, DeKoninck, 1844.

(Anim. Foss. Carb. Belg., 101.)

CARDIOMORPHA SUBGLOBOSA, Meek.

Plate 15, figs. 6a, b.

Shell subglobose, or a little higher than long, with convexity nearly equaling the length; anterior and posterior margins rounding regularly into the base, and forming with the latter more than three-fourths of a

circle; hinge line very short, ranging nearly at right angles to the vertical axis of the valves, and meeting the upper termination of the posterior margin at an obtuse angle; cardinal margins a little inflected, so as to form a broad, shallow, corselet-like depression; beaks prominent, gibbous, incurved nearly at right angles to the hinge, and located centrally. Surface only showing obscure lines and a few somewhat stronger marks of growth, excepting on the immediate umbones, where there are small regularly disposed concentric wrinkles. Lunule moderately deep, narrow subovate, and not distinctly defined.

Length, 1.47 inches; height, 1.64 inches; convexity, about 1.33 inches.

I know nothing of the hinge and interior of this shell, and merely refer it to the genus *Cardiomorpha* from its similarity of form to some of the short elevated and gibbous forms originally included in that genus by its founder, DeKoninck. It agrees more nearly with the form he refers to *C. oblonga*, Sowerby (sp.), than with any other with which I have compared it, though its beaks are not near so strongly incurved or spiral, and differ in being marked with small regular wrinkles. It is also less gibbous, and does not have the margins of its valves meeting at acute angles, as in that shell, nor does it show any traces of the large concentric undulations seen on the same.

Locality and position: Rushville, Ohio. Waverly group of Lower Carboniferous. Prof. Andrews's collection.

GENUS PROTHYRIS, Meek, 1869.

(Proc. Acad., N. S., Philad., XXI, 172.)

PROTHYRIS MEEKI, Winchell, MS.

Plate 15, fig. 2.

Prothyris Meeki, Winchell (1872); cited from his ms. in Hayden's Nebraska Report, page 223.

Shell transversely elongate-rhombic in outline, with height more than one-third the length, rather convex; basal margin long, nearly straight, or sometimes faintly sinuous near or behind the middle; dorsal outline short, straight, and sub-parallel to the base; posterior extremity very narrowly rounded and prominent below, and nearly straight, with a long, very oblique slope above from the posterior end of the hinge; anterior end quite short, moderately gaping, with its notch shallow and very obtuse; beaks small, oblique, rising little above the hinge margin, rather gibbous, and placed only about one-seventh the entire length from the

anterior end; umbonal slopes very convex, or forming a prominent rounded ridge from the beaks obliquely backward and downward to the posterior basal margin; flanks more or less flattened or contracted along the middle near the basal margin, and thence obliquely forward and upward to the beaks. Surface showing only moderately distinct lines of growth.

Length of a large, mature specimen, 1.07 inch; height, 0.33 inch; convexity, about 0.30 inch.

This species will be at once distinguished from *P. elegans*, the type of the genus, by its much greater convexity, more rhombic outline (caused by greatly more oblique outline of its posterior margin), and particularly by its more shallow and more obtuse anterior notch, and decidedly more prominent umbonal slopes.

Locality and position: Rushville, Ohio, in the Waverly group of the Lower Carboniferous series.

GENUS SANGUINOLITES, McCoy, 1844.

(Synop. Carb. Foss. Ireland, 47.)

SANGUINOLITES? OBLIQUUS, Meek.

Plate 16, figs. 2a, b.

Sanguinolites? obliquus, Meek (1871), Proceed. Acad. Nat. Sci., Philad., XXIII, 13.

Shell so depressed and elongated as to be nearly three times as long as high, rather distinctly convex, particularly along the posterior umbonal slopes, which are more or less angular from the beaks nearly to the posterior basal extremity; pallial margin very nearly straight along most of its length; anterior end extremely short, and a little sinuous on the upper side just in front of the beaks, the sinuosity being caused by a very small, deep lunule, at the lower end of which the margin is a little projecting and angular or sub-angular in outline, and from this little projection it curves obliquely backward into the base; cardinal margin extending back about three-fourths the length of the valves, and inflected so as to form a well defined lanceolate escutcheon along its entire length; posterior side narrowed with a long slope above from the end of the hinge to the extremity, which is a little gaping and very narrowly rounded or almost angular below; beaks strongly depressed, very oblique, compressed below the ridges, very nearly terminal, and with the immediate points incurved over the little lunule. Surface showing only lines

and furrows of growth, with occasional small, obscure concentric wrinkles that are not regularly arranged.

Length, 2.13 inches; height, 0.77 inch; convexity, 0.70 inch.

This species seems to be nearly related to a form from the same rock at Medina, Ohio, specimens of which were loaned by Dr. Newberry to Prof. Hall sometime back, and returned with the name *Sanguinolites æolus* attached. A careful comparison, however, of good specimens of each shows them to be clearly distinct, the form under consideration being much more convex along the umbonal slopes, which are also more angular. Its beaks likewise differ in being decidedly more nearly terminal and the inflection of its cardinal margin wider. The specimens of *S. æolus* also show faint traces of two or three very obscure longitudinal ridges above the umbonal angle of each valve, and impressions in casts, of a slight ridge behind the anterior muscular impression, that are not seen in our shell.

From the little that is now known of the shell that will probably have to be regarded as the type of the genus *Sanguinolites*, it is impossible to determine whether or not such species as this can be properly referred to that genus. They seem to agree, however, more nearly with the same than they do with the typical forms of *Allorisma*, to which they are also related.

Locality and position: Rushville and Newark, Ohio. Upper part of the Waverly group of the Lower Carboniferous.

SANGUINOLITES ÆOLUS, Hall.

Plate 16, figs. 1a, b, c.

Sanguinolites æolus, Hall (1870 ?), Preliminary Notice of the Lamellibranchiate Shells of the Upper Helderberg, Hamilton and Chemung groups, etc., page 46.

Shell depressed, sub-elliptic, rather compressed, with height equaling about two-fifths the length; basal margin forming a long, semi-elliptic curve, or sometimes nearly straight along the middle and curving up gradually at the extremities; dorsal margin behind the beaks, long, subparallel to the base, nearly straight, or very slightly convex in outline, and abruptly inflected along its entire length so as to form a narrow, lanceolate false area or escutcheon, while in front of the beaks it slopes abruptly forward with a distinctly concave outline to the most prominent part of the front margin, which is above the middle and more or less angular, or very narrowly rounded; beaks small, oblique, compressed laterally, depressed nearly to the dorsal line, and placed about one-

seventh the entire length of the valves behind the anterior extremity; posterior umbonal slopes very oblique, angular at and near the beaks, but becoming more obtuse as they extend obliquely backward and downward to the most prominent part of the posterior margin; flanks below and posterior dorsal regions above the umbonal ridges more or less flattened, while in some specimens a very faint impression may be seen extending from each beak obliquely backward and downward below each umbonal slope nearly to the central region of the base (see fig. 1a, pl. 16). Surface marked with rather distinct concentric lines, and obscure ridges and furrows, crossed sometimes by very obscure traces of radiating lines that are generally quite obsolete on casts, while some specimens show scarcely perceptible indications of two linear radiating ridges, or raised lines on each posterior dorsal region, above the umbonal ridge (see fig. 1c).

Length of largest specimen seen, about 1.71 inch; height, 0.70 inch; convexity, 0.40 inch.

Our figures and description are from some of the original typical specimens of the species, or at least that were labeled and returned to Dr. Newberry, with the name attached, by the author of the species. It seems to be related to the last, but differs in the characters mentioned in the remarks on that species.

Locality and position: Our figured specimens are from the Cuyahoga shale (a part of the Waverly sandstone series), Medina county, Ohio; it also occurs at the same horizon at Newark, Ohio.

GENUS PROMACRUS, Meek, 1871.

(Am. Jour. Conch., VII, 4.)

PROMACRUS ANDREWSI, Meek.

Plate 17, figs. 1a, b.

Sanguinolites (Promacrus) Andrewsii, Meek, 1871, ib., 7.

Shell attaining a large size, elongate-subtrapezoidal, the length being more than three times the height, moderately convex, with flattened flanks; posterior margin obliquely truncated from the posterior extremity of the hinge to the base; basal margin long, nearly straight or but slightly convex in outline; anterior extremity very narrowly rounded; dorsal margin nearly straight and parallel to the base behind the beaks, but declining gently forward with a slightly concave outline in front, where it seems to be inflected so as to form a lanceolate lunule; beaks

nearly central, or located a little in advance of the middle, depressed nearly to the horizon of the dorsal line behind them; posterior umbonal slopes sub-angular near the beaks, but becoming more prominently rounded along a line between the posterior basal extremity and the umbonal region; ligament apparently extending nearly the whole length of the cardinal margin behind the beaks, more or less prominent externally, but apparently extending rather deeply between the margins all the way along. Surface with moderately distinct ridges and furrows of growth, most clearly defined on the anterior slope, where they seem to be somewhat interrupted by obscure traces of radiating furrows.

Length, about 6.90 inches; height, about 2.22 inches; convexity, 1.60 inches.

This fine species is intermediate in its characters between *P. nasutus*, Meek, and *P. Missouriensis*, Swallow. It differs from the latter, however, in having its beaks more nearly central, and its posterior dorsal margin proportionally shorter, as well as in having its anterior dorsal margin more concave in outline, and its posterior umbonal slopes decidedly less angular. The farther anterior position of its beaks, and its obtusely rounded umbonal slopes, also readily distinguish it from *P. nasutus*.

I originally placed this group as a subgenus under *Sanguinolites* of McCoy; but it is more probably distinct generically from that group, though this question can never be positively decided until the hinge of these shells, and that of Prof. McCoy's type, can be known and compared. The species here described is named in honor of Prof. E. B. Andrews, of the Ohio Geological Survey, who discovered the typical specimen.

Locality and position: Sciotoville, Ohio. Waverly group of the Lower Carboniferous.

GENUS ALLORISMA, King, 1844.

(Mag. Nat. Hist., XIV, 316.)

ALLORISMA (CERCOMYOPSIS) PLEUROPISTHA, Meek.

Plate 13, figs. 4a, b, c.

Allorisma (*Sedgwickia*?) *pleuropistha*, Meek, (1871), Proceed Acad. Nat. Sci., Philad., XXIII, 14.

