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FAUNA OF THE WEWOKA FORMATION OF OKLAHOMA

BY

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FAUNA OF THE WEWOKA FORMATION OF OKLAHOMA.

By George H. Girty.

INTRODUCTION.

In his scientific work the paleontologist is at once a biologist and a stratigrapher. As a biologist he is concerned with the discrimination and identification of species; as a stratigrapher he is concerned with the discrimination and identification of faunas. The stratigraphic paleontologist or, as he might be called, the stratilogist, is not primarily concerned with the delineation of geologic formations on a map. He can work from measured sections alone, and his special task is the correlation of formations that are geographically separated, a task which can not ordinarily be performed by the stratigrapher.

Faunal descriptions.—In order to identify a fauna one must have for comparison faunas previously described, and in order to justify his identification he must describe the fauna that he is especially considering. He may accomplish this either by describing and figuring each species, which is a considerable task, or by merely listing them, a task which is comparatively easy, but which is practicable only if the species have already been described. An undescribed fauna may, of course, be listed by genera merely, and the general character of new species may be indicated by suggesting their relationship to known species, but this method of describing a fauna is at best imperfect and unsatisfactory. To list a fauna without describing it is in effect to state conclusions without producing evidence, and such identifications find acceptance only according to the known accuracy and carefulness of the writer. As it seems to be a psychological fact that formulating a description in words stimulates as well as necessitates detailed and accurate observation, so the faunas listed by even the most careful writers are less reliable and satisfactory than the faunas described, while the lists of some authors have hardly any value at all. The formulation of a description not only conduces to greater accuracy and refinement of scientific work, but, with the figures, it serves also as a voucher which puts the reader into possession of the principal facts that led the author to his identification. It follows from this that quoted descriptions and figures presented by other writers and based on alien material serve little purpose save to reproduce in another place statements which are perhaps already accessible in their original place.

Just which method should be employed in describing any particular fauna must depend on the attendant circumstances and on the object in view. In works dealing with new territory, however, and in works of authority and permanence dealing with old territory the descriptive method is the only one which is satisfactory, and this fact is so generally recognized that faunal lists are commonly treated as more or less provisional and are held in but little regard.

Range of a fauna.—A similar latitude of judgment must be conceded as to the geographic area or geologic limit to be covered by a faunal investigation. The word "fauna" is used with meanings varying greatly in extent. In the most restricted sense paleontologists use "fauna" or "flora" for the fossils that occur at a single geographic point and at a single geologic horizon. More loosely, they apply that designation to the organic types ranging upward or downward for varying distances from a particular horizon, or to the same types appearing at the same horizon at varying distances from a particular locality. Both stratigraphically and geographically, however, either far away or close at hand, the faunal facies will so change that the fossil groups can no longer be said to constitute a fauna. Many such changes are abrupt, but others are gradual, and it may be difficult to decide whether a particular collection, representing a considerable geographic or stratigraphic range, can more properly and advantageously be considered to constitute one fauna or two. But, however the fossils are grouped, it is evident that usually in the statement and always in the investigation the geographic or geologic units should be rigidly distinguished.

Carboniferous faunas.—Most of the early work done in the Carboniferous formations of the United States should be classed as biologic rather than stratigraphic. The purpose of most writers on the paleontology of the Carboniferous period seems to have been to describe species rather than faunas. An eminent exception is found in the work of James Hall, who with some other workers proceeded along lines that were in part faunistic. Of late years investigators have assembled and presented their facts somewhat more nearly along faunal lines, perhaps because the need of this method has become more apparent.

The failure of the early paleontologists to work along faunal or at least stratigraphic lines is more noticeable perhaps in papers on the Pennsylvanian than in those on the Mississippian series, this failure probably being due to the fact that the Pennsylvanian faunas are less sharply differentiated. However, some important faunal works on the Pennsylvanian were written, such as those of Geinitz[1] and of Meek,[2] the latter being in a manner a critique on the former.

Although it often answers every immediate purpose to describe faunas from an explored or exploited area merely by listing, this method becomes less practicable in proportion as the faunal occurrence is remote from known areas. As much of the early and some of the later work on Carboniferous fossils was concentered in the relatively small portion of the Carboniferous outcrop in the Ohio and upper Mississippi valleys, a very great amount of work remains to be done to make known the Carboniferous faunas of the United States, and it must be performed, if performed properly, by the descriptive method. This deficiency I have set myself to remedy so far as my qualifications and my opportunities permit.

The Oklahoma section.—The Carboniferous area of Oklahoma is especially interesting because it is so far removed from the well-known Carboniferous areas farther north and east (or perhaps I might better say that the rocks were laid down under physical conditions so different) that both its sediments and its faunas show marked differences from those already studied. The Oklahoma section is one of those whose faunas I hope to investigate and describe in detail. A beginning of this project was made in 1909, when I described the fauna of the lower portion of the Caney shale, and the present work is another item in the same scheme. If this work were done serially, the Wewoka fauna would not be undertaken for a long time, for it is many formations higher in the section than the Caney shale. Its investigation was taken up out of the logical order because of the unusually excellent preservation of its fossils, which offered an opportunity for careful generic and specific studies that will be advantageous as a starting point for work on less satisfactory material.

The Wewoka formation is typically exposed in the northwestern part of the Coalgate and the southwestern part of the Wewoka quadrangles. The details of its extension into other areas have not been determined. The collections described in the present report came from the two quadrangles mentioned.

Acknowledgments.—I embrace this occasion to express my gratitude to the former State geologist of Oklahoma, Prof. C. N. Gould, for his cooperation in obtaining paleontologic data. A valuable series of collections lent by him formed an important supplement to those already in the possession of the United States Geological Survey. The latter were made at various times by J. A. Taff, G. I. Adams, R. D. Mesler, and myself. To all these colleagues grateful acknowledgment is made.

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[1] Geinitz, H. B., Carbonformation und Dyas in Nebraska, 1866.

[2] Meek, F. B., Report on the paleontology of eastern Nebraska: U. S. Geol. Survey Nebraska Final Rept., pt. 2, 1872.

Wewoka formation.—The following description of the Wewoka formation was given by Taff in the Coalgate folio:[1]

Above the Watumka shale there is a succession of massive and, for the most part, friable sandstones and shales, seven in number, in alternate beds 40 to 130 feet thick. These beds together are about 700 feet thick and are named the Wewoka formation, from the town of the same name in the Wewoka quadrangle to the north. The separate massive beds composing the formation are of sufficient thickness to be mapped, but on account of the obscurity of the contact lines, due to the friable nature of the beds, it is not possible to accurately distinguish them.

The lowest of the four sandstone divisions of the Wewoka formation is thinner, though generally harder, than the succeeding ones. At its base there are local indurated beds of sandy chert conglomerate. These conglomerates are most prominent near the western border of the quadrangle where they form bluffs facing Boggy Creek valley. This group of sandstones and conglomerates becomes thinner eastward and northward, so that its outcrop is hardly perceptible on the border of the Canadian River valley.

Above this sandstone and conglomerate there is fossiliferous friable blue clay shale for 120 feet, ending locally in thin white fossiliferous limestone. This shale is exposed in many deep gulches bordering the Canadian River on the south, and outcrops in the rolling prairie land between Allen and Leader. Especially good exposures may be seen in the deep ravines in NE. ¼ sec. 23, T. 5 N., R. 8 E., where abundant fossil shells weather out free and also occur in calcareous clay concretions.

The succeeding sandstone member is about 110 feet thick. It caps the high land near the western border of the quadrangle, south of Canadian River and forms high bluffs surmounting the escarpments, facing eastward upon the north side of the river. Its beds are massive and friable, breaking down readily into loose sand and weathering into rounded ledges.

Above this sandstone, and near the middle of the formation, there is a soft fossiliferous blue shale nearly 130 feet thick. This shale is remarkable for the abundant and perfectly preserved fossil shells which it contains. Its full section is exposed on the Memphis Choctaw Railroad, 2 miles north of the mouth of Little River. Above this thick shale there is a sandstone member of the formation, which is estimated to be about 100 feet in thickness. The uppermost beds of this sandstone are shaly and culminate in a shelly sandy limestone. These uppermost strata of the Wewoka formation are concealed for the most part in the valley of Little River, across the northwest corner of the quadrangle.

On account of the friable nature of the sandstone, fine, loose sand derived from it is spread over the whole surface of the formation north of Canadian River, as well as over the western part of its outcrop south of that stream. The soil is a loose sandy loam and the country is covered by heavy forest.

Fossils from the Wewoka formation.—The present report is based upon 36 collections, 12 from the Coalgate quadrangle and 24 from the Wewoka quadrangle. Stratigraphically, all the collections came from the two lower shaly members of the formation. Geographically, they were obtained in groups along the line of outcrop made by the valley of Canadian River, which here runs nearly northeast. The report on these collections was completed in June, 1911.

The collections from the Coalgate quadrangle are credited to stations 2026, 2001, 7193, and 2004. The most westerly was obtained

[1] Taff, J. A., U. S. Geol. Survey Geol. Atlas, Coalgate folio (No. 74), 1901.

at station 2026 in the southwest corner of sec. 32, T. 5. N., R. 8 E.,[1] from the thin, light-colored limestone mentioned in Taff's description, quoted above, as locally occurring near the top of the lower shale. From the western part of sec. 24 and the northeastern and northwestern parts of sec. 23 come seven collections. Two of them are stated to be from the lower shale, 50 feet below the sandstone, and the five others were no doubt obtained at about the same horizon. As the localities are at most not much over a mile apart and probably represent about the same stratigraphic horizon, it would seem to be introducing unnecessary details to give separate lists for each of them and I will list the paleontologic data obtained at these seven localities under station 2001. Two other collections from the lower shale, one from sec. 32, the other from the SW. ¼ sec. 33, T. 6 N., R. 9 E., may be regarded as a third group which will be entered under station 7193.