Shell depressed and elongated, or more than twice as long as high, moderately convex centrally and anteriorly, and attenuated and produced behind; pallial margin long, nearly straight along the middle, rounded up anteriorly, and ascending more gradually behind; posterior side very narrow, truncated and somewhat gaping at the extremity, which meets the

cardinal margin at an obtuse angle, and rounds abruptly into the base; anterior side wider (higher) than the other, and more or less abruptly rounded; dorsal margin depressed below the horizon of the beaks behind the latter, where it is concave or nearly straight in outline, and inflected so as to form a short corselet near the beaks, while in front of them it slopes forward rather abruptly, and is provided with a well defined oval lunule; beaks moderately prominent, rather gibbous, and incurved without any obliquity or *fissure*, placed a little less than one-third the length of the valves from the anterior margin; posterior umbonal slopes forming obscure subangular ridges which extend toward the posterior basal extremity, but become obsolete before reaching it, while above this ridge the posterior dorsal region is flattened, or a little concave, and smooth. Surface ornamented with more or less defined concentric wrinkles and lines of growth, which are crossed on the posterior-central regions by linear, but distinct, raised, radiating costæ, separated by wider depressions. Of these costæ the anterior sometimes descend almost vertically from the beaks, with more or less curve, to the base, while farther back they gradually become more oblique, and near the middle of the flanks more closely arranged, but above and behind this they are more widely separated again, and nearly as oblique as the obscure umbonal ridge, above which they are not defined.

Length, 2.28 inches; height, 1 inch; convexity, about 0.85 inch.

This shell strongly reminds me, by its general outline and physiognomy, of those Jurassic species for which Prof. Agassiz proposed the genus *Cercomya*. In that group, however, there is no lunule, and I am not aware that any of the species of the same are marked by radiating costæ as in the species under consideration. From all that is known of its characters I am inclined to believe it more nearly allied to the curious Lyonsia-like carboniferous shells upon which Prof. McCoy originally proposed to found the genus *Sedgwickia*, but which he afterwards referred to the genus *Leptodomus*. Still it differs from this group (*Sedgwickia*) also in the possession of radiating costæ. These costæ are not mere rows of granules such as doubtless existed on nearly all the different types of this family (*Anatinidæ*), but decided costæ, such as we see in *Pholadomya*; and, what is rather singular, they do not exist on the anterior part of the valves, but extend only as far forward as the beaks, under which they end abruptly, the anterior one being as strongly defined as any of the others, while only the concentric striæ and wrinkles exist on the anterior third of the valves, as well as on the posterior dorsal region. In the possession of the radiating costæ mentioned, as well as in the shortness of its hinge, the inflection of its cardinal margin, and in its general

physiognomy, it differs from the typical species of *Allorisma*, and hence it may be thought desirable to establish a subgenus for its reception, in which case I have elsewhere proposed for the group the name *Cercomyopsis*

Along with the typical specimen of the foregoing species another was found, with the same form and surface characters, excepting that its anterior end, in front of the beaks, is shorter, and more angular at the lower end of the lunule, while the anterior of its radiating costæ are directed much more obliquely backward, instead of descending nearly vertically from the beaks to the base. This specimen (see fig. 4b) has the posterior end broken away, but as the peculiarities mentioned seem not due to any distortion, it may possibly belong to another species; if so, *Allorisma* (*Sedgwickia*?) *obliqua* would be a good name for it.

Locality and position; Rushville, Ohio. Waverly group of Lower Carboniferous. Prof. Andrews's collection.

ALLORISMA WINCHELLI, Meek.

Plate 16, figs. 3a, b, c.

Allorisma Winchelli, Meek (1871), *Proceed. Acad. Nat. Sci., Philad.*, XXIII, 167.

Shell of about medium size, elongate subelliptic, the length being equal to about three and a half times the height, moderately convex; posterior extremity a little gaping, obliquely subtruncated above and narrowly rounded below the middle; anterior extremity very short, closed, concave in outline obliquely forward and downward from the beaks above to the lower end of the lunule, where it is subangular, and from this point rounding off obliquely into the base; ventral margin forming a broad, gentle curve, but generally somewhat straightened, or sometimes faintly sinuous near the middle; dorsal margin nearly straight, or a little concave in outline, and showing the usual inflection, which forms a lanceolate escutcheon with a slight ridge on each side, from the beaks to the posterior extremity of the hinge, which equals about three-fourths the entire length of the valves; beaks much depressed, very oblique, incurved, and located only about one-fourteenth the entire length of the shell from the anterior extremity; posterior umbonal slopes merely somewhat prominently rounded; anterior umbonal slopes generally slightly subangular near the beaks, and sometimes this prominence is obscurely continued as a faint rounded ridge obliquely backward and downward to a point a little in advance of the middle of the base. Surface ornamented with concentric lines and ridges of growth, that generally assume the character of little regular wrinkles on the umbones. Lunule small, rather deep, moderately well defined, and obovate in form.

Length of a mature specimen, 1.74 inches; height to middle of dorsal side, 0.83 inch; do. to horizon of beaks, 0.87 inch; convexity, 0.70 inch; length of hinge line, 1.17 inches.

This is a very neat, symmetrical species, often found in an excellent state of preservation as casts of the exterior, showing perfectly the form and surface-markings, excepting the fine granulations usually, if not always, existing in species of this genus. Like some other species of the group, it varies considerably in form, some individuals being proportionally shorter and higher than others. In size and general appearance it sometimes closely resembles *A. clavata* of McChesney, from the Chester group. It does not resemble the particular *variety* of that shell, however, figured by Prof. McChesney, so nearly as it does what I have always believed to be the usual form of the same; his typical specimen having the beaks more prominent and farther removed from the anterior end than in the more normal form of the species, and its dorsal outline straighter and more sloping posteriorly, with the valves more compressed. Compared with specimens that I have referred to, *A. clavata* from the Chester group of West Virginia, collected by Prof. Stevenson, our Waverly species is found to agree very nearly with some individuals of the latter, though it always has its ridges of growth less strongly defined and more irregular, and its anterior basal margin usually more oblique. It also differs in the possession of an obscure anterior umbonal ridge extending from the beaks obliquely backward and downward nearly or quite to the basal margin, a little in advance of the middle.

The specific name is given in honor of Prof. A. Winchell, the able State Geologist of Michigan, who has described many fossils from the same horizon in the western States.

Locality and position: Rushville and Newark, Ohio. Upper part of the Waverly group of the Lower Carboniferous.

ALLORISMA VENTRICOSA, Meek.

Plate 16, figs. 4a, b.

Allorisma ventricosa, Meek (1871), Proceed. Acad. Nat. Sci., Philad., XXIII, 168.

Shell subovate, the length being about once and a half the height, moderately convex; posterior margin obliquely subtruncated above, and narrowly rounded or subangular near the middle; thence curving obliquely under and forward; base rather deeply and somewhat irregularly rounded, the most prominent part being near the middle; anterior side short, with an obliquely truncate or concave forward slope above, to the lower extremity of the lunule, where there is a more or less angular

projection, below which the margin curves with a slightly convex outline obliquely backward and downward sometimes nearly to the middle of the base; dorsal margin more or less concave in outline, and showing the usual lanceolate escutcheon margined on each side by a subangular ridge; hinge equaling about two-thirds the length of the valves; lunule rather small, deep, well defined, and narrow-subovate in form; beaks moderately prominent, oblique, and placed about one-seventh the length of the valves from the anterior end. Surface ornamented by small, irregular ridges and furrows of growth.

Length, 1.46 inches; height to cardinal margin, 0.98 inch; do. to horizon of beaks, 1.03 inches; convexity, 0.66 inch; length of hinge, 1 inch. Another specimen, 1.54 inches in length, has a convexity of 0.75 inch.

It is quite possible that this may be only a variety of the last, but as I have before me ten good specimens of that shell, and two of the form under consideration, and there are among them no intermediate gradations between the two forms, I can but regard them as distinct species. The shell here described differs from the last, with which it was found associated, in being proportionally decidedly shorter and wider (higher), as well as in having its ventral margin much more prominent or deeply rounded in the central region. Its beaks are also less oblique, rather more prominent, and proportionally farther from the anterior end. It shows some faint traces of a similar anterior oblique umbonal ridge to that seen in the preceding species, but it is less distinct, and does not show so decided a tendency to become angular at the beaks.

Locality and position: Rushville, Ohio. Waverly group.

GASTEROPODA.

GENUS PLATYCERAS, Conrad, 1840.

(Prelim. Report Palæont. N. Y., 205.)

PLATYCERAS (ORTHONYCHIA ?) LODIENSE, Meek.

Plate 13, figs. 1a, b.

Platyceras (Orthonychia?) lodiense, Meek (1871), *Proceed. Acad. Nat. Sci., Philad.*, XXIII, 170.

Shell rather small, non-spiral, or merely having the form of a rapidly expanding cone, with a backward obliquity that brings the apex nearly over the posterior margin; lateral slopes nearly straight or slightly concave, and converging to the apex at an angle of about 80°; posterior side vertical and decidedly concave in outline; anterior slope a little more than twice as long as the height of the posterior side, moderately convex

in outline, and provided with a ridge or obtuse carina along its entire length; aperture oval-suborbicular, being slightly longer than wide; lip more or less sinuous at the middle of the anterior side, on one or both sides of the termination of the central ridge of the anterior slope, which ridge terminates in a little projection at the margin. Surface marked by fine lines of growth, which are most distinct on the anterior slope, where they curve backward as they approach the mesial ridge, and then abruptly forward in crossing the ridge; extremely faint traces of minute radiating striæ apparently also exist; apex rather abruptly pointed and directed backward without any lateral obliquity.

Length, measuring obliquely from apex, 0.97 inch; breadth, 0.82 inch; length from anterior to posterior margin, 0.90 inch; height of apex, 0.44 inch.

This species is remarkable for its regular, depressed, obliquely conical form and non-spiral apex, which is merely obtusely pointed and directed backward without the slightest lateral curve. It therefore departs widely in form from the typical species of *Platyceras*, and agrees more nearly with an Oriskany shell described in the third volume of the Palæontology of New York, under the name *Cyrtolites? expansus*, excepting that its apex is not so attenuated and produced. Although probably not a true *Platyceras* it seems to me more nearly allied to the section of the same, for which the name *Orthonychia* has been proposed, than to *Cyrtolites*, which was founded on a very different type (*C. ornatus*, Con.), with a peculiar style of ornamentation. In its surface markings our shell agrees with *Platyceras*, being merely marked with fine lines of growth, more or less undulated on the anterior slope, while the traces of very fine radiating striæ indicate relations to the section *Orthonychia*, with which the shell also agrees more nearly in its non-spiral form. It therefore bears the same relations to the elongated forms of *Orthonychia* that those depressed, rapidly expanding species of *Platyceras*, such as *P. calanticum* and *P. obesum*, bear to the typical forms of the latter genus.

Locality and position: Lodi, Ohio. Waverly group of Lower Carboniferous.

GENUS PLEUROTOMARIA, DeFrance, 1826.

(Dict. Sci. Nat., XLI, 381.)

PLEUROTOMARIA TEXTILIGERA, Meek.

Plate 13, figs. 7a, b.

*Pleurotomaria textiliger*a, Meek (1871, Proceed. Acad. Nat. Sci., Philad., XXIII, 176.

Shell attaining a medium or somewhat larger size, turbate or rhombic, suboval in general outline, with height a little greater than the

breadth; spire depressed conical; volutions four or five, flattened exactly on a line with the slope of the spire from the apex to near the middle of the last turn, where there is more or less defined angle; last turn large, somewhat ventricose below the angle, and produced so as to make this angle near the middle of the entire bulk of the shell; umbilical region a little excavated, the excavation apparently being continued as a small perforation up into the axis; aperture, as inferred from sections of the body volution, obliquely rhombic-oval; suture merely linear, or sometimes very narrowly channeled between the middle volutions; spiral band occupying, and slightly truncating, the angle of the body volution, where it is flat or a little concave, and passing around immediately above the suture on the volutions of the sphere, excepting on some of the upper turns, where it seems to sink nearly or quite below the suture line. Surface very neatly cancellated by distinct, regular, curved, thread-like transverse and revolving lines, of about equal size and distance apart, the former becoming much finer and arched backward in crossing the band.

Height of a large specimen, 1.42 inches; breadth of revolving band on body volution, 0.10 inch; angle of spire, 70° to 80°.

I was for some time inclined to think this might be the form described by Dr. White and Mr. Whitfield, from the same horizon at Burlington, Iowa, under the name *Pleurotomaria Mississipiensis*, but on comparison with a sketch of the typical specimen in the Museum of the University of Michigan, sent to me by Prof. Winchell, I find it to be quite distinct. The type specimens of *P. Mississipiensis* are natural casts, but Prof. Winchell's sketches show that they differ from casts of the species under consideration in having the angle of the body volution continued on those of the spire distinctly above the suture, so as to give them a turreted appearance instead of being all flattened exactly on a line with the slope of the spire. It also has the spire more elevated than that of our shell, and the upper slope of the body volution concave instead of flat. Indeed, White and Whitfield's species is more nearly allied to *P. tabulata* of Conrad, from the Coal-Measures, than it is to that under consideration.

Locality and position: Medina, Ohio. Waverly group of the Carboniferous, where it seems to be quite abundant.

PTEROPODA.

GENUS CONULARIA, Miller, 1818.

(Sowerby's Min. Con., .)

CONULARIA MICRONEMA, Meek.

Plate 18, figs. 1a, b, c, d.

Conularia micronema. Meek (1871), Proceed. Acad. Nat. Sci., Philad., XXIII, 84.

Shell elongate-pyramidal, with the sides equal and diverging from the apex at an angle of about sixteen degrees; lateral surfaces nearly flat, and without any mesial furrow, but sometimes showing a very faint, slender mesial ridge, that becomes nearly or quite obsolete toward the smaller end; each of the four angles a little rounded and provided with a shallow, moderately distinct longitudinal furrow. Surface with numerous extremely small, closely crowded transverse striæ, of very nearly the same size on all parts of the shell; striæ gently arching forward as they cross the side, and scarcely interrupted at the little mesial longitudinal ridge, minutely crenate, and separated by extremely slender linear furrows, numbering fifteen in the space of one-tenth of an inch, on all parts of the surface; crenulations of striæ twelve to fifteen in one-tenth inch.

Length of a specimen broken at both ends, with a diameter of 0.96 inch at the larger end, and 0.46 inch at the smaller, 2.30 inches.

This species is remarkable for the extreme fineness and closely crowded uniform character of the transverse striæ on all parts of the surface. I know of no other species resembling it in other respects, with near such fine, crowded striæ. At a little distance these lines are often entirely invisible to the unassisted eye, and it requires the aid of a magnifier to see them distinctly. The furrows between these striæ are mere impressed hair lines in which no crenulations are visible in the specimen.

Locality and position: Sciotoville, Ohio. Waverly or lowest division of the Carboniferous.

CONULARIA NEWBERRYI, ~~HALL~~

Plate 18, figs. 2a, b.

Conularia Newberryi, Hall.*

Shell attaining a moderately large size, presenting the usual elongate-pyramidal form, with equal or subequal lateral surfaces diverging from the apex at an angle of about sixteen degrees; sides a little convex, and

* I have not been able to find Prof. Hall's description of this shell, and only know that the form here described has been generally identified with it.

showing an obscure, undefined mesial line; each of the four angles more or less rounded and strongly furrowed. Surface with distinct, sharply-elevated, finely-crenate transverse costæ, that are separated by larger furrows, and all arching a little forward from the angles to an indistinct mesial line, along which their inner ends sometimes terminate alternately, or are, in other instances, directly continuous across, without interruption; number of costæ in 0.51 inch, where the sides measure 0.85 inch across, eleven to twelve, and each bearing about fifteen crenulations in 0.18 inch at the same place; furrows between the costæ apparently smooth.

Length apparently from three to four inches.

This species will be at once distinguished from the last by its very much larger and more distant costæ, which apparently also differ in increasing regularly in size, as well as in their distance apart, from the smaller to the larger extremity, instead of continuing of nearly the same size. Cross sections indicate a slightly greater diameter in one direction than at right angles to the same, but this may be due to accidental pressure. As far as can be seen in the specimens examined, the rather wide furrows between the costæ seem to be smooth, or with only faint traces of minute striæ of growth.

Locality and position: The original type specimens of this species were found in the Waverly group of the Lower Carboniferous. The example from which the foregoing description and our figures were prepared, came from the same horizon at Loudonville, Ohio.

CRUSTACEA.

ENTOMOSTRACA.

GENUS CERATIOCARIS, McCoy.

? SUBGENUS COLPOCARIS, Meek, 1872.

(Proceed. Acad. Nat. Sci., Philad., XXIV, 333.)

On first examining the species here placed under the above subgeneric name, their general similarity to certain forms that have been referred to *Ceratiocaris* of McCoy was readily perceived, but a critical comparison with the figures and descriptions of Prof. McCoy's original typical species of that group, such as his *C. solenoides*, *C. ellipticus*, and his more recently described *C. ornatus* from the Silurian, satisfied me that our species present differences of apparently more than specific importance. I therefore sent some of the specimens to Prof. Dana, of New Haven, with the

view of obtaining his opinion respecting their relations to the genus *Ceratiocaris*, and he informed me that Dr. S. I. Smith, of that city, and himself concur in the opinion that they do not properly belong to the same genus as the typical forms of *Ceratiocaris*.

The differences to which I allude consist first in the general form of the carapace valves, which, instead of being truncated with a nearly straight outline from below forward and upward, are truncated backward and upward, with a *profoundly sinuous outline*, the sinus being directed somewhat obliquely forward and upward, while the posterior extremity of the dorsal margin is produced, pointed, and curved downward. Again, they show a peculiar inflection of the ventral margin, which gives it a more or less carinate appearance. In the species *C. Bradleyi*, this margin is always fixed along this line at an acute angle inward and upward, while in the species *C. elytroides* it is less strongly inflected, though the linear carina is well defined, and sometimes minutely crenated. This last mentioned species also shows another linear, minutely crenate carina or ridge near the dorsal margin, and would, therefore, bear some resemblance to *Dithyrocaris* in this respect, but otherwise, particularly in the form of its carapace valves, it is quite distinct from that type.

It is also worthy of note that none of the specimens yet obtained show any traces of an ocular tubercle or spot, so constantly seen in the typical species of *Ceratiocaris*. Again, they always present a clear, smooth outline to the dorsal margin of the carapace valves, thus indicating that they were merely connected there by a kind of flexible ligament, while the valves of *Ceratiocaris* were supposed by Prof. McCoy to be anchylosed, and rigidly united at a fixed angle along the dorsal margin.

I have little or no doubt in regard to the importance of some, if not all, of these differences, but from deference to the general reluctance of geologists and some palæontologists to accept new genera separated under such circumstances, I merely proposed, in first describing the following species, to arrange them provisionally as a subgenus of *Ceratiocaris*, under the name *Colpocaris*, in allusion to the sinus of the posterior margin. The same arrangement is also continued, provisionally, here.

CERATIOCARIS (COLPOCARIS) BRADLEYI, Meek.

Plate 18, figs. 6a, b, c, d, e.

Ceratiocaris (Colpocaris) Bradleyi, Meek (1872); Proceed. Acad. Nat. Sci., Philad., XXIV, 332.

Carapace valves large, rhombic-subelliptic, more than twice as long as high, moderately convex; dorsal margin forming a broad, depressed arch from end to end; ventral margin more deeply arched downward than

the dorsal is upward, its most prominent part being near the middle, along which the inflected edge is directed upward and inward, while its entire length, owing to the obliquity of the posterior end, is shorter than the dorsal margin; posterior margin very deeply and somewhat obliquely sinuous, thus causing the downward-curved, posterior-dorsal extremity to project considerably farther backward than the end of the basal margin below the sinus; anterior end narrowed, with its margin rounded up from below so as to connect with the dorsal nearly at a right angle above. Surface smooth to the unassisted eye, but showing under a magnifier very minute reticulated markings.

Length about 2.75 inches; height, 1.25 inches.

This species agrees most nearly, in size and form, with *Ceratiocaris* (*Colpocaris*) *sinuatus*, Meek and Worthen, from the Lower Coal Measures of Grundy county, Illinois, and was found by Prof. Bradley enveloped in exactly the same way in concretions. It differs, however, specifically in being proportionally narrower in its vertical diameter, with the most prominent part of its basal margin more nearly central. It also differs in having its posterior dorsal extremity more produced and more pointed, as well as more curved downward, while that of its lower margin is proportionally shorter, owing to the obliquity of the deep sinus of the posterior end of the valves.

Associated with these fossils Prof. Bradley also found the caudal appendages (telson and stylets) probably of this species, judging from their comparatively large size. One of these specimens has these appendages 1.35 to 1.40 inches in length, and about 0.10 inch in breadth, at the larger end, the telson being apparently slightly shorter than the stylets, (see fig. 6*d*, of plate 18).

The specific name was given in honor of Prof. Frank H. Bradley, of Knoxville, Tennessee, to whom I am indebted for the use of the type specimens. The large specimen represented by fig. 6*a* is considered the type of the species.

Locality and position: Base of the Waverly group, at Danville, Kentucky. Prof. Bradley's collection.

CERATIOCARIS (*COLPOCARIS*) ELYTROIDES, Meek.

Plate 18, figs. 5*a*, *b*, *c*.

Ceratiocaris (*Colpocaris*) *elytroides*, Meek (1872), Proceed. Acad. Nat. Sci., Philad., XXIV, 334.