Two other collections were obtained close by, almost at the same spot, one from the southeast corner of the SW. ¼ sec. 32, the other from the southwest corner of the SE. ¼ of the same section. One of the two was found in the middle instead of in the lower shale (from which the preceding group was obtained) and the other may provisionally be assumed to have come from the same stratigraphic position. These two collections will be cited as from station 2004.

The collections from the Wewoka quadrangle are credited to stations 2010, 2009, 2005, 2006, and 2021. Station 2010 is said to lie in sec. 10, T. 6 N., R. 9 E., in blue shale below sandstone, apparently the lower shale, as the middle shale comes in farther back from the river and at a much higher topographic position. A small collection (2009) is said to come from a railroad cut near the center of sec. 9 in the same township. The matrix would indicate that it might have come from the sandstone separating the lower and middle shales, but I believe that it actually did come from a thin sandstone in the lower shale. Four collections made in the SE. ¼ sec. 2 (station 2005) were taken, according to some of the labels but not according to others, from the middle shale, about 50 feet below the sandstone. Seventeen collections come from the northern part of sec. 5, T. 6 N., R. 9 E., and the adjacent southern part of sec. 32, T. 7 N., R. 9 E.; they were closely grouped along a line of bluffs and were all from the middle shale, from 25 to 75 feet below the sandstone which divides that member from the upper shale; these collections I group under station 2006. Lastly, a single collection (2021) comes from the NW. ¼ sec. 31, T. 7 N., R. 9 E.; the horizon is not given but it appears to be in the middle shale.

[1] For a detailed description of localities indicated by number in this report, refer to the register of localities on p. 271.

The following table shows the fossil species thus far found in the Wewoka formation, their geographic distribution, and their stratigraphic range:

Range and distribution of species in the Wewoka formation.

	2001	2004	2005	2006	2009	2010	2021	2026	7193	Lower shale.	Limestone lens.	Middle shale.
Fusulina inconspicuá								×			×	
Archæodiscus? sp								×			×	
Wewokella solida		×										×
Virgula? sp				×								×
Sponge? sp				×								×
Lophophyllum profundum	×	×	×	×		×			×	×		×
Lophophyllum profundum var. radicosum	×	×		×					×	×		×
Hapsophyllum? sp	×	×	×	×					×	×		×
Michelinia eugeneæ				×								×
Crinoid stems, group A				×			×		×	×		×
Crinoid stems, group B				×			×					×
Eupachycrinus verrucosus?	×	×		×						×		×
Eupachycrinus sp				×								×
Cromyocrinus? sp				×								×
Poteriocrinus? sp		×		×			×					×
Scaphiocrinus? sp				×								×
Delocrinus hemisphericus?			?	×		?				?		×
Delocrinus? sp	×	×	×	×						×		×
Hydreionocrinus patulus			×									×
Echinocrinus aff. E. cratis	×		×						×	×		×
Enchostoma serpuliforme				×								×
Enchostoma sp	×									×		
Serpulopsis insita	×	×	×	×					×	×		×
Conularia crustula			×	×								×
Conularia crustula var. holdenvillæ		×		×								×
Fistulipora carbonaria				×					×	×		×
Fistulipora carbonaria var. nebraskensis				×								×
Stenopora aff. S. distans				×								×
Rhombopora lepidodendroides?				×								×
Chainodictyon laxum?	×									×		
Lingula carbonaria?			×	×								×
Lingulipora nebraskensis		×		×								×
Rœmerella patula		×	×	×					×	×		×
Rœmerella? sp	×	×		×						×		×
Crania modesta	×	×	×	×					×	×		×
Derbya crassa	?	×	?	?						?		×
Streptorhynchus oklahomæ	×									×		
Chonetes granulifer			×	×								×
Chonetes granulifer var. armatus									×	×		
Chonetes mesolobus var. decipiens	×	×	?	×					×	×		×
Chonetes mesolobus var. euampygus	×		×	×						×		×
Productus inflatus var. coloradoensis	×								×	×		
Productus nebraskensis	×	×	×	×					×	×		×
Productus cora	×	×	×	×		×			×	×		×
Productus insinuatus					×					×		
Productus pertenuis			×	×								×
Marginifera splendens	×	×		×						×		×
Marginifera muricata	×	×	×	×					×	×		×
Marginifera lasallensis?		×	×	×					×	×		×
Strophalosia spondyliformis?			×									×
Pugnax osagensis	×		×							×		×
Pugnax osagensis var. percostata	×	?							?	×		?
Pugnax rockymontana	×	×		×					×	×		×
Rhynchopora illinoisensis			×									×
Spiriferina kentuckyensis				×								×
Spirifer cameratus	×	×		×					×	×		×
Spirifer aff. S. boonensis				×								×
Squamularia perplexa	×	×	×	×		×			×	×		×
Ambocœlia planiconvexa	×	×	×	×					×	×		×
Composita subtilita		×	×	×					×	×		×
Cleiothyridina orbicularis	×	×	×	×					×	×		×
Hustedia mormoni		×		×								×
Edmondia ovata		×		×								×
Edmondia gibbosa?		×	×	×								×
Nucula wewokana	×			×						×		×
Nucula anodontoides?	×	×	×	×					×	×		×
Anthraconeilo tafliana	×	×	×	×		×				×		×
Nuculopsis ventricosa	×	×	×	×		×			×	×		×
Leda bellistriata	×	×	×	×		×			×	×		×
Leda bellistriata var. attenuata		×	×	×					×	×		×
Yoldia glabra		×	×	×					×	×		×

Range and distribution of species in the Wewoka formation—Continued.

	2001	2004	2005	2006	2009	2010	2021	2026	7193	Lower shale.	Limestone lens.	Middle shale.
Aviculipinna americana	×		×							×		×
Pseudomonotis kansasensis			×									×
Schizodus alpinus	×	×		×						×		×
Schizodus affinis?	×			×						×		×
Deltopecten texanus			×									×
Deltopecten vanvleeti?	×									×		
Acanthopecten carboniferus	×									×		
Lima retifera			×									×
Limatula? fasciculata				×								×
Plagiostoma? acosta				×								×
Modiola subelliptica?				×								×
Allerisma? sp				×								×
Astartella concentrica	×	×	×	×	×	×			×	×		×
Astartella varica?	×		×	×	×	?			×	×		×
Dentalium semicostatum			×	×								×
Dentalium indianum				×								×
Dentalium subleve			×	?								×
Plagioglypta annulistriata	×		×							×		×
Plagioglypta meekiana				×								×
Phanerotrema grayvillense	×	×	×	×		×			×	×		×
Worthenia tabulata	×	×	×	×					×	×		×
Worthenia tabulata var	×	×	×	×						×		×
Orestes nodosus	×	×	×	×		×			×	×		×
Trepospira depressa	×	×	×	×		×			×	×		×
Pleurotomaria carbonaria?			×									×
Bellerophon crassus var. wewokanus		×	×	×					×	×		×
Pharkidonotus percarinatus		×	×	×								×
Bucanopsis meekiana	×	×	×	×						×		×
Patellostium montfortianum	×	×	×	×		×				×		×
Euphemus carbonarius	×	×	×	×		×			×	×		×
Schizostoma catilloides	×	×	×	×					×	×		×
Zygopleura rugosa			×									×
Zygopleura multicostata?			×	×								×
Zygopleura parva?				×								×
Zygopleura plebeia?		×										×
Holopea peoriensis?				×								×
Sphærodoma brevis	×	×	×	×						×		×
Sphærodoma brevis var		×	×	×								×
Sphærodoma gracilis				×								×
Sphærodoma intercalaris	×			×		×				×		×
Sphærodoma paludiniformis		×	×	×								×
Sphærodoma primigenia	?	×	×	×					×	×		×
Sphærodoma aff. S. regularis?				×								×
Sphærodoma ventricosa	×		×	×						×		×
Meekospira peracuta var. choctawensis	×	×	×	×		×			×	×		×
Meekospira bella?				×								×
Bulimorpha inornata?		×		×								×
Ianthinopsis gouldiana				×								×
Orthoceras tuba		×	×	×					×	×		×
Orthoceras sp. A			×									×
Orthoceras sp. B		×	×						×	×		×
Orthoceras sp. C				×								×
Pseudorthoceras knoxense	×	×	×	×					×	×		×
Pseudorthoceras seminolense			×	×								×
Protocycloceras? rushense?			×	×								×
Protocycloceras? rushense var. crebricinctum				×								×
Coloceras liratum	×	×	×	×					×	×		×
Coloceras liratum var. obsoletum	×	?	×	×						×		×
Metacoceras cornutum	×		?							×		?
Metacoceras cornutum var. sinuosum			×									×
Metacoceras cornutum var. carinatum		×		×								×
Metacoceras cornutum var. multituberculatum		×										×
Metacoceras perelegans	×	×	×	×					×	×		×
Metacoceras sculptile			×	×								×
Cyrtoceras peculiare				×								×
Cyrtoceras?? sp			×									×
Pronorites?? sp.				×								×
Gastrioceras venatum		×		×								×
Gastrioceras hyattianum	×	×	×	×		?			×	×		×
Gastrioceras angulatum	×		×	?						×		×
Gastrioceras excelsum	×									×		
Dimorphoceras lenticulare	×		×							×		×
Dimorphoceras oklahomæ				×								×
Gonioloboceras welleri var. gracile		×	×	×								×
Phillipsia sangamonensis	×	×	×	×					×	×		×
Griffithides parvulus			×	×								×
Cytherella sp								×			×	