Carapace valves narrow-subelliptic, about twice and a half to three times as long as high, and rather distinctly convex; anterior end narrower than the other, and subangular or narrowly rounded above; dorsal

margin gently arcuate from end to end, and terminating behind in a pointed projection that extends a little farther backward than the lower margin, and curves distinctly downward; posterior margin truncated obliquely from above forward and downward, and very deeply sinuous, the sinus being directed a little upward and forward; basal margin most prominent near the middle, and behind this straight, or sometimes very faintly sinuous, and ascending to the rather obtusely pointed, posterior basal extremity, while from near the middle forward it ascends gradually, at first, with slight convexity of outline, and farther forward with a stronger upward curve until it intersects the dorsal margin above. Surface with an obscure, linear, sometimes minutely crenate carina, or raised line along near, but not exactly parallel, to the lower margin (being most remote from it along near the middle), and another similar but more distinctly crenate carina, running along parallel to and about one fifth the height of the valves below the dorsal margin, otherwise appearing to the unassisted eye as if perfectly smooth, but when examined in a favorable light, by the aid of the highest power that can be conveniently used as a hand magnifier, seen to be very beautifully and minutely striated, the striae being very regular, closely arranged, and more or less divaricating from the carinae.

Length of carapace valves, 1.25 inches; height, 0.46 inch; convexity of each valve, 0.09 inch.

This species may be readily distinguished from the last, not only by its smaller size, but by its narrower form and two minutely crenate longitudinal carinae, but particularly by the different nature of its microscopical sculpturing, that of the last described species presenting a delicate reticulated appearance, instead of minute hair lines. The basal margins of its valves, below the carina, are also only a little deflected inward and downward, while in all the specimens of the last yet seen, they are abruptly deflected at an acute angle inward and upward.

Locality and position: Same as last.

SUB-GENUS SOLENOCARIS, Meek, 1872.

(Proceed. Acad. Nat. Sci., Philad., XXIV, 335.)

I did not submit this form to Prof. Dana, but as it differs quite as materially (though in other respects) from the typical forms of *Ceratiocaris* as those I sent to him do, and as widely, or even more widely, from those I sent than the latter do from *Ceratiocaris* proper, I have ventured to separate it under a distinct subgeneric name. Like the last described

type, it shows no traces of ocular spots, while it has the posterior end merely subtruncated very obliquely backward from below, but not in the slightest degree sinuous. At a first glance it looks like the valves of a narrow, elongated bivalve mollusk, but its sculpturing is decidedly of crustacean type, being like that of some species of *Ceratiocaris* proper. It shows no indications of having its valves anchylosed along the dorsal margin.

CERATIOCARIS (SOLENOCARIS) STRIGATA, Meek.

Plate 18, figs. 4a, b, c.)

Ceratiocaris (Solenocaris) strigata, Meek, (1872); *Proceed. Acad. Nat. Sci., Philad., XXIV.*, 335.

Carapace valves narrow and elongated, the length being about four times the height, rather distinctly convex; dorsal and ventral margins nearly straight and parallel; anterior very narrowly rounded, the most prominent part being at the middle; posterior end so obliquely truncated as to impart a pointed appearance to the posterior dorsal extremity, which is not curved. Surface showing well-defined, comparatively rather coarse, more or less anastomosing longitudinal striæ, that seem not to curve exactly parallel to the anterior and lateral margins, and are usually more or less impressed upon internal casts.

Length, 1.24 inches; height, about 0.30 inch; convexity, about 0.23 inch.

Locality and position: Same as last. Prof. Bradley's collection.

TETRADECOPODA.

? GENUS ARCHÆOCARIS, Meek, 1872.

(*Proceed. Acad. Nat. Sci., Philad., XXIV.*, 335.)

ARCHÆOCARIS VERMIFORMIS, Meek.

Plate 18, fig. 7.

Archæocaris vermiformis, Meek (1872); *Proceed. Acad. Nat. Sci., Philad., XXIV.*, 335.

The specimens of this fossil yet known are too imperfect to be systematically characterized, but it may be described, in a general way, as follows, the description being intended to apply to a side view of an individual, as seen more or less compressed laterally in concretions:

Cephalothorax, or head, about equaling the length of the first three and a half of the body segments behind it; subtrigonal in form, being some-

what pointed in front, with the posterior margin wider, obliquely truncated from above backward and downward, and sinuous, so as to give more or less angularity to the posterior basal extremity; basal margin apparently with a kind of ridge or fold along most of its length, and ascending with a slightly convex outline forward, so as to meet the dorsal margin (which is more nearly horizontal) at a rather acute angle in front; eyes (if there are any) unknown; abdomen or body with the six segments of nearly equal size, and strongly imbricating; telson apparently as long as three of the abdominal segments, flattened, of moderate breadth anteriorly, and tapering behind; stylets not clearly seen, but apparently one on each side of the telson. Other abdominal appendages unknown. Surface of all parts smooth.

Length of head or cephalothorax, from the anterior to the posterior basal extremities, 0.34 inch; height, 0.18 inch; length of the six body or abdominal segments, 0.51 inch; height, 0.16 inch; length of telson unknown.

In one of the specimens there is a leg-like appendage, seen in the matrix extending close along under and parallel to the basal margin of the head or cephalothorax. This appendage, or rather what can be seen of it, consists of three joints, two long and one short. The posterior joint, although apparently broken at the posterior end, is 0.13 inch long, and rather stouter than the next in front of it, which is of the same length. The third joint only shows a little of one end, which connects with the anterior end of the forward one of the two longer joints, and is flexed at right angles to the latter, so as to pass under the anterior margin of the cephalothorax. This may possibly be one of the abdominal appendages bent forward, but it has more the appearance of a stout antenna bent backward. Prof. Dana thinks it most probably the latter.

In regard to the affinities of this type not much can be said without better specimens for comparison. Prof. Dana suggests, however, that it may possibly have some relations to the recent genus *Cuma*. Being unable to find any defined genus to which it can be properly referred, I proposed for its reception a new genus under the name *Archæocarid*, in allusion to the ancient period of its existence.

Locality and position: Same as preceding.

TRILOBITA.

GENUS PHILLIPSIA, Portlock, 1843.

(Report Geol. London, etc., 305.)

PHILLIPSIA (GRIFFITHIDES?) LODIENSIS, Meek.

Plate 18, fig. 3.

Compare *Phillipsia insignis*, Winchell (1863); Proceed. Acad. N. S., Philad., XV., 24.

Rather small, with an elliptic general outline, the length being somewhat less than twice the breadth; cephalic shield forming rather more than a semicircle, with the posterior lateral angles terminating in acutely pointed spines that extend back to the third thoracic segment; anterior and lateral margins rounded in outline, and provided with a more or less flattened border, ornamented above with a row of small tubercles,* that extend back a little upon the posterior lateral spines, while it is somewhat thickened and finely striated on the under side; glabella small, longitudinally oval, moderately prominent, separated from the cheeks on each side by a well-defined furrow, but without visible lateral furrows of its own (unless there may be a posterior one on each side separating a little tubercle); whole surface occupied by about twenty-five distinct tubercles or coarse granules; eyes small, tuberculiform, rather prominent, and situated near and opposite the posterior third of the glabella, with the visual surface smooth or very minutely reticulated; cheeks occupied by comparatively coarse, prominent tubercles, like those on the glabella; thorax with middle lobe somewhat wider and higher than the lateral, from which it is separated by well-defined furrows; segments of mesial lobe ornamented with tubercles, arranged so as apparently to form five longitudinal rows; pleuræ each provided with two nodes, arranged so as to form two rows along each lateral lobe, those of the outer row being a little larger than the others, and situated somewhat within the middle of each lateral lobe at the point where the pleuræ bend to form the slope to their lateral extremities; pygidium semielliptic, with length and breadth as three to four, very convex; mesial lobe very prominent and equaling more than one-third the entire breadth at the anterior end, rather rapidly tapering backward to an obtuse, prominent termination before quite reaching the posterior margin, provided with twelve or thir-

* Not represented in the figure, or clearly seen in the specimen drawn, but observed in others.

teen segments, each one of which bears five little nodes arranged so as to form five rows, those of the middle row being larger and more prominent than the others, and thus giving the lobe a carinated appearance; lateral lobes somewhat flattened above for about half their breadth, at which point they bend suddenly downward for a short distance, and then obliquely outward to form a rather broad, sloping border, each provided with seven to nine segments, the posterior of which are very obscure and directed nearly backward, the segments each bearing two or three little nodes arranged so as to form as many longitudinal rows, and all continued down upon and across the sloping border, at the edge of which they terminate in little pointed projections so as to present a fimbriated appearance around the posterior and lateral edges. (This latter character is not represented in the figure.)

Length, 0.49 inch; breadth, 0.28 inch; length of cephalic shield, 0.20 inch; do. of a pygidium of another specimen from Loudonville, in a ferruginous matrix, 0.23 inch in length by 0.30 in breadth, with a height (of mesial lobe) of 0.10 inch.

As the only specimen of this species showing the entire fossil has the head somewhat crushed, it is possible that it may be necessary to modify the description of that part in some of the details when perfect specimens can be examined. This condition of the cephalic shield also renders the generic characters somewhat obscure. The apparently smooth eyes and glabella, without visible lateral furrows, would seem to indicate relations to *Griffithides*, though the form of the glabella is more like that of *Phillipsia*. The fimbriated character of the posterior and lateral margins of the pygidium, however, is very peculiar and hitherto unknown, I believe, in either of the above mentioned genera, though it occurs in one section (*Phæton*) of the allied genus *Proetus*; hence it is possible our species should be called *Proetus (Phæton) Lodiensis*, as it would not be very surprising that this genus should be here found in this oldest member of the Carboniferous, though hitherto, I believe, only known in the Silurian and Devonian.

Specifically the head of this trilobite resembles *Phillipsia McCoyi* of Portlock, more nearly than any other known to me, particularly in its coarsely tuberculated surface, with a row of tubercles arranged around the anterior and lateral margins, as well as in the oval form of its glabella. Its eyes, however, are proportionally smaller, its occipital ridge much more strongly developed and wider, while the tubercles of its marginal row are not nearly so crowded as in Portlock's species.

So far as can be determined from a description alone, the form under

consideration would seem to be nearly related, in some of its characters, to *Phillipsia insignis*, Winchell. In the description of that species, however, the presence of a row of nodes around the margin of the cephalic shield is not mentioned, and its posterior lateral spines must be decidedly longer than in our species if I correctly understand the description, in which they are said to "reach twice the length of the glabella from the anterior end." In the arrangement of the tubercles on the glabella, and in the possession of well-defined lateral lobes in the same, Prof. Winchell's species also seems to differ, as well as in its "large" eyes. There would likewise appear to be much more important differences in the pygidium, which in our species has the segments of the lateral lobes distinctly continued across the somewhat flattened margin, and terminating in little spine-like projections, so as to give the border a fimbriated appearance, while in *P. insignis* they are merely said to "become indistinct and disappear toward the margin."

Locality and position: In the Cuyahoga shales at Lodi, Medina county, Ohio, and in ferruginous arenaceous beds of the Waverly group at Loudonville, Ohio. Lower Carboniferous.

COAL-MEASURE SPECIES.

MOLLUSCA

POLYZOA.

GENUS SYNOCLADIA, King, 1849.

(Ann. Mag. N. H., 2d ser., III., 388.)

SYNOCLADIA BISERIALIS, Swallow.

Plate 20, figs. 5a, b.

Synocladia biserialis, Swallow (1858), Trans. St. Louis Acad. Sci., I., 179; Meek (1872), Palæont. Eastern Nebraska, in Hayden's Report, U. S. Geol. Survey of Nebraska, 156, pl. VII., figs. 5a-e; also (1874) Am. Jour. Sci. and Arts, 486.

Compare *Septopora Cestriensis*, Prout (1858), Trans. St. Louis Acad. Sci., I., 448, pl. XVIII., figs. 2a, b; Meek and Worthen (1870), Proceed. Acad. Nat. Sci., Philad., 15; Palæont. Illinois, pl. XXIV., figs. 14a-c; Meek (1874), Am. Jour. Sci. and Arts, 486.

Among the specimens from the Lower Coal Measures at Flint Ridge, near Newark, Ohio, there is a *Synocladia* agreeing so nearly with *S. biserialis* of Swallow that I am inclined to regard it as a variety of that species. It grows in very rapidly spreading, foliated, or possibly widely infundibuliform expansions, the stems seeming to radiate from the same point, and throwing off on each side lateral branches, which also give off, in the same way, lateral branchlets. The dissepiments, as in the typical forms of *S. biserialis*, are smaller than the primary and secondary branches, and strongly arched or angulated in passing across, while they give origin to intermediate branches about as often as in the typical specimens of *S. biserialis*, as in the latter there are only two rows of pores on each branch and stem, with minutely nodose mesial ridge or carina between. The pores on the dissepiments are arranged much as in *S. biserialis*, as is also the case with the fenestrules.

The principal differences between these specimens and good examples of *S. biserialis* from Kansas and Nebraska are the following: In the first place, the entire structure of the form under consideration is more deli-

cate, particularly the longitudinal stems and thin branches, all of which are proportionally more slender, so as to form with the dissepiment a finer and more regular reticulated structure. Again, the dimorphous cells of its non-poriferous side are proportionally larger and arranged very regularly on the stems and branches, *one at each end of each dissepiment*, instead of being very irregularly scattered over the whole of the non-poriferous side. If it should be considered desirable to designate this as a distinct variety of *S. biserialis*, or if it should be found from a careful comparison of a good series of specimens to be specifically distinct from *S. biserialis*, it may take the name *S. gracilis*.

Locality and position: Lower Coal Measures, near Newark, Ohio.

GENUS PTILODICTYA, Lonsdale, 1839.

(Murch. Sil. Syst.)

PTILODICTYA (STICTOPORA) SEREATA, Meek.

Plate 20, fig. 4.

Bifurcating or ramose, the bifurcations occurring usually at rather distant intervals, and the divisions generally diverging at right angles from each other; poriferous surfaces nearly flat or much compressed; lateral margins of both stems and branches sharp and smooth, and provided with very short, obtuse or truncated, alternating, closely and regularly arranged lobes, or flattened lateral divisions, standing out at right angles to the margins, and, like the main stems and branches, bearing pores on each side; pores small, apparently without distinctly projecting lips, and arranged in quincunx, so as to form on the stems and branches about six to eight longitudinal rows, generally separated from each other in all directions by spaces about equaling twice the diameter of the pores themselves; surface between the pores smooth or without ridges.

Entire length of stems and branches unknown; breadth, exclusive of the short, lateral projections, 0.12 inch; thickness, about 0.04 inch; number of pores in 0.10 inch, measuring in the direction of the length of the stems, six; do., measuring obliquely, about seven.

This species differs remarkably from all of the others known to me by the possession of the numerous, very short, regularly and closely arranged, obtuse or truncated lateral divisions, given off at right angles from both lateral margins of stems and branches. At first I was inclined to view these as the remains of lateral branches that had been accident-

ally broken away. They are too uniform in length, however, for this, and when carefully examined under a magnifier do not show any indications of having been broken. They are generally about half as wide as the stems from which they spring, near 0.06 inch in length, and are arranged at intervals of about their own breadth apart, with rounded sinuses between, thus giving a crenate or serrated appearance to the margins. The pores continue out on these short, lateral divisions exactly as on the stems, without interruption.

Locality and position: Flint Ridge, Ohio. Lower Coal Measures. Prof. Andrews.

PTILODICTYA (STICTOPORA) CARBONARIA, Meek.

Plate 20, figs. 3a, b.

Ptilodictya (Stictopora) carbonaria, Meek (1871); *Proceed. Acad. Nat. Sci., Philad., XXIII., 160.*

Ramose, branches from their origin generally nearly equaling the breadth of the stems, from which they spring more or less alternately, and at angles generally of about 50° to 60°; poriferous surface of each side flattened-convex; lateral margins sharp and smooth; pores of each side arranged in quincunx, so as to form from about seven to nine longitudinal rows (those of each two adjacent rows alternating), and about the same number may be counted in each oblique row, very nearly or quite circular, and each with prominent margins, so as to appear as if penetrating minute pustules; intervening spaces usually once and a half to twice the breadth of the pores, and smooth, or without longitudinal ridges or furrows.

Entire size unknown; breadth of a medium sized branch, 0.14 inch; thickness in the middle, 0.05 inch; number of pores in a space of 0.10 inch of each longitudinal row, six, while in the oblique rows about seven may be counted in the same space.

Among the Silurian species of *Stictopora* this seems to agree most nearly with *S. punctipora*, Hall, from the Niagara group, which it nearly resembles in its round pores with raised margins, as well as in the number and arrangement of its pores. It differs, however, in having its sharp, lateral margins smooth instead of being striated. A critical comparison of specimens would doubtless show other differences. Its branches are narrower, and the number of its longitudinal rows of pores is also less than in a species from the Corniferous limestone I have named *P. Gilberti*, which also differs in having longitudinal ridges between the rows of pores.

Locality and position: Newark, Ohio. Coal Measures.

BRACHIOPODA.

GENUS SPIRIFER, Sowerby, 1815.

[Min. Con., II., 42.]

SPIRIFER (TRIGONOTRETA) OPIMUS, Hall ?

Plate 19, figs. 14a, b, c, d, (e?).

Spirifer opimus, Hall (1858); Geol. Report Iowa, I., Part II., Palæont., 711.Compare *S. subventricosus*, McChesney (1860); Descriptions Palæozoic Fossils, 44.

Shell attaining nearly a medium size, varying from transversely oblong to truncato-suboval, or approaching semicircular, moderately convex; lateral margins connecting with the hinge behind at nearly right angles or less, and rounding anteriorly to the front, which is usually broadly rounded in outline, or sometimes subangular at the middle; hinge line generally equaling the greatest breadth of the valves; dorsal valve a little less convex than the other, with its beak projecting very slightly beyond the hinge line, and incurved; mesial fold moderate, very narrow at the beak, and widening more or less rapidly to the front, bearing about five or six rather small plications or costæ, the lateral ones of which often bifurcate once; lateral slopes each provided with about twelve to fifteen generally simple but sometimes in part bifurcating costæ; ventral valve rather evenly convex; beak not very prominent, and more or less incurved; area and foramen moderate, the former rather well defined and arching with the beak; mesial sinus commencing very small at the beak, widening to the front, and occupied by about seven costæ, only the marginal ones of which usually extend to the beak, while the others within generally connect with these on each side at various distances between the front and beak; costæ of the lateral slopes as in the other valve.

Length of a medium sized specimen, 0.80 inch; breadth, 1.04 inches; convexity, 0.63 inch.

Like other analogous species of this genus, this varies in form, some specimens being more extended on the hinge line than others, and the number of costæ differing. Usually the costæ are mainly simple, excepting the lateral ones of the mesial sinus and fold, but sometimes a few of those on the lateral slopes also divide once. The form represented by fig. 14e has a narrow mesial sinus, a more extended hinge line, and more numerous plications, and consequently may belong to a distinct species,

though these shells, as stated, vary much in these characters. Both of the forms figured look unlike Prof. Hall's type of *S. opimus*, as illustrated in the Iowa Report, being less gibbous and more transverse, with more numerous plications, but in the Illinois Coal Measures there are shells apparently undistinguishable from *S. opimus*, that seem to shade off into forms like those here figured. In some respects these Ohio shells agree more nearly with *S. subventricosus*, McChesney, which, however, is generally regarded as a variety of *S. opimus*. I have also found it difficult to distinguish all of these shells from *S. Keokuk*, var., Hall (Iowa Report, I., part II., 676, plate XXIV., fig. 4a).

Locality and position: This shell occurs at many localities in the Coal Measures of Ohio, Illinois, Iowa, Missouri, and West Virginia; also numerous places in the Rocky Mountain region of the far West.

MOLLUSCA (PROPER).

LAMELLIBRANCHIATA.

GENUS AVICULOPECTEN, McCoy, 1851.

(Ann. Mag. Nat. Hist., VII., 171.)

AVICULOPECTEN (STREBLOPTERIA ?) HERTZERI, Meek.

Plate 19, figs 13a, b, c.

Shell usually under medium size, higher than wide, rather compressed, the right valve being nearly flat, and the left only moderately convex; subovate in general outline (exclusive of the small ears), with a slight backward obliquity, caused by the greater prominence of the anterior margin; basal outline semicircular and rounded regularly into the rather prominently rounded anterior margin; posterior margin less prominent than the anterior, and forming a longer and more gentle curve from the posterior ear into the base; hinge distinctly shorter than the antero-posterior diameter of the valves; posterior ear in both valves very small, flattened, very obtusely angular, and much shorter than the margin below, from which it is only separated by a faint sinuosity, though it is well defined from the umbo; anterior ear of each valve distinctly larger than the posterior, though not nearly as prominent as the anterior margin below, rather strongly compressed or flattened, so as to be abruptly separated from the umbo, and in both valves defined by a distinct sinus from the margin below, the sinus being deeper and more angular in

the right valve; beaks compressed, scarcely projecting above the cardinal margin, and placed a little behind the middle of the hinge, as well as that of the valves. Surface of both valves elegantly ornamented by numerous, sometimes sharply elevated, nearly equal, very regularly arranged radiating and concentric lines, which are larger and more strongly defined on the anterior ear of the right valve, particularly the radiating markings, which there sometimes assume the character of small costæ, while the concentric markings there in some examples project as little lamellæ slightly above the hinge margin, so as to give it a subdentated appearance.

Height of one of the largest specimens seen, 1.32 inches; antero-posterior diameter, 1.20 inches; convexity, about 0.18 inch.

I know of no other shell in our rocks that is liable to be confounded with this, its general form and neatly cancellated markings being sufficient to distinguish it. Although I refer it provisionally to *Aviculopecten*, I really do not think it belongs properly to that genus, as restricted to the typical forms. At least it differs from all the characteristic forms of *Aviculopecten* in having the anterior ear larger than the posterior, as well as in having its beaks placed a little behind the middle of the valves, thus giving the slight backward obliquity mentioned in the description. This latter character seems to approximate it to *Streblopecteria* of McCoy, but as we know nothing of its hinge and interior, it is not possible to determine whether it belongs to that group or not.