In addition to the collections definitely included in the Wewoka fauna, two others may be noted which show the Wewoka facies but which are supposed to have come from the overlying formation, the Holdenville shale. Both are from the Wewoka quadrangle; one (station 2031) is said to have been obtained from blue clay shale in the northeast corner of the NW. ¼ sec. 2, T. 6 N., R. 8 E.; the other (station 2032) also from blue clay shale, was obtained in the northeast corner of sec. 26, T. 7 N., R. 8 E., about 1½ miles southwest of Holdenville. Both collections consist of common Wewoka species; the latter represents a somewhat larger fauna containing *Nuculopsis ventricosa*, *Leda bellistriata*, *Astartella concentrica*, *Phanerotrema grayvillense*, *Orestes nodosus*, *Trepospira depressa*, *Euphemus carbonarius*, and *Pseudorthoceras knoxense*. The former contains only *Rœmerella patula* and *Trepospira depressa*.

It has already been said that the fossils considered in this report represent three horizons in the Wewoka formation—the lower shale, a limestone lens near the top of the lower shale, and the middle shale. The fossils occurring at these horizons are listed in the last three columns of the preceding table, the lower shale comprising lots 2001, 2009, 2010, and 7193; the limestone lens being represented only by lot 2026; and the middle shale comprising lots 2004, 2005, 2006, and 2021. A comparison of these three columns shows at once that the very small fauna of the limestone lens is peculiar to it, while the faunas of the two shales are very closely related. Certain diversities nevertheless appear. The crinoidal representatives seem to be restricted chiefly to the middle shale, as do also the Conularias, the rare Bryozoa, and the Lingulas. Aside from the Lingulas the discrepancies among the Brachiopoda are not essentially noteworthy and may be readily seen from the table. All the abundant Pelecypoda occur equally in the two beds. With a few exceptions the rarer ones appear to be restricted to the middle shale, probably because the collections from that bed are much more complete than those from the lower. Possibly the same is true of the Dentalia, which, as recorded, appear to be restricted practically to the upper zone. The same Gastropoda also occur in both shales, but it is perhaps deserving of mention that *Pharkidonotus percarinatus*, all the Zygopleuras, and most of the Sphærodomas have been found only in the upper shale.

The cephalopods are nowhere very abundant, and it is only in accord with the generally more extensive fauna occurring in the middle shale, and with the more numerous collections made from it, that while nearly all the cephalopods of the lower shale occur also in the middle shale, a large proportion of those found in the middle shale are not known from the lower.

The collections from the Wewoka quadrangle illustrate three distinct types of lithology and preservation. One lot (station 2026) is contained in a whitish granular limestone, the same which is mentioned in the description of the Wewoka formation as occurring locally near the top of the lower shale. On close inspection the constituent particles of the limestone prove to be small crinoid stems, a small species of Fusulina with other Foraminifera, oolitic grains, and the like, thickly scattered through a fine calcareous base. The single hand specimen of the limestone collected is rather friable. Another small collection (station 2009) is in a soft fine-grained yellow sandstone, in which the fossils are preserved as molds, the containing rock being so pressed together that the cavities represented by the original shells no longer exist. This collection may have come from the sandstone between the lower and middle shales, but is believed to have come from a thin bed in the lower shale. It is perhaps noteworthy that these two collections (2026 and 2009), which differ markedly from the rest in the matter of lithology, seem, for the known faunas are extremely small, to present an almost equal contrast faunally.

The great bulk of the collections from the Wewoka consist of free specimens, which have weathered out of the shales. Although most of them are more or less broken, at least about their margins, and a few are compressed, some are almost perfect and have unusually well preserved surface characters. These fossils possess one exceptional feature. The original carbonate of lime (calcite or aragonite), of which most Carboniferous fossils were composed, has been replaced not by silica or by pyrite, the most common replacement substances, but by a compound of the carbonates of iron, magnesia, and lime, which shows but little effervescence with cold hydrochloric acid.

Considered as a fauna, the fossils of the Wewoka formation show remarkable diversity. In the majority of the Pennsylvanian faunas the brachiopods predominate, and some of them contain little else. In the Wewoka fauna, however, most of the important zoologic groups are represented, and with exceptional balance. The brachiopods do not predominate. In fact, numerically they are probably not so well represented as the pelecypods and gastropods, both of which, though often almost absent from many other collections, are abundant in those from the Wewoka, as are also the cephalopods, both nautiloids and ammonoids, which are absent even from many faunas in which the other mollusks are present. Except for their single occurrence at station 2026, the Fusulinas, which are so characteristic of the Carboniferous and which in some places occur in great profusion, are entirely absent. Sponges, generally rare, are represented by a few specimens. Corals are abundantly represented by the single species *Lophophyllum profundum*. Crinoids, which commonly occur as fragments of stems, are represented by stems, plates, and a few more or less entire cups. Conspicuously rare in this fauna, though abundant in many other Pennsylvanian faunas, are the Bryozoa. Not even a single fenestellid has come to hand. As already noted, the brachiopods are proportionally less well represented than usual. Several types are notably rare. The strophomenoids are very rare; not a Meekella, not even a Derbya has been found, the few known representatives of this group appearing to belong to the uncommon genus Streptorhynchus. The Producti, especially the large representatives of Productus, like *semireticulatus* and *punctatus*, are rare or absent, yet there is hardly a fossil more typically Carboniferous than *P. semireticulatus*. *Spirifer cameratus*, an ubiquitous fossil in most Pennsylvanian faunas, is rare and not typical, and *Composita subtilita* is also rather rare. Thus, these four most characteristic and usually most abundant brachiopod types of the Pennsylvanian are relatively inconspicuous. On the other hand, *Pugnax rockymontana*, a species very seldom seen, is fairly common. The unusual abundance of the true mollusks has already been noted. *Astartella concentrica*, *Nuculopsis ventricosa*, and *Phanerotrema grayvillense* are probably the most common species in the entire fauna, and a few other mollusks are scarcely less abundant.

The general composition of the Wewoka fauna, the presence of *Chonetes mesolobus*, and the absence of Meekella and like forms, suggest an early stage of the Pennsylvanian, and the fauna resembles the faunas of the early Pennsylvanian much more closely than those of the late Pennsylvanian of the upper Mississippi Valley. The Wewoka formation is almost too remote from the Pennsylvanian sections of the Mississippi Valley to justify its correlation with any of the numerous and sometimes thin formations which there make up the system. However, in the Survey collections from Kansas, those from about the horizon of the Fort Scott limestone show a striking resemblance to the Wewoka fauna, and the relationship suggested by this resemblance appears to be corroborated by the stratigraphy, for Prof. Gould [1] recently reported that a sandstone which immediately overlies the Wewoka formation has been traced north to a position closely aligned with the southward extension of the Fort Scott limestone.

[1] Gould, C. N., oral communication. Prof. Gould desires me to state that most of the tracing was done by J. A. Taff.

DESCRIPTION OF SPECIES.

PROTOZOA.

FORAMINIFERA.

Family FUSULINIDÆ.

Genus FUSULINA Fischer-de-Waldheim.

FUSULINA INCONSPICUA Girty.

Plate I, figures 1–8.

1911. *Fusulina inconspicua.* Girty, New York Acad. Sci. Annals, vol. 21, p. 120. Wewoka formation: Coalgate quadrangle, Okla.

Shell small, subcylindrical to somewhat fusiform. The average length is perhaps 3 millimeters, with a diameter of about 1 millimeter, but specimens 3.5 millimeters long are not uncommon. A few have a length of 4 millimeters, while one specimen provisionally referred to this species is nearly 5 millimeters long and 1.5 millimeters thick. For the most part this species is of very regular growth with a subcylindrical shell abruptly rounded at the ends. Different specimens differ appreciably in proportions, some being slender and others more robust, and some also taper more distinctly than others. In general the slender shape and gentle taper seem to be immature characters, appearing in young shells more frequently than in mature ones and being retained in some to a later stage than in others.

The initial cell is rather large, about 0.1 millimeter in diameter. The largest measured had a diameter of 0.11 millimeter, others of 0.099 millimeter, still others of 0.084 millimeter; others were even smaller. It seems reasonable to infer that the initial cell varies in size in different specimens but that many of the smaller measurements are due to the section not passing through its center. The walls are thin, the septa and outer wall being nearly equal in thickness. The specimens studied do not show the minute structure. In mature specimens (1 millimeter in diameter) 5 or even 6 revolutions of the outer wall can be counted in addition to the initial cell. In a mature specimen (1 millimeter in diameter) some 23 septa occur in the outer volution, and this appears to be about normal.

The specimens examined may not show this character with accuracy, but the suture or superficial lines formed by the septa are indistinct and not depressed. The septal walls are straight or nearly straight at the surface, but a little below it they appear to become strongly plicated.