The specific name is given in honor of the Rev. H. Hertzner, of the Ohio Geological Survey, to whom I am indebted for the use of some fine specimens from his own private collection.

Locality and position: Newark, Ohio. Lower Coal Measures.

GENUS PLACUNOPSIS, Morris and Lycett, 1853.

[Monogr. Fossils Great Oolite, 6.]

PLACUNOPSIS RECTICARDINALIS, Meek.

Plate 19, fig. 12.

Shell truncato-suboval or subquadrilateral, slightly oblique, with length and breadth nearly equal; cardinal margin straight, not quite equaling the greatest breadth of the valves; lateral margins almost straight and parallel, meeting the hinge at nearly right angles, and rounding regularly to the rounded ventral edge; upper valve depressed, most convex

between the beak and central region; beak small, depressed, and but slightly projecting beyond the cardinal margin, near the middle of which it is placed with scarcely perceptible obliquity; surface showing fine, obscure lines, and a few stronger marks of growth, with faint traces of radiating striæ, and an entirely distinct set of regular, transverse, waved or arched, parallel, little linear ridges or costæ, which appear to have resulted from the markings of the surface of the object upon which the shell had grown; lower (right?) valve unknown.

Ventro-dorsal and transverse diameters each about 0.95 inch; convexity of the upper (left?) valve, about 0.13 inch.

The shells of this type seem to vary so much in form that it is barely possible that this may be only an extreme variety of *Placunopsis carbonaria*, Meek and Worthen. (See Illinois Geol. Rep., V., pl. 27, figs. 2a-d.) Its much longer and straighter hinge, however, and angular lateral extremities, with its less prominent, more nearly central beaks, and nearly obsolete radiating striæ, all combine to give it so different an appearance that with such means of comparison as we now have on hand I can but regard it as a distinct species.

It is not possible, from the specimens yet examined, to be absolutely sure that these Carboniferous shells agree exactly with the genus *Placunopsis*, but so far as can be determined they seem to agree quite closely with it. The Illinois specimens show the lower valve to be flat, or at least to conform to the contour of the surface to which it seems to have grown by its whole under surface. It shows no traces of a perforation or sinus for the passage of a byssal plug, as in *Anomia*, while the upper valve, which, from the direction of its slight obliquity, appears to be the left one, always shows a curious mingling of concentric and radiating markings, with an entirely different set of regular, transverse, or oblique lines or ridges, as if the latter had been produced by the markings of some other shell upon which it had grown, as we often see in *Anomia*, *Crania* and some other attached shells.

Baron de Reyckholt has described a genus, *Anomianella*, from the Carboniferous rocks of Tournay, that had a similar habit of growing on other shells, and assuming their style of markings. At one time I thought it highly probable, from a notice I had seen of his genus, that it might include our shells of the type under consideration; but on seeing the figures of his *A. proteus*, which is supposed to be the typical species (I have not yet seen his description), I find it to be an oval shell, without the slightest traces of a straightened cardinal edge or marginal beak. Consequently it is very improbable that our shells can properly be placed

in the same genus. Baron de Reyckholt probably saw in some of his specimens characters distinguishing his genus from *Crania*, but if I were to form an opinion from his figures only, I should almost be led to think they represented a thin species of that genus.

Locality and position: Coal Measures at Flint Ridge and Putnam Hill, Ohio. Prof. Andrews's collection.

GENUS POSIDONOMYA, Brown, 1837.

(Leth. Geogn., 88, 164 and 342.)

POSIDONOMYA FRACTA, Meek.

Plate 19, figs. 7a, b.

Shell obliquely subovate, compressed, very thin; posterior basal margin regularly rounded; posterior dorsal edge ascending obliquely forward to the hinder extremity of the hinge, which it meets at an obtuse angle; anterior margin descending or truncated more or less nearly vertically from the beaks above, and rounding obliquely into the base below; hinge line straight, very short, and ranging at an angle of about 45° to 60° above the longer oblique axis of the valves; beaks terminal, very oblique, and projecting very little or not at all above the hinge margin; surface marked by regular concentric undulations, with intermediate parallel striæ.

Length of a narrow right valve, 0.72 inch; breadth of same, 0.43 inch; length of hinge, 0.22 inch.

As may be seen by the figures, this little shell presents exactly all the external characters of an oblique *Inoceramus*, the smaller right valve represented by fig. 7a being, in form and ornamentation, an *exact* miniature of the well known cretaceous *Inoceramus problematicus*. I know nothing of the hinge of these shells, but there is, of course, no probability that they belong to the genus *Inoceramus*, and it is scarcely possible that *I. problematicus*, which is unknown in any intermediate position, could occur both in the Cretaceous and Carboniferous rocks, even if the genus had so great a range in time, of which we have no evidence. I therefore refer this shell to the genus *Posidonomya*, to which it much more probably belongs, though its generic relations cannot be considered definitely settled until its hinge characters can be determined.

It will be observed that our figures represent a right and a left valve, that differ quite enough in form to belong to different species, but as they are opposite valves (of course not of the same individual), and such

shells often vary much in form, I prefer not to attempt to separate them specifically without knowing from the study of a series of specimens the extent to which this species varies. To prevent confusion, however, in case they may be found to belong to two distinct species, I would state that the form represented by fig. 7a is considered the type of the species here described.

Locality and position: In dark shales of the Coal Measures at Flint Ridge, Ohio. I think I have also seen imperfect specimens of the same shell from the Coal Measures of Illinois.

GENUS MACRODON, Lycett, 1845.

[Buckman in Murch. Geol. Chelt., 2d ed.]

MACRODON OBSOLETUS, Meek.

Plate 19, fig. 9.

Macrodon obsoletus, Meek (1871); List Carb. Fossils from West Virginia, 5 (Extr. from Rep. Regents University of West Virginia).

Shell (as determined from internal casts) transversely elongated sub-rhombic, rather compressed; hinge line nearly equaling the length of the valves; posterior margin compressed, obliquely truncated, and very slightly, so as to meet the hinge above at nearly a right angle, and subangular or very abruptly rounding into the base below; anterior margin intersecting the hinge at a right angle above, thence rounding downward into the base, which is not quite parallel to the dorsal margin and slightly sinuous near or a very little in advance of the middle; beaks depressed very nearly to the line of the dorsal margin, rather compressed, and placed about one-fourth the length of the hinge from the anterior extremity; surface showing a few distant concentric marks, traces of fine striæ of growth, which are crossed on the posterior dorsal region by fine, rather closely arranged, radiating striæ.

Length, 1.40 inches; height, 0.58 inch; convexity, about 0.22 inch.

The original type specimen of this species is only about two-thirds as large as that here figured, which latter is only a partly internal cast of a right valve. This cast shows the impressions of two or three elongated posterior hinge teeth, nearly parallel to the cardinal margin. In a cross light it also shows obscurely the fine, radiating and concentric striæ of the posterior dorsal region, the former of which escaped the eye of the artist when drawing the figure. On this part of the type specimen these striæ form a finely cancellated style of ornamentation.

At a first glance this shell recalls *Macrodon tenuistriatus*, M. and W., (Ill. Report, V., 576, pl. XXIII., figs. 4a, b), but it is a much larger, *decidedly* less gibbous shell, and appears to be entirely without the minute, crowded, radiating striæ seen on the central and anterior portions of that species. This absence of radiating markings on its central and anterior portions will also distinguish it from *M. carbonarius* (= *Arca carbonaria*, Cox), Kentucky Geol. Rep., Atlas, pl. VIII., fig. 5), which has well defined radiating costæ all over.

Locality and position: The original type specimens of this species were in the lower part of the Coal Measures in Monongahela county, West Virginia, while the specimen here figured came from the Coal Measures at Newark, Ohio. Rev. Mr. Hertzner's collection.

GENUS YOLDIA, Moller, 1842.

(Kroyer's Nat. Tidsskr., IV., 91.)

YOLDIA STEVENSONI, Meek.

Plate 19, figs. 4a, b.

Yoldia Stevensoni, Meek (1871); List Carb. Foss. from West Virginia, 6 (Ext. from Rep. Regents University of West Virginia).

Shell much compressed, very thin, longitudinally elliptic-subovate, being about twice as long as high, with the widest part a little in advance of the middle; anterior margin narrowly rounded; posterior narrower and more compressed than the anterior; basal outline broadly semiovate, being a little more prominent anteriorly; cardinal border sharply carinated, and provided with a marginal furrow on each valve, slightly convex in outline anteriorly, and straight or a little concave behind the beaks; umbonal slopes not angular; beaks depressed and placed very slightly in advance of the middle. Surface ornamented by fine, regular, concentric lines, separated by wider furrows.

Length, 0.78 inch; height, 0.38 inch; convexity, 0.16 inch.

This is a very neat, remarkably compressed species, having exactly the form and external appearance of a true *Yoldia*, but its hinge and interior are unknown. The specific name was given in honor of Prof. John J. Stevenson, of New York, late of the University of West Virginia.

Locality and position: The figured specimen was from Monongahela county, West Virginia, found in a dark shale just below the Mahoning sandstone.

YOLDIA (PALÆONEILO ?) CARBONARIA, Meek.

Plate 19, fig. 5.

Yoldia (Palæoneilo?) carbonaria, Meek (1871); List Carb. Foss. West Virginia, 6 (Ext. from Rep. Regents University of West Virginia).

This species is much more convex and elongated than the last, and has its beaks located farther forward, its anterior margin more narrowly rounded, and its posterior dorsal slope straighter and more declining. Its dorsal margin also wants the carinate and sulcate character of that shell, from which it also differs in having its posterior basal margin slightly sinuous, instead of regularly convex, and its surface without fine, regular, concentric striæ.

Length, 0.84 inch; height, 0.38 inch.

The hinge and interior of this shell are unknown, but it has the external characters of form, etc., of some of the species included in the group *Palæoneilo*.

Locality and position Same as last.

GENUS SCHIZODUS, King, 1844.

(Ann. Mag. Nat. Hist., XIV., 313.)

SCHIZODUS CUNEATUS, Meek.

Plate 20, fig. 7.

Shell attaining a large size, ovate-subtrigonal, rather decidedly compressed, the greatest convexity being in the anterior and umbonal regions; anterior side very short, obliquely subtruncated above, and broadly rounded from near the beaks into the base; basal margin longitudinally semiovate, being most prominent anteriorly, somewhat straightened and ascending obliquely behind to the abruptly rounded or subangular posterior basal extremity; posterior side long, cuneate, somewhat narrowed, obliquely truncated above from the end of the hinge to the posterior basal extremity; hinge line straight behind the beaks, where it is about one-third as long as the valves and a little declining backward; beaks prominent, erect, incurved, and located only about one-fourth the entire length of the valves from the anterior margin; posterior umbonal slopes subangular near the beaks, and continued thence as a rounded prominence obliquely to the posterior basal extremity. Surface smooth, or only showing obscure lines of growth.

Length, 2.15 inches; height to top of beaks, 1.62 inches; convexity, 0.72 inch.

This fine species agrees in size and form, perhaps, more nearly with the well known European Permian species, *S. obscurus*, Sowerby, than with any other described species, though in some respects it is, perhaps, more nearly related to *S. truncatus*. It attains a considerably larger size, however, than even *S. obscurus*, from which it differs in having its beaks more elevated, and without any backward inclination. Its valves are also proportionally less convex, and have the anterior margin less prominently rounded in outline, while its posterior ventral margin shows not a trace of the sinuosity said to become more conspicuous in that species in large, mature specimens. In the latter character it differs still more decidedly from *S. Schotheimi*, of Geinitz, as well as in its less elongated, more inequilateral form, and higher beaks. Its much larger size, more compressed form, more elevated beaks, and shorter anterior side, distinguish it from *S. truncatus*, King.

I know of but two other American species that attain so large a size as this. These are *S. amplus*, M. and W., and *S. occidentalis* (= *Cypricardia occidentalis*, Swallow), both of which are from the Coal Measures. Compared with the former, it is at once distinguished by its much more elevated beaks, decidedly narrower and truncated posterior side, and sub-angular posterior umbonal slopes. In some of these characters it agrees more nearly with Prof. Swallow's species, while in other respects it differs far more widely, that shell being very much more ventricose, with a greatly more sloping posterior dorsal outline, less truncated posterior margin, and distinctly sinuous posterior basal margin, more angular posterior basal extremity, and more prominently rounded anterior basal outline.

I have before me, from the Upper Coal Measures at Nebraska City, Nebraska, a very similar form, differing only in its smaller size, more nearly central beaks, and much more prominent ventral and anterior margins. It is, however, probably a distinct species.

Locality and position: Putnam Hill and Flint Ridge, Ohio. Lower Coal Measures. Prof. Andrews's collection.

AVICULOPINNA AMERICANA, Meek.

Plate 20, fig. 2.

Avicula pinnæformis, Geinitz (1866); Carbonif. und Dyas in Nebraska, 31, tab. II., fig. 13 (not *Avicula pinnæformis*, Geinitz, 1857).

Aviculopinna Americana, Meek (1867); Am. Jour. Sci. and Arts, XLIV., 282, and (1872) Palæont. Eastern Nebraska, in Hayden's Report of Geol. Survey of Nebraska, 197.

Shell small, compressed, with the general form of a narrow *Pinna*; ventral margin ascending very gradually forward, and nearly or quite

straight, but rounding up behind, so as to connect with the hinge at right angles; dorsal margin very nearly straight, equaling the greatest length of the valves, and provided with a narrow marginal ridge; beaks very nearly obsolete, extremely oblique, and placed a little behind the narrow, obtusely pointed, anterior extremity. Surface with numerous concentric lines and lamellæ running parallel to the basal and posterior margins.

Length, 2.03 inches; height, 0.62 inch.

The only specimens of this shell that I have seen from the Ohio Coal Measures are all crushed perfectly flat between the laminae of shale, so as to obscure, to some extent, their characteristic features. The specimen figured seems to show the inside only of the right valve. It will be seen to be larger than the Nebraska type specimens of the species, and differs slightly in some of its details, but the latter differences are believed to be mainly due to the condition of the specimen, and the fact that it is probably the inner side that is seen.

That these little American Coal-Measure shells are entirely distinct from the European Permian species, *A. pinnæformis*, will, I think, be obvious enough without detailed comparisons. For remarks on this point, however, I would refer the reader to the Nebraska Report cited at the head of this description. Figures of the European form, for comparison, are also given there.

Locality and position: The original type specimens of this species was found in the Upper Coal Measures, at Nebraska City, Nebraska. It also occurs at near the same horizon in western Iowa, and at a somewhat lower horizon in the central region of that State. The Ohio specimen here figured came from the lower part of the Coal Measures.

GENUS PLEUROPHORUS, King, 1844.

(Ann. Mag. Nat. Hist., XIV., 313.)

PLEUROPHORUS TROPIDOPHORUS, Meek.

Plate 19, figs. 10a, b.

Shell transversely oblong, much compressed, with length a little greater than twice the height; posterior margin flattened and bifurcated, the lower truncation being nearly vertical, and the upper sloping obliquely downward and backward from the hinder end of the hinge; cardinal margin straight, equaling about two-thirds the length of the valves; anterior rounded below and sloping abruptly forward from the beaks

above; basal margin long, parallel to the hinge, nearly straight for most of its length, or faintly sinuous near the middle, rounding up anteriorly, and forming a more or less defined angle at its connection with the lower part of the posterior margin behind; posterior umbonal slope distinctly angular from the beaks to the angular posterior basal extremity, while a second carina passes obliquely backward and downward along the middle of the posterior dorsal space above the umbonal ridge of each valve; beaks depressed to the line of the cardinal margin, very little projecting, and placed one-fifth to one-fourth the length of the valves from the anterior margin. Surface marked by distinct concentric lines of growth, that become strongly defined on the flanks and anterior parts of the valves, but are less distinct on the space above and behind the umbonal angles.

Length, 1.10 inches; height, 0.52 inch; convexity, about 0.20 inch.

This shell has *very* much the form and general appearance of *Cypriocardia striato-lamellosa*, DeKoninck, as figured in his An. Foss. Carb., Belg., pl. H, figs. 8a, b, but its beaks are less prominent and not so curved forward, and it seems to be entirely destitute of the deep lunule seen in that shell. I have not seen its hinge, but one of the specimens (fig. 10b), which is partly an internal cast, shows the impression of a long, posterior, lateral tooth, and marks of a rather deep, anterior adductor muscle, as in *Pleurophorus*. Judging from the distinctness of the surface markings on the casts, it is probable that the shell itself is thin.

Locality and position: Coal Measures, at Newark, Ohio.

GENUS SOLENOMYA, Lamarck, 1818.

(Hist., V., 488.)

SOLENOMYA ?? ANODONTOIDES, Meek.

Plate 19, fig. 11.

Shell transversely elliptic-subovate, compressed, nearly twice as long as high, with the greatest height a little behind the middle; posterior margin nearly regularly rounded in outline; anterior extremity shorter and more narrowly rounded than the other; basal margin forming a broad, semioval or semielliptic curve, being generally slightly more prominent behind than in front of the middle; dorsal margin presenting a nearly straight, or very gently arched, outline from the beaks posteriorly, and rounding into the posterior margin behind, while in front of the beaks

it declines forward, with a straight or slightly sinuous outline above, and rounds into the narrowly rounded front below; beaks depressed to the line of the dorsal margin, rather compressed, and placed about one-third the length of the valves from the anterior end. Surface marked by concentric striæ and some ridges of growth.

Length, 1.40 inches; height, 0.74 inch.

I know nothing of the hinge and interior of this shell, and have, therefore, only referred it provisionally to the genus *Solenomya*. Possibly I should call it *Edmondia anodontoides*, though it is quite as probable that it will be found to belong to neither of these genera when its hinge characters can be seen.

Locality and position: From the Coal Measures, at Newark, Ohio.

GENUS ASTARTELLA, Hall, 1858.

(Geol. Report Iowa, I., part II, 715.)

ASTARTELLA NEWBERRYI, Meek.

Plate 19, fig. 3.

Compare *Astartella vera*, Hall (1858), *ib.*, pl. 29, figs. 1*a*, *b*.

Shell of medium size, trapezoidal-subovate, being wider anteriorly, with height about three-fourths the length, rather convex; anterior margin rounded; base longitudinally semiovate, being more convex in outline anteriorly, and a little sinuous behind; posterior side narrowed, and nearly vertically truncated; dorsal margin sloping and nearly straight behind, declining more abruptly, with a more or less concave outline in front; beaks moderately prominent, located about one-third the length of the valves from the anterior margin; posterior umbonal slopes forming an obtuse ridge that extends obliquely backward and downward to the abruptly rounded posterior basal extremity; above this ridge the triangular posterior dorsal region is flattened and cuneate, while the flanks just in advance of it are a little concave. Surface ornamented by about twenty to twenty-five very regularly disposed, distinct, concentric, slender ridges, that are separated by wide, rounded furrows, in which traces of very fine lines of growth may be seen by the aid of a magnifier.

Length, 0.63 inch; height, 0.51 inch; convexity, about 0.24 inch.

Of this form I have seen but a single very perfect left valve, and that is so firmly and closely attached to the hard rock that its lunule and

escutcheon can not be clearly seen, though it is evident enough that they exist. In general appearance it strongly recalls certain forms of *Cras-satella*. Compared with *Astartella vera*, Hall (Iowa Report, I., part 2, figs. 1a, b), it will be seen to differ in having its beaks decidedly less prominent, less tumid, and farther from the anterior margin, while its posterior dorsal outline is straighter, and its concentric ridges more numerous, more prominent, and more regularly arranged. In its surface markings it more nearly resembles *Astartella concentrica* (= *Nuculites concentricus*, Conrad, Jour. Acad. Nat. Sci., Philad., VIII., pl. 6, fig. 19, 1839), from the Coal Measures of western Pennsylvania, but it is a more depressed, elongated shell, with less elevated and less nearly terminal beaks. It is barely possible that our shell may be a variety of one or the other of the species with which I have compared it; but with the only means of forming an opinion on this point now at hand, I can but regard it as a distinct species from both.

I have seen a specimen in Dr. Hayden's collections, from near Virginia City, Montana, that I could not distinguish from this, though it came, with some other Coal-Measure fossils, from beds apparently of the age of the Chester limestone.

Locality and position: Newark, Ohio. From the Coal Measures.

ASTARTELLA VARICA, McChesney.

Plate 19, fig. 2.

Astartella varica, McChesney (1860); Descriptions of New Palæozoic Fossils, 55, and (1869) Trans. Chicago Acad. Sci., I., 42, pl. 2, fig. 7.

I merely refer this shell doubtfully to the above cited species, not having had an opportunity to compare it with authentic examples of that form. So far as can be determined, however, from Prof. McChesney's figure and description, it seems to agree quite closely with his species in outline, being only a little more depressed, yet its concentric ridges appear to be less sharply elevated, and it is possible that a direct comparison might show other differences.

Locality and position: Coal Measures, at Newark, Ohio.

ASTARTELLA (undetermined sp.).

Plate 19, fig. 1a, b.

I have been unable to decide in regard to the specific relations of this shell. At one time I thought it might be a variety of *A. vera*, Hall, but

it differs so decidedly from the type of that species in form that I think it can hardly belong to the same species. When the figure was prepared I had intended to make thorough comparisons with *A. vera*, but circumstances beyond my control have prevented this.