The height of the final chamber is about 0.07 or 0.08 millimeter; the thickness of the outer wall is about one-third to one-fourth as much, or 0.028 to 0.02 millimeter.

This diminutive species, which occurs in great numbers at the one horizon in the Wewoka formation where it is found at all, is readily distinguished from all other American species thus far known by its much smaller size, and from some of them by its elongated and cylindrical instead of fusiform shape. In size it resembles the European *F. minima* Schellwien,[1] but is somewhat larger; in shape it is more slender and less fusiform. Its shape suggests *F. lutugini* Schellwien[2] and *F. longissima* Möller,[3] but it is very much smaller.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2026).

Family NUMMULINIDÆ.

Genus ARCHÆODISCUS Brady.

ARCHÆODISCUS ? sp.

Thin sections of limestone taken from the lens at station 2026 show that the rock consists largely of *Fusulina inconspicua* and small crinoid stems together with a considerable amount of transparent calcareous cement. The appearance of the Fusulinas varies greatly, depending on the part of the shell traversed by the section and the angle at which the shell is cut. The specimens that can be positively referred to *F. inconspicua* show, indeed, variation so great that I hesitate to exclude from that species a few shells of more unusual type, and still more to name a genus in which they can be placed, because they are so few that it is impossible to assemble them in concept in a form that will be related to three dimensions instead of only two. Some of them are comparable to Möller's figures of *Archæodiscus karreri* Brady.[4] All are under 0.6 millimeter in diameter, somewhat smaller than the originals of Möller's figures, and all are more or less elliptical in shape, and a few are somewhat pointed at the ends.

If these specimens are to be excluded from Fusulina the sections examined may possibly contain several other genera. One small form, only 0.2 millimeter in diameter, suggests Cristellaria. Two may perhaps represent a Spirillina. They are about 0.4 millimeter long and are very slender, so that they must be cut at a right angle to the plane of revolution. Still another type, which has a diameter of 0.6 millimeter, is somewhat suggestive of Discorbina. Another unique form resembles Ammodiscus, but it is not arenaceous and is very small, measuring only about 0.15 millimeter in diameter.

[1] Schellwien, Ernst, Monographie der Fusulinen, Teil 1, Die Fusulinen des russisch-arktischen Meeresgebietes: Palæontographica, vol. 5 , p. 167, pl. 13, fig. 23, 1908.

[2] Idem, p. 177, pl. 17, figs. 2, 3, 7, 8, 12–14.

[3] Idem, p. 163, pl. 13, figs. 14–20.

[4] Möller, V. von, Die Foraminiferen des russischen Kohlenkalks: Acad. imp. sci. St.-Pétersbourg Mém., ser. 7, vol. 27, No. 5, p. 77, pl. 7, figs. 4 and 5, 1879.

These specimens are all very small and the structure in some is not distinct. Some may really belong to Fusulina, but if they do they must represent very young individuals, or perhaps mature individuals cut nearly tangent to the small ends, or they may be merely fragments. The fact that no similar bodies have been found macroscopically either on rock surfaces or among broken-up material appears to weigh against their being regarded as distinct from Fusulina.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2026).

SPONGIÆ.

LITHISTIDA.

Genus WEWOKELLA Girty.

1911. Wewokella. Girty, New York Acad. Sci. Annals, vol. 21, p. 121.

The form for which this title is introduced is rare in the Wewoka formation, only two specimens having come to hand. They might perhaps be referred to the genus Doryderma were it not for the fact that they indicate a form which has a large central cloaca instead of a number of axial canals and which apparently lacks the radial canals of Doryderma. The type is nevertheless supposed to be related to that genus, which has also been cited from Carboniferous strata.

The form is roughly that of a cylinder with a large tubular cloaca. No dermal layer has been observed. The walls are rigid and are made up of large interlaced spicules. The typical spicule appears to be the tetraxon, but many do not show this shape and appear to be long, irregularly branched, and more or less contorted. Generally speaking, however, the trend of the spicules is longitudinal.

Type species.—*Wewokella solida.*

WEWOKELLA SOLIDA Girty.

Plate I, figures 12–13b.

1911. *Wewokella solida.* Girty, New York Acad. Sci. Annals, vol. 21, p. 121. Wewoka formation: Coalgate quadrangle, Okla.

Sponge body irregularly cylindrical, attaining a diameter of at least 25 millimeters. The center is occupied by a large tubular cloaca, the walls being about 7 millimeters thick and showing no evidence of being pierced by radial canals. A dermal layer, if originally present, has been lost. The walls are now made up of large spicules, which are doubtless typically 4-rayed, with one of the rays more or less reduced. Some of the others are perhaps aborted, so that many of the spicules seem to be irregularly branched. They are so interwoven as to make up a wall having considerable rigidity to augment which they may be partly cemented, although it is doubtful if they anastomose. The structure, then, though extremely varied in detail, makes on the whole a homogeneous wall which is apparently the same on the inside as on the outside. Among the large spicules are other much smaller tetraxons.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

Genus VIRGULA Girty.

VIRGULA ? sp.

Plate I, figures 11–11b.

This type is represented by a single specimen, which probably had originally a cylindrical shape, but which is now compressed to an inconsiderable thickness and has a width of 6 or 7 millimeters. It appears to be made up of large spicules, between which is a relatively coarse and open mesh. The structure is unusually regular, and as the openings left between the arms of the spicules are approximately hexagonal, the spicules were probably normally of the 4-rayed type. Their ends appear to be solidly connected.

This structure if interpreted aright would indicate that the specimen was a Lithistid sponge of the suborder Tetracladina, but most of the described genera of that group are of Mesozoic age, and few of them have the form of a solid or hollow cylinder like the present species. The Guadalupian fauna, however, contains a few Carboniferous types having a cylindrical or branching shape, and it is not unlikely that the present species may be referred to one of these, the genus Virgula.[1]

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

INCERTÆ SEDIS.

SPONGE ? sp.

Plate I, figures 9–10a.

A few of the crinoid stems and one of the plates show a pathologic condition, apparently due to some boring organism, probably a species of sponge—that is, they are in places perforated with closely set, nearly circular holes of irregular size, the smaller holes being on the outer edges of the area affected. These perforations are rounded or cup-shaped at the bottom, and so far as observed are more or less superficial, none passing through the stem or plate, and the area in which they appear is irregularly enlarged or swollen. My specimens seem to indicate that these perforations do not represent one organism attached to another, but a pathologic condition of one caused by another. There is no apparent difference

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[1] Girty, G. H., The Guadalupian fauna: U. S. Geol. Survey Prof. Paper 58, p. 73, 1908.

in structure and no sharp line between the affected and the normal portions, as there would be if there were really two organisms, and although the stems are conspicuously deformed the plate seems to be in no way distorted, unless perhaps it is somewhat thickened.

If the general facts are as stated, the particular cause of this deformity can not be determined. Many organisms possess the power of boring or absorbing hard substances such as stone or shell, yet it seems hardly likely that the agent here was some boring bivalve like Saxicava or Lithophagus. A gastropod boring for food would probably not produce such an excavation, for it would doubtless be better instructed by instinct than to bore into a crinoid stem or only partly through a crinoid plate. It is important to note that these perforations are restricted to the Crinoidea; they have not been observed on any of the Mollusca or Molluscoidea, although this fact might be cited with almost equal force against any of the other hypotheses. The work was more probably that of a sponge, although the boring sponges that I have seen produce more irregular and interlacing work.

At all events the following consideration seems to be in a general way determinative. If, as seems probable, the phenomena are due to a pathologic condition in the crinoid and not to another organism attached to it, the deformation must have been of slow growth, covering a period of weeks if not of months. It seems likely, then, that the agent was not excavating for a habitation, still less for food, although hypotheses covering both suppositions might be framed. The apparently slow progress of the derangement and its colony-like nature suggest not the work of single depredators seeking food or shelter, but a gradually expanding parasite whose growth was compensated by development in the organism attacked.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

CŒLENTERATA.

TETRACORALLA.

Family ZAPHRENTIDÆ.

Genus LOPHOPHYLLUM Milne-Edwards and Haime.

LOPHOPHYLLUM PROFUNDUM Milne-Edwards and Haime.

Plate II, figures 1–6a; Plate VI, figures 12, 14.

1851. *Cyathaxonia profunda.* Milne-Edwards and Haime, Mon. des Polyp. Foss., p. 323. Carboniferous: Flint Ridge, Ohio.

1860. *Cyathaxonia profunda.* Milne-Edwards, Hist. Nat. Coralliaires, vol. 3, p. 331. Carboniferous: Ohio.

1860. *Cyathaxona prolifera.* McChesney, Desc. New Spec. Foss., p. 75. (Date of imprint, 1859.)
Coal Measures: Widely distributed in the Western States.

1865. *Cyathaxonia prolifera.* McChesney, Illus. New Spec. Foss., pl. 2, figs. 1-3.

1866. *Cyathaxonia* (?) sp. Geinitz, Carb. und Dyas in Nebraska, pp. 65, 66, tab. 5, figs. 3, 4.
Upper Coal Measures: Plattsmouth, Nebr.

1868. *Cyathaxonia prolifera.* McChesney, Chicago Acad. Sci. Trans., vol. 1, p. 1, pl. 2, figs. 1-3. (Date of imprint, 1867.)
Coal Measures: Springfield, Ill.

1872. *Lophophyllum proliferum.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 144, pl. 5, figs. 4a, 4b.
Upper Coal Measures: Nebraska City and Rock Bluff, Nebr.; Springfield and La Salle, Ill.; Texas.

1873. *Lophophyllum proliferum.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 560, pl. 24, fig. 1.
Upper Coal Measures: Springfield, Ill.

1876. *Lophophyllum proliferum.* White, U. S. Geol. and Geog. Survey Terr., 2d div., Powell's Rept. Geology Uinta Mountains, p. 88.
Lower Aubrey group: Confluence of Grand and Green rivers, Utah.

1884. *Lophophyllum proliferum.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 118, pl. 23, figs. 6, 7.
Coal Measures: Indiana, Illinois, Iowa.

1887. *Cyathaxonia prolifera.* Foerste, Denison Univ. Sci. Lab. Bull., vol. 2, p. 86, pl. 7, figs. 15a-c.
Coal Measures: Flint Ridge and Bald Hill, Ohio.

1887. Zaphrentis sp. Herrick, idem, p. 50, pl. 2, fig. 21.
Coal Measures: Flint Ridge, Ohio.

1888. *Lophophyllum profunda.* Foerste, idem, vol. 3, p. 136.
Coal Measures: Flint Ridge, Ohio.

1888. *Lophophyllum proliferum.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 225. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1890. *Lophophyllum profundum.* Worthen, Illinois Geol. Survey, vol. 8, p. 79, pl. 10, figs. 14, 14a.
Coal Measures: Lasalle, Ill.

1894. *Lophophyllum proliferum.* Keyes, Missouri Geol. Survey, vol. 4, p. 115, pl. 13, figs. 8a, 8b.
Upper Coal Measures: Kansas City, Mo.

1896. *Lophophyllum proliferum.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 235.
Upper Coal Measures: Poteau Mountain, Okla.

1897. *Lophophyllum proliferum.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab., No. IX, p. 25.
Upper Coal Measures: Poteau Mountain, Okla.

1900. *Lophophyllum profundum.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 17, pl. 2, figs. 7, 7b.
Upper and Lower Coal Measures: Fort Scott, Marmaton, Bourbon County, Thayer, Olathe, Kansas City, Lawrence, Lecompton, Topeka, McFarland, Grand Summit, Kans.

1903. *Lophophyllum profundum.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 320.
Hermosa formation: San Juan region and Sinbads Valley, Colo.
Maroon formation: Crested Butte district, Colo.
Glenwood Springs and Uinta Mountain region, Colo.

1906. *Lophophyllum profundum.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 260, pl. 5, fig. 4.
Carboniferous: Weeping Water, Louisville, Cedar Creek, and Nehawka, Nebr.

1910. *Lophophyllum profundum.* Raymond, Carnegie Mus. Annals, vol. 7, No. 1, p. 157, pl. 25, fig. 2; pl. 27, fig. 4.
Ames limestone: Brilliant cut-off, Pittsburgh, Pa.

The fossils here under consideration are abundant in the Wewoka formation and show great variety. They have the usual conical shape and vary from gently curved to nearly straight, but some specimens expand more abruptly than others, most of the short specimens expanding more abruptly than the long ones. In the long specimens the sharpest curvature and expansion occur in the lower part, the upper part being more nearly straight and cylindrical. A length of 55 millimeters and a diameter of 24 millimeters are about the maxima observed. These fossils bear concentric striæ and growth lines, which in some specimens are very sharp and regular. More pronounced irregularities of growth are common and appear to be more highly developed in the short, abruptly expanding forms but are in some degree common to all. The longitudinal striations are strongly marked and are intimately connected with the development of the septa, each of the little grooves occurring opposite one of the septa and each of the ridges opposite an interseptal loculus. Three lines of discrepancy can usually be discerned in the arrangement of these ridges which branch more or less pinnately from them. They divide the perimeter approximately into a half and two quarters. Another external structure consists of small stolons or apophyses, which are given off by some specimens in considerable numbers, though others have only a few, and still others lack them altogether. They seem to be especially abundant on the short, spreading specimens, which have been separated as a distinct variety. In *L. profundum* as here interpreted they are rare.

The septa are of two orders, the short ones projecting but slightly and the long ones reaching to the center. There are from 24 to 31 or less of each, the number depending on the size of the specimen. Interseptal tissue is scantily developed and is possibly absent in some individuals. In others the interseptal loculi are subdivided by plates which occur at irregular intervals and extend obliquely from the center downward. The fossula is large.

A very striking feature of these organisms is the columella, which in numerous specimens is extremely large and prominent. It is generally more or less oval in cross section and subangular at the ends of the long diameter. In many specimens it is asymmetric, one end being rounded and the other angular, and in some it is additionally differentiated, the sculpture passing around one end and the other end having its angular carina intensified by two slight longitudinal grooves. In some specimens the columella is nearly circular; in others, particularly near the upper extremity, it is very attenuate, like a thin, sharp blade. It is marked by ridges that vary much in size and arrangement. In some specimens they are coarse and rather regular and may be either directly longitudinal or somewhat spiral; in others, they are much finer and more or less inosculating, producing a rather reticulate appearance; or they may be combined with reticulations, which occur chiefly near the apex. These markings are confined to the upper part of the columella, the lower part being smooth. In very many specimens the columella appears to be connected with one of the septa and to have the fossula opposite it. In others, several or possibly all the septa appear to unite with the columella. In some specimens the septa are much enlarged near the middle of the coral.

The different parts that are unsymmetrical usually bear a constant relation to one another. So far as I have observed the long axis of the columella invariably extends through the fossula and is connected with one of the septa at the end opposite the fossula, if such a connection is apparent at all. As already noted, the columella is not connected with any of the septa in the cavity of the calice, though it may be connected with several or all of them below. In the specimens observed, which show especially the condition at the bottom of the calice, the only septum regularly connected with the columella, or the one most conspicuously connected, is that opposite the fossula. Furthermore, contrary to what might be expected, the carinated side of the columella is usually directed toward the fossula and the rounded side toward the septum, with which the columella itself is especially united. Most of the coralla are conspicuously, regularly, and gently curved, the curvature being almost invariably such that its direction is in line with the longer axis of the columella. A very small number of specimens are bent at right angles to the columella and, as has already been stated, some are essentially straight or were differently flexed at different stages of growth. Furthermore, the curvature is normally such that the fossula lies on the concave side of the corallum, though in a few specimens it lies on the convex side.

Thin sections give what is in some respects a better idea of the structure of this coral, modifying somewhat the impressions derived from other methods of study. Probably the minute structure of the specimens sectioned has been more or less changed by fossilization, but it is sufficiently preserved to permit at least a distinction between the original structure and that produced by subsequent development of stereoplasma, a development that took place especially in the older parts of the corallum, the original structures being best seen in the calicinal portions.

Sections through the lower part of the calice show the theca, the septa, and the columella. The septa consist of single plates of more or less dense and uniform tissue, probably the primitive central lamellæ of Nicholson (Primär-streif).

The theca consists of alternating transverse bands of translucent and of denser tissue, the latter narrower than the former. The denser bands are a continuation of the median plate (here equivalent to the septum), but they are not sharply defined, being more or less broken up into dark strips with light strips between, the light strips being mottled with dark flecks.

The columella has a radiating structure, obvious in some specimens and very obscure in others, the radii seeming to correspond in texture and more or less in direction with the median plates. The spaces between the lines of greater density are filled in with stereoplasma (like that composing the walls ?), which forms a solid relatively large column of subcircular or oval section, having in some specimens distinctly fluted margins. The line of denser tissue through the long diameter is more striking and persistent than the lines that radiate laterally. The stereoplasma appears to have been deposited along these radii or plates and a rather distinct line appears where the deposits occurring on the opposite sides of adjacent plates meet midway between them to complete the solid axis.

A secondary deposit of stereoplasma seems to have gathered along these primary structures, chiefly, perhaps, about the ends of the septa and along the walls, but also probably about the columella and the sides of the septa. This deposit ultimately fills more or less completely the interseptal loculi, but the first result of its formation is to bring one or more of the septa into fused contact with the columella and with each other, this result, of course, being more complete in the early part of the corallum than in the calice. Although one or more and in some specimens perhaps all the septa are united with the columella the union is not primary but secondary for, as shown by Nicholson for *Lophophyllum eruca* and by Duerden for the present species, the columella in the early stages is intrinsically connected with one of the septa, the primitive central lamella being continuous from one to the other. In the specimens studied in the thin sections the median plate of the septum stops short of the columella and does not unite with the corresponding primary plate of that structure, but only a few specimens were studied in this manner.

Although the ridges of the exterior of the theca are directly connected with the septa and may be said to represent them, the tetrameral symmetry is usually much more clearly shown by the ridges than by the septa themselves, for the ridges show the stage of development of the septa, whereas the ordinary method of observing the septa in thin section or at the base of the calice shows merely their position at one stage of growth.

Of the three lines of discrepancy observed in the external ridges on the differentiated half of the corallum the median line is correlated with the septum that lies in the fossula. This line is frequently marked by the greater prominence of two of the ridges which extend from top to bottom of the coral but from which the others diverge pinnately. The internal and external features can not invariably be observed on the same specimen, but in this correlation of the fossular septum with the median division of the external ridges I feel some confidence. The lateral divisions, as previously remarked, are less obvious in the septa themselves than on the outside, but more than once a disparity in the septa on opposite sides of the corallum has been observed about a quadrant distant from the main fossula, suggesting the sporadic occurrence of auxiliary lateral fossulæ.

The names which should be used for the critical septa in this coral can hardly be doubted. The septum corresponding to the median of the three discrepant lines among the external ridges is the cardinal septum; that opposite each of the lateral lines, an alar septum; and that opposite the cardinal septum, with which the columella is connected, is the counter septum. As already noted, the alar septa are not as a rule clearly differentiated on the interior of the corallum. The cardinal septum then lies normally in the fossula on the concave side of the corallum, and the counter septum is on the convex side and is connected with the columella. In the rare specimens in which the curvature is reversed the cardinal septum is on the convex side of the columella and the counter septum on the concave side.

This nomenclature requires some comment, because Nicholson states that the cardinal septum is placed on the convex side of the corallum but also defines it as that from which new septa are developed on both sides, in a pinnate manner. By this rule, the septum which I call the counter septum, as determined by the curvature of the corallum, he would call the counter septum, and the septum which I call the cardinal, as determined by the symmetry of arrangement, he also would call the cardinal. The variability of the curvature with reference to the internal structure as shown in the present species would indicate that the curvature was subordinate in importance to the symmetry. Consequently, the definition that seems preferable is Jakowlew's, that the cardinal septum is always the one contained in the fossula, or Gordon's,[1] that it is the one with which the secondary septa in the same quadrant exhibit a pinnate arrangement.

Many of the observations and comments set down above have been anticipated by Duerden [2] and Gordon,[3] who have discussed this species at length in connection with the bearing which its ontogenetic changes have on the classification and relations of the rugose corals. Merely to show that my observations were independent and perhaps on that account have additional weight, I may state that they were made and formulated before I took up the discussions written by the authors mentioned. My own observations, however, do not cover the growth stages of *Lophophyllum profundum*, and their papers may

[1] Gordon, C. E., Am. Jour. Sci., 4th ser., vol. 21, p. 117, 1906.
[2] Duerden, J. E., Ann. Mag. Nat. Hist., 7th ser., vol. 9, pp. 381-398, 1902; vol. 18, pp. 226-242, 1906.
[3] Op. cit., pp. 109-127.

be advantageously consulted on all the structural features of the species and especially on the developmental features.

The structure and development of this species have been studied by several investigators and the facts observed have been used in classifying the Paleozoic corals. A controversy has arisen between J. D. Duerden and C. E. Gordon concerning the interpretation of some of the early stages. The investigation of the ontogeny of *L. profundum* and especially a discussion of the affinities of the rugose corals are beyond the purview of the present paper. There seems to be a general agreement regarding the structure of mature *L. profundum,* and the mature organism furthermore has little bearing on the subject. I therefore purpose to take no part in the dispute except as regards a few minor points. In the identification of the cardinal and counter septa my conclusions agree with those of Gordon and not with those of Duerden, who, in fact, now accepts the same view. I regard the septum in the fossula as the cardinal septum and that connected with the columella as the counter septum, so that my cardinal septum is what Duerden in his original discussion called counter septum, and my counter septum is what he called cardinal septum. This terminology (that employed by Gordon and myself) is the one used also by Nicholson.[1]

On the other hand, my observations apparently do not support Gordon's contention in the interpretation of the structure. The controversy between him and Duerden is not easy to follow and my understanding of it may not be entirely accurate, but it would appear to be essentially this—that Duerden has observed six septa in a very early stage of *L. profundum* and therefore believes that the original symmetry of that species and of the whole group of rugose corals, in so far as *L. profundum* is representative of it, is hexagonal, like the living corals. It is his conclusion, furthermore, that in the Rugosa the original hexagonal symmetry is subsequently modified and concealed by the development and introduction of septa in only four of the six original mesenteries, so that in later stages the symmetry appears to be tetrameral instead of hexagonal. Duerden therefore regards all the six original septa as primary, whereas Gordon believes that two of the six apparently original septa are secondary septa, which by acceleration have appeared almost contemporaneously with the primary ones, so that the original symmetry is not hexameral but tetrameral. To support this view, which he presents rather as a hypothesis than as a conclusion, Gordon adduces a number of facts (such as the asymmetric position of two of the six original septa) which are not without weight but which are rather discredited by some of the observations recorded here. He builds, in other words, partly on a resem-

[1] Nicholson, H. A., Manual of paleontology, 3d ed., vol. 1, p. 295, 1889.

blance, certainly rather striking, between Duerden's figures showing the arrangement of the septa in cross sections and the familiar diagram employed by textbook writers to show the development of the septa in the Tetracoralla, a diagram corresponding to the arrangement of the septal ridges on the outside of the corallum. This seems to me, however, a false analogy, not only (1) because the mutual relation of the septa as seen in cross sections and their development as shown by the septal ridges are two very different things intrinsically, but also (2) because the analogy appears only when the two diagrams are inversely arranged, so that the cardinal segment of the diagram showing development is compared with the counter segment of the section showing septal arrangement at a given stage, and vice versa. In so far then as Gordon's conclusions depend for support upon this analogy, it seems to me they fall to the ground. His hypothesis nevertheless is interesting and is sufficiently probable to deserve serious attention and further investigation.

As already pointed out, in the mature corallum not one of the septa (as described by Nicholson for Lophophyllum) nor two opposite ones (as described by Milne-Edwards and Haime for the same genus) are intrinsically united with the columella. By stereoplasmic deposits, however, not one septum only but several, and in some specimens all the septa, may be united with the columella, thus simulating, though perhaps only superficially, the genus Cyathaxonia. I have not seen a description of the structure of the columella in either authentic Lophophyllum or Cyathaxonia, but apparently the columella in the present form is not merely the enlargement of the end of one of the septa, except at a very early stage. The columella in *L. profundum* is very much enlarged as compared with the species studied by Nicholson. He did not find the primary and secondary septa well differentiated, whereas in *L. profundum* they are sharply and regularly differentiated. *L. profundum* certainly has more or less interseptal tissue, which is said to be entirely absent from Cyathaxonia, but, on the other hand, it does not appear to have the ample development of tabulæ and dissepiments shown by Nicholson. The present form exhibits marked tetrameral symmetry, as does also Lophophyllum, according to the descriptions, whereas Cyathaxonia is described as being radially symmetrical or undifferentiated.[1]

L. profundum therefore does not agree entirely with either genus as described, but it shows fewer lines of departure from Lophophyllum than from Cyathaxonia. Some specimens present enough of the appearance of Cyathaxonia, however, to suggest that species may have been referred to that genus which really belonged to Lophophyllum,

[1] Zittel, K. A. von, Textbook of paleontology, Am. ed., vol. 1, p. 74, 1900.

or possibly even that Lophophyllum and Cyathaxonia are essentially the same.

Not only, then, is the generic position of this form in some doubt, but its specific relations also are not entirely clear. It has been the practice to refer the columella-bearing corals of the Pennsylvanian to *Lophophyllum proliferum* McChesney, or, more recently, to *L. profundum*, McChesney's species being placed in the synonymy of the latter; and the Wewoka fossils are almost certainly specifically identical with many of these corals so referred.

L. profundum was based on an external mold of a calice from Flint Ridge, Ohio, in which the following characters were observed or inferred: The calice is subcircular and deep, with a strong, subelliptical columella. A septal fossula is present. The principal septa are rather strong and well developed, are 24 in number, and alternate with an equal number of smaller septa. They are said to be disposed near the columella in a subramified manner. The coral was inferred to be curved. The mold had a diameter of 18 millimeters and a depth of 15 millimeters.

So far as it goes this definition applies well to the form under consideration, to McChesney's *L. proliferum*, and to most of the corals which have been described and figured as *L. proliferum* or *L. profundum*. None of the descriptions, however, mentions all the characters which my specimens show—for example, the structure of the columella, its striated exterior, and the variation in the number of the septa that unite with it. It seems rather more probable that the same characters were present in the other corals but that they were not so well developed and were overlooked, for the descriptions agree in many other particulars. Consequently I am referring the form in hand to *L. profundum*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

LOPHOPHYLLUM PROFUNDUM var. RADICOSUM Girty.

Plate II, figures 7–9.

1911. *Lophophyllum profundum* var. *radicosum*. Girty, New York Acad. Sci. Annals, vol. 21, p. 122.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Associated with individuals having the character of *Lophophyllum profundum*, described above, occur other specimens, which differ strikingly in the profuse development of hollow, spiniform stolons. Correlated with this character we usually find a more rapid expansion, a more irregular growth, a rather straighter shape, and a thinner more knifelike pseudocolumella. The stolons, which are usually broken off close to the epitheca, disclosing their tubular structure, are especially developed in the lower portion of the corallum. It seems doubtful whether these structures served primarily for support, since they are found in specimens having an unusually broad and secure attachment and are absent from others in which the point of attachment is small and the anchorage apparently insecure.

The stolons vary from large and very numerous to small and very few, some specimens showing only one or two. In this way a transition appears between the two forms of *L. profundum* (which in their extreme expressions look very much unlike each other), so that a dividing line can hardly be drawn between them. The forms with more or less straight, irregular, rapidly expanding coralla grade on the one hand into forms with very abundant stolons and on the other into forms having the narrow, more or less curved, regular coralla of typical *profundum*. Few of the narrow, regular coralla, however, exhibit any development of the rootlike process.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Genus **HAPSOPHYLLUM** Simpson.

HAPSOPHYLLUM? sp.

Plate II, figure 10.

A few specimens, though presenting no appreciable difference on the outside, are distinguished from *Lophophyllum profundum*, the common coral in the Wewoka formation, by having, instead of the large central boss or pseudocolumella, a fovea or pit of about the same size and in the same place. Some specimens of *L. profundum* present much the same appearance through the breaking away of the pseudocolumella below the bottom of the calice, but the presence of this structure can be usually determined by sectioning. Another difference also seems to exist between these forms and *L. profundum*. All the specimens that can definitely be included in this group have only primary septa, but most specimens of *L. profundum* of the same size have secondary septa. The septa in most of the specimens examined number about 24, the smallest number counted being 21 and the largest 28. Interseptal tissue is developed sparingly about as in *L. profundum*.

The weathered specimen represented by my figure shows in the center of the calice a large subcircular depression connecting with a considerably narrower channel, the fossula, which leads down to the wall of the calice. The boundary of this depressed area is formed by the thickened and connate ends of the septa. A fracture section through another specimen having similar external features shows the median portion of the corallum filled in with stereoplasma, in which no definite columella can be distinguished. The number of specimens which it has been possible to examine is not large nor is their condition very favorable for study, but such as have been included in this group appear to have no columella. Nevertheless I am inclined to suspect that they may really be misleading examples of *L. profundum*, in spite of the strong resemblance to Hapsophyllum which some of them present. If these specimens really belong to Hapsophyllum they should have septa of the secondary order. Even in the few specimens provisionally included in this group that possess secondary septa these secondary septa are free, as in *L. profundum* and do not bend toward and unite with the primary septa in the manner characteristic of Hapsophyllum.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

TABULATA.

Family FAVOSITIDÆ.

Genus MICHELINIA De Koninck.

MICHELINIA EUGENEÆ White.

Plate II, figures 11, 11a.

1884. *Michelina Eugeneæ.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 119, pl. 23, figs. 14–16.
Coal Measures: Edwardsport, Knox County, and Eugene, Vermilion County, Ind.

1900. *Michelina eugeneæ.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 21, pl. 2, figs. 12, 12b.
Upper Coal Measures: Pomeroy, Wyandotte County, Kans.

A single specimen referred to this species may be described as irregularly hemispherical, but it has been, perhaps, somewhat compressed. The diameter and the maximum height are about 20 millimeters. The base is wedge-shaped, convex on one side and concave on the other. The point of attachment, represented by a broken surface, is small, but the concave side of the basal portion seems to have been in contact with though not attached to some other object. Both sides of the base are covered with a concentrically wrinkled epitheca. The walls are thin and the cells are irregularly polygonal. They are of unequal size, the larger ones having a diameter of 2.5 or even 3 millimeters. The surface of the cell walls is covered with small granules, which are obscurely arranged in longitudinal rows.

This form agrees closely with White's description, and if the single specimen obtained is representative the identification is probably correct.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

ECHINODERMATA.

CRINOIDEA.

Crinoidal remains are of rather common occurrence in the Wewoka formation. They consist mostly of stems and of dissociated plates. Entire crinoid heads are very rare. As usual, the stems are of more common occurrence than other portions of the organism and as they are abundant it seems desirable to give some brief account of them. Almost every specimen shows peculiarities in which it differs from others. For purposes of description, however, it seems necessary to make some rough division among them, although it is not conceived that these divisions of necessity have any scientific value or correspond to genera or species based on the diagnostic parts of the crinoid.

In external appearance the crinoid stems of the Wewoka formation fall into two general types. All are circular in cross section but in one type (group B) the segments have rounded instead of flat edges, so that the sutures are depressed and the stems have as a whole a more or less strongly annulated appearance. In the other type (group A) the segments have straight sides so that the stems are smoothly cylindrical and the sutures between adjacent segments are inconspicuous. This division into two groups, however, is not entirely satisfactory, because specimens occur which are not strongly annulated yet are not exactly smooth and cylindrical, presenting an appearance that may possibly be due to weathering and solution.

CRINOID STEMS (GROUP A).

In group A, which is by far the more abundant, the stems (Pl. III, figs. 1–6) differ greatly in size, ranging in diameter from about 2 to about 38 millimeters. Some of the smaller stems, to judge from their size and markings, may belong to *Hydreionocrinus patulus* or some of the other types represented in the collection by plates, but the larger stems are far too large for any heads that have been observed. In all except one specimen, to be mentioned later, the segments are of uniform height but their proportional thickness varies inversely to their diameter. In general they are very thin and discoidal. An extreme is presented by one specimen in which the segments are only 1.5 millimeters in thickness but have a diameter of 20 millimeters.

As a rule the median portion of the upper and lower sides of each disk-shaped segment is depressed, the elevated margin, which may be narrow or broad, being marked by regularly arranged radiating ridges, which of course articulate with corresponding markings on the contiguous segments. These ridges bifurcate once or even twice and new ones are introduced, so that the denticulation of the outer edge is finer than that of the inner. The depressed median portion is pierced by an axial canal having the shape of a cinquefoil, usually of large size. The relative dimensions of the parts differ greatly in different specimens.

Generally speaking, the nodes to which cirri were apparently attached are very small, few, and irregular. In some specimens, however, especially those of smaller size, the cirri were not only relatively but actually larger, and they manifest a tendency to be arranged in longitudinal rows. Where the joints of the cirri are large, their articulation may extend from one plate to an adjacent one.

Possibly several subdivisions of this group of stems might be recognized. One imperfect specimen is distinguished by having very thin and rather unequal segments with strongly serrated sutures. The diameter of this stem is 15 millimeters and the thicker segments are only 1 millimeter in thickness.

Another group might be made of the smaller stems which had large nodes for cirri. As already noted, the size of the ring and the shape of the axial canal in *Hydreionocrinus patulus* suggest that some of the smallest of these stems may belong with that species, but they may also be cirri of some of the larger stems. The five-rayed shape of the axial canal is less obvious in some specimens than in others; in the very small ones particularly it appears to be very nearly if not quite circular. This is true also of the basal disk of *H. patulus* and it is likewise true of the nodes for cirri on the sides of the large stems.

A third group might be constituted of the specimens to which the foregoing general description applies, without the exceptions noted.

Some segments of moderate size seem to have a large circular (instead of 5-rayed) axial canal without any depressed areas around it. If this is not an accidental character, these may constitute still a fourth group. None of these groups, however, has any sharp demarcation.

These stems served as the host or perhaps I might better say support or place of attachment for various organisms. The Bryozoan genera Stenopora and Fistulipora are especially numerous, most of the specimens collected being so attached. Occasionally also a Lophophyllum or a Crania or a Serpulopsis is found, though hardly as frequently as one would expect. Some of the stems and a few of the plates appear to have been affected by an organism which bored in them large, round, shallow holes, which are accompanied by an abnormal growth of the parts adjacent. The nature of this organism is not definitely known; its effects are more fully described under the title Sponge sp. A.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (stations 2006 and 2021); Coalgate quadrangle, Okla (station 7193).

CRINOID STEMS (GROUP B).

The stems (Pl. III, figs. 7–8a) of group B are much less common in the Wewoka formation than those of group A, from which they are distinguished by being annulated, each of the constituent segments being rounded from suture to suture. In detail they do not differ materially from those of group A, except that the axial canal is relatively smaller and the arms of the cinquefoil narrower. The periphery of each segment is marked by a row of granules, not very conspicuous in some specimens, and by occasional small nodes for cirri.

Stems having these characters may be further subdivided into two groups, in one of which the segments are of equal and in the other of distinctly unequal height. The inequality is more or less regular. Frequently two thin segments occur between two of greater height (but not of greater diameter), or more rarely three intermediate segments are found, the middle one being slightly larger. In some stems the annulation is less marked, and possibly a gradation may be noted to the smooth cylindrical form of group A.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2006 and 2021).

Family POTERIOCRINIDÆ.

Genus EUPACHYCRINUS Meek and Worthen.

EUPACHYCRINUS VERRUCOSUS White and St. John?

Plate III, figure 12.

1868. *Hydreionocrinus? verrucosus.* White and St. John, Chicago Acad. Sci. Trans., vol. 1, p. 117, fig. 1.
Upper Coal Measures: Western Iowa.

1872. *Eupachycrinus verrucosus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 150, figs. 3, 4.
Upper Coal Measures: Plattsmouth, Nebr.

1894. *Eupachycrinus verrucosus.* Keyes, Missouri Geol. Survey, vol. 4, p. 217, pl. 27, fig. 2.
Upper Coal Measures: Kansas City, Mo.

This species is represented in the collection by a few dissociated plates covered with large, strong tubercles, which differ in different plates or even on the same plate. These tubercles vary in outline from circular to elliptical or even to elongate and vermicular. On some plates they are much more regularly circular than on others, but probably on none are those of the more or less elongate type wholly lacking. They vary also in prominence but as a rule are strongly elevated, the circular ones standing out like short, blunt spines, some of which are even slightly undercut. They vary also in size, those on some plates being finer than those on others. They are rather closely arranged, usually less than their own diameter apart. For the most part they have no regular order, but in a few specimens an arrangement into rows is rather conspicuous. Both the spaces between the tubercles and the sides of the tubercles themselves are covered with fine but prominent granules of various sizes. The sides of the plates are not beveled, and indeed I judge that when in position the sutures would not be strongly depressed.

It may be that we have here more than a single species, but due allowance must be made for individual variation and for variation in sculpture normal to different plates of the same crinoid. At all events nothing certain can be determined on this point until it is possible to study specimens that have the parts in place.

Satisfactory identification of this form is impossible from the data at hand. Several species are more or less similar to it although, of course, a comparison can not be made of characters shown by the organism as a whole. This form resembles *E. tuberculatus* in the absence of beveled edges to the plates and a few specimens show a linear arrangement of the tubercles, but in the general lack of such arrangement, in the elongated instead of circular shape of many of the tubercles, in their close arrangement, and in the granulose surface they differ from that species.

Miller and Gurley compare their *E. magister* with *E. tuberculatus*, and perhaps the differences which they point out are sufficient. They do not, however, compare it with *E. verrucosus*, with which it seems to be still more closely related. I know of no very marked difference between my specimens and either of the species named, except that mine lack the beveling on the edges of the plates. The granulated surface of my specimens is especially suggestive of *E. verrucosus*. The size of some of the plates, however, indicates a larger crinoid than Meek's figure of *verrucosus* and one more the size of *E. tuberculatus*. The tuberculation is also on a larger scale in some of the specimens. Very similar differences exist when this form is compared with *E. magister* as described by Miller and Gurley.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (stations 2001 and 2004).

EUPACHYCRINUS sp.

Plate III, figure 11.

Under this title is included especially a single pentagonal basal plate which agrees with those called *E. verrucosus?* in not having beveled edges but differs in being rather smaller and in having the nodose elevations relatively coarser and connected with one another so as to form a labyrinthine pattern. It is not certain that the depressed areas between the elongated confluent nodes are granulose.

I know of no species of Eupachycrinus which has heavy vermicular markings comparable to these. A second smaller but otherwise rather similar basal has also come to hand. Mr. Springer writes me that the plates with the very large confluent nodes or wrinkles, if numerous enough to show constancy, might well be ranked as of a new species. Among a good many specimens of *verrucosus* from different localities showing considerable variation, he had observed none that went so far as this.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus **CROMYOCRINUS** Trautschold.

CROMYOCRINUS? sp.

Under this title are included three dissociated plates which possibly belong to a species of Cromyocrinus; the exact relationship is at present undeterminable.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus **POTERIOCRINUS** Miller.

POTERIOCRINUS? sp.

This form is represented by dissociated plates which at some localities are fairly abundant. It appears to have had a rather high calyx and is probably an undescribed species, but the data at hand are not adequate for a specific description. In generic position it is allied to both Poteriocrinus and Scaphiocrinus but is more like the former on account of its relatively short radial facets.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (stations 2006 and 2021); Coalgate quadrangle, Okla. (station 2004).

Genus **SCAPHIOCRINUS** Hall.

SCAPHIOCRINUS? sp.

A single plate in the collection has the usual broad radial facet of Scaphiocrinus. It may be compared with similar plates of *S. washburni* Beede from the Topeka limestone of Kansas.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus **DELOCRINUS** Miller and Gurley.

DELOCRINUS HEMISPHERICUS Shumard?

Plate III, figures 9, 9a.

1858. *Poteriocrinus hemisphericus.* Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 221. (Whole volume bears date of imprint, 1860.)
Coal Measures: Hinkston Creek, Boone County, and near Lexington, Mo.; headwaters of Verdigris River, and 9 miles southwest of Council Grove, Kans.

1872. *Scaphiocrinus? hemisphæricus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 147, pl. 5, figs. 1a, 1b; pl. 7, figs. 1a–c.
Upper Coal Measures: Nebraska City, Bennetts Mill, and Omaha, Nebr.
Coal Measures: Iowa, Kansas, Illinois.

1873. *Scaphiocrinus? hemisphericus.* Meek and Worthen, Illinois Geol. Survey, vol 5, p. 561, pl. 24, fig. 5.
Upper Coal Measures: Springfield and La Salle, Ill.

1890. *Delocrinus hemisphericus.* Miller and Gurley, Cincinnati Soc. Nat. Hist. Jour., vol. 13, p. 12, pl. 2, figs. 8–10.
Upper Coal Measures: Kansas City, Mo.

1890. *Delocrinus hemisphericus.* Miller and Gurley, Indiana Dept. Geology and Nat. Hist. Sixteenth Ann. Rept., for 1888, p. 335, pl. 2, figs. 8–10; p. 370, pl. 10, fig. 5. (Date of imprint, 1889.)
Upper Coal Measures; Kansas City, Mo.

1894. *Ceriocrinus hemisphericus.* Keyes, Missouri Geol. Survey, vol. 4, p. 220, pl. 28, figs. 2, 5.
Upper Coal Measures: Lexington, Columbia, and Kansas City, Mo.

1900. *Ceriocrinus hemisphericus.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 34, pl. 6, figs. 5, 5b.
Upper Coal Measures: Jefferson County, Kans.

1906. *Ceriocrinus hemisphericus.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 264.
Carboniferous: Louisville, Cedar Creek, and Nehawka, Nebr.

1906. *Scaphiocrinus hemisphericus.* Woodruff, Nebraska Geol., Survey, vol. 2, pt. 2, p. 264, pl. 7, fig. 6.
Carboniferous: Cedar Creek, Nebr.

This species is represented by a few loose plates and a fragment of a cup made up of four plates, more or less broken; one of them, fortunately, is the azygous plate, which is hexagonal, somewhat longer than wide, and has parallel sides, which are perpendicular to the base. The upper three sides form a truncated triangle. This plate is curved, so that this extremity is considerably interior to the edges of the radials, which are not known in their entirety but appear to have been strongly transverse and five-sided. The base of the pentagonal is long and in position uppermost. The upper surface of these plates is marked close to the outer edge by a rather deep groove, within which on either side is a short ridge, crenulated as is also the outer side of the groove. Another and shallower groove traverses the outer side of the plate close to its upper margin with an abrupt slit in the median portion. This groove likewise is crenulated.

The brachials, or the plates which from their configuration and sculpture appear to belong with the imperfect calyx described above, are so produced as to form a short blunt spine. The surface of the plates is marked by small, abruptly raised granules, which on the radials are more crowded toward the upper margin.

Mr. Frank Springer writes me that some of these plates may belong to an undescribed species with a higher calyx which occurs in the Florena shale member of the Garrison formation and in the Winfield limestone of Kansas, but that the others are probably correctly referred to the species named above.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2006, 2005?, and 2010?).

DELOCRINUS ? sp.

Plate III, figures 10–10b.

Here are subsumed a number of plates, chiefly radials and first brachials, which I had originally included with *Hydreionocrinus patulus* though with more or less doubt. The radials seemed to agree with those in the calyx of the described specimen of *H. patulus* and the first brachials also were referred to that species, because of a close agreement in their markings. Mr. Springer writes me, however, that aside from the single calyx taken as the type there is nothing which he would positively identify as of the genus Hydreionocrinus, and he thinks it is more probable that the specimens belong to Delocrinus.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001 and 2004).

Genus HYDREIONOCRINUS De Koninck.

HYDREIONOCRINUS PATULUS Girty.

Plate III, figures 13–13c.

1911. *Hydreionocrinus patulus.* Girty, New York Acad. Sci. Annals, vol. 21, p. 122. Wewoka formation: Wewoka quadrangle, Okla.

This species is based on a somewhat imperfect calyx, distinguished by its low convexity. The median portion of the under side is strongly concave and the height of the whole is but little greater than the thickness of the plates. These peculiarities may, however, have been somewhat enhanced by compression.

The general shape is pentagonal, with angular notches at the corners and a wider irregularity at the azygous angle. The plates themselves are thick and highly tumid on the outer side. They tend to recurve near the margins, so that the sutures are not so depressed as the general curvature of the surface if continued to the edges would make them. The plates near their margins tend to be rather regularly and finely crenulated and the infrabasals and adjacent portions of the basals are finely granulose. Unless lost through abrasion these markings do not extend to the other plates, but among the dissociated plates provisionally referred to this species are some that retain this feature.

The infrabasals form a small pentagon of which the radius of the scar of the stem occupies half the distance from the center to the side. The scar is small, crenulated about the circumference, and has a diminutive round axial canal. The basals are irregularly pentagonal, like a triangle with its basal angles truncated. That to the right of the azygous plates is slightly larger than the others and is not symmetrical.

The radials are seven-sided, twice as wide as they are high, the base of the heptagon being upward and very long. The two apical sides are also long and somewhat concave, while the two lateral sides are short. The two plates near the azygous group are asymmetric, and have the apical sides of unequal length. Just below the upper margin of each of the radials there is a short slitlike excavation. Above this, on the broad upper side of the plate, is a triangular depression defined by two elevations or ridges which also bend outward and extend along the outer margin of the upper surface. A somewhat similar triangular excavation marks the inner side of the upper edge of the thick plate.

The azygous basal is subquadrate, much longer than wide, being in reality seven-sided, with a relatively broad base. The sides are formed by a broken line of which the lower portion is much shorter than the upper. The upper side is also made by a broken line, the dextral part of which is long and oblique and the sinistral part short, merely truncating the angle which the other would otherwise make with the left side. This plate is therefore bounded below by the infrabasal, on the right and left sides by the basal and the radial, and on the upper side by the two other azygous plates. The second and third azygous plates are missing from the specimen