Locality and position: Same as last.

GENUS CYPRICARDINA, Hall, 1860.

(Palæont. N. Y., III., 266.)

CYPRICARDINA? CARBONARIA, Meek.

Plate 19, figs. 8a, b.

Cypricardina? carbonaria, Meek (1871); Proceed. Acad. Nat. Sci., Philad., XXIII., 163.

Shell small, longitudinally oval, less than twice as long as high, the widest (highest) part being under the posterior extremity of the hinge; rather gibbous, with usually a broad impression extending from the beaks obliquely backward and downward to the middle of the base of each valve; anterior side extremely short, or nearly obsolete, convex, and rounded; posterior side broader, more compressed or cuneate, with its upper edge straight and sloping obliquely backward to the regularly rounded posterior margin; base broadly and slightly sinuous in the middle, and rounding upward at the extremities; hinge line straight, between one-half and two-thirds as long as the valves, ranging at an angle of about 25° with the oblique, longer axis of the shell, so as to meet the sloping upper edge of the posterior margin at a very obtuse but moderately well-defined angle, thus imparting to the somewhat compressed posterior dorsal region a very faintly alate appearance; beaks extremely oblique, depressed nearly to the dorsal margin, very nearly terminal, and scarcely projecting beyond the rounded outline of the anterior extremity. Surface ornamented by about fifteen to twenty exceedingly regular, well-defined, subimbricating, flattened, concentric ridges or undulations, that gradually become smaller and more closely approximating on the umbones.

Length of largest specimen seen, 0.55 inch; height at the posterior extremity of the hinge, 0.32 inch; convexity about 0.18 inch; length of hinge, about 0.30 inch.

This little shell has nearly exactly all the external characters of *Cypricardina* (*C. lamellosa*, Hall), as found in the Upper Silurian, excepting that its beaks are more nearly terminal, and its concentric markings or

ridges not quite so prominent, while I have seen no indications of the minute sculpturing of that species.

In regard to the hinge of the typical species of *Cypricardina* nothing is known. In the shell here described, however, one of the casts shows that it has a moderately well-developed hinge plate, with one linear tooth in one valve, and one or two in the other, running very nearly parallel to the cardinal margin along its entire length, and at the posterior end of the hinge one or two shorter linear teeth, parallel to and beneath the others, while at the anterior end there is, in the right valve, one very small, slightly oval tooth, fitting between two similar ones in the left valve. These little teeth are slightly compressed from above and below, and placed so as to range, with their longer axis, nearly parallel to the hinge margin. No cardinal area can be seen, though there may have been a very small, narrow one immediately between the beaks, as there is no cavity seen in the hinge for an internal cartilage. The muscular and pallial impressions are so faintly marked that no traces of them have been seen on the casts of the interior.

Until the hinge of the typical species of *Cypricardina* can be made out it is impossible to determine whether our shell belongs to that genus or not. I have the impression, however, that it probably belongs to a distinct Carboniferous group, nearly allied to the Silurian genus *Cypricardites* of Conrad, but differing in having its principal hinge teeth extending the entire length of the cardinal margin, with cardinal area nearly or quite obsolete, and anterior muscular impression very obscure. It also differs from the known species of Mr. Conrad's genus in having remarkably regular, prominent, imbricating, concentric ridges or laminae. *Arca squamosa*, *A. obscura*, and *A. faba*, DeKoninck, belong apparently to this group, and possibly also the form he has referred, in his work on the Carboniferous fossils of Belgium, to *A. cucullæ obtusa* of Phillips, though the latter approaches still more nearly the typical Silurian forms of *Cypricardites* in its hinge characters.

If *Cypricardina* shall be found to have a different hinge structure, I would propose for the group, including our shell, the name *Synopleura*, in allusion to its regular, concentric lamina or costæ of growth. It is possible, however, that this group may be thought too nearly allied to *Cypricardites* to stand as a full genus, in which case the name of our species would have to be written *Cypricardites (Synopleura) carbonaria*.

Locality and position: Newark, Ohio. Lower Coal Measures.

GENUS ALLORISMA, King, 1844.

(Ann. Mag. Nat. Hist., XIV., 316.)

ALLORISMA COSTATA, M. and W.

Plate 19, figs. 6a, b.

Allorisma costata, Meek and Worthen (1869); Proceed. Acad. Nat. Sci., Philad., XXI 171, and (1873) Report Geol. Survey of Illinois, V., 585, pl. 26, fig. 15.

Shell small, or under medium size, longitudinally oblong, or trapezoidal, with length a little more than twice the height, moderately convex in the central and umbonal regions; anterior margin short, closed and rounded; basal margin forming a long, semielliptic curve; posterior side compressed, apparently a little gaping, somewhat obliquely truncated above, and connecting with the base below, so as to form a more or less defined angle at the termination of the oblique, posterior umbonal carinæ; posterior dorsal region above the umbonal carinæ compressed; cardinal margin equaling more than half the length of the valves, nearly straight, and slightly inflected, so as to form a very narrow, obscurely defined false area or corselet; beaks rising a little above the cardinal margin, and located near the anterior end; lunule small but well defined, and lance-oval in form. Surface ornamented by very regular, sharply raised, concentric costæ, separated by wider, rounded furrows, and all ending very abruptly behind, at the equally angular umbonal carinæ.

Length, 0.63 inch; height, 0.32 inch; convexity, about 0.20 inch.

The specimen from which our figures were drawn is not quite so complete on the posterior margin as fig. 6a would indicate, this margin being a little broken, so that the figure does not give its exact original outline. The surface of the posterior dorsal region is also not in a condition to show the lines of growth as represented on the figures, while fig. 6b is defective in not showing the narrow, obscure corselet, which, however, is nearly obliterated in the specimen by compression.

On comparing the figures on plate 19 with that of the large, more nearly perfect typical specimen given on plate 26, Vol. V., of the Illinois Report, the latter will be seen to differ in having its posterior margin bitruncated, and a second oblique ridge on the compressed space above the umbonal angle. This difference, however, seems to be mainly, if not entirely, due to the imperfection and smaller size of the Ohio specimen, which, as above stated, has the posterior margin not entirely perfect in

outline. I think I can also see some traces of the oblique second angle on the compressed, posterior dorsal region, especially near the beaks, though this is so faintly marked as to have escaped the attention of the artist.

Locality and position: The original type specimen of this species was found near the base of the Illinois Coal Measures, in Warren county of that State. I have, however, seen it from the upper part of the Coal Measures in Illinois and western Iowa. The specimen here figured came from the Coal Measures at Greentown, Stark county, Ohio.

GASTEROPODA.

GENUS PLATYCERAS, Conrad, 1840.

(Prelim. Report Palæont. N. Y., 205.)

PLATYCERAS TORTUM, Meek.

Plate 20, figs. 1a, b, c.

Platyceras tortum, Meek (1871); Proceed. Acad. Nat. Sci., Philad., XXIII., 171.

Shell very thin, dextral, attaining about a medium size, in young specimens composed of about one and a half to two volutions, subglobose, these first turns being contiguous, rounded, and rapidly increasing in size, after which the next turn, which composes the larger part of the shell, becomes free, very oblique, and increases more gradually in size, thus making the entire outline very obliquely elongate-rhombic; body volution a little flattened on the upper slope, subangular above, and somewhat prominently rounded near or below the middle; aperture apparently oval-suborbicular; lip without sinuses. Surface non-plicate, and with only moderately distinct lines of growth.

Length, 1.36 inches; breadth, about 0.90 inch; breadth and length of aperture, each 0.70 inch.

I have long been familiar with casts of this shell in the collections of the Illinois Geological Survey, but had some doubts whether they might not be distorted internal casts of a *Macrocheilus*. The specimens from which the above description was made out, however, retain the thin shell, and show that it is a true *Platyceras*. Specifically it is more nearly allied to some of the non-plicate varieties of the New York Upper Silurian, *P. spirale*, than it is to any Carboniferous species known to me, though its first two volutions are more compactly coiled together.

Locality and position: Greentown, Stark county, Ohio. Coal Measures.

GENUS MACROCHEILUS, Phillips, 1841.

(Palæoz. Foss., 103.)

MACROCHEILUS KLIPPARTI, Meek.

Plate 20, figs. 6a, b, c.

Macrocheilus Klipparti, Meek (1872); Proceed. Acad. Nat. Sci., Philad., XXIV., 328.

Shell attaining a large size, elongate-subfusiform, the length being sometimes from two and a half to three times the breadth; spire pointed at the apex, forming about half the entire length, with its lateral slopes concave above and convex below; volutions six to eight or nine, the upper five or six being very compactly coiled, and forming comparatively but a small part of the entire shell, while those below suddenly increase in size much more rapidly than the others, particularly in the direction of the longer axis of the shell, and form most of its bulk, these larger turns in large, adult examples sometimes assuming together a sub-cylindrical outline; last or body whorl comparatively long, cylindrical, or more or less oval, and somewhat produced below; suture moderately distinct, almost transverse between the smaller upper turns, but becoming decidedly more oblique below; aperture comparatively small and narrow, apparently sub-rhombic in form and effuse below; inner lip much thickened all the way up; columella twisted, so as to form a single prominent fold below the middle of the aperture. Surface nearly smooth, or only showing very obscure lines of growth. Outer lip unknown.

Length of one of the largest, most elongated specimens, 2.23 inches; breadth, 0.87 inch; length of aperture, about 1 inch.

This fine species most nearly resembles *M. Newberryi* of Stevens, but may be readily distinguished by its form, the slopes of the upper part of its spire being distinctly concave and the lower part convex in outline, instead of being evenly and moderately convex all the way down. This peculiarity is caused by the sudden enlargement of the middle and lower volutions, and the greater obliquity of their spiral curve, while in *M. Newberryi* the volutions increase in size regularly, and have the same uniform, spiral curve from the apex throughout the whole length of the spire. Young examples of the form under consideration are proportionally shorter, the elongation being to a considerable extent produced by the obliquity and prolongation of the last two volutions. These less elongated, younger shells, however, will be distinguished from *M. Newberryi* by the concave slopes of their spire, and the greater proportional

breadth of their body volution. It is also a larger and more robust species than *M. Newberryi*.

As none of the specimens yet seen have the outer lip and lower part of the aperture entire, the form of the aperture can not be made out, and there may even be room for some little doubt whether or not it is, in perfect examples, narrowed and produced into a canal below. If this is the case, the name of the species should be *Solenicus Klipparti*, as it appears to present very nearly the other characters of the type of that group.

The specific name is given in honor of John H. Klippart, Esq., of Columbus, Ohio, Secretary of the State Board of Agriculture, who discovered the specimens from which the foregoing description was made out.

Locality and position: Near base of Coal Measures, near Somerset, Perry county, Ohio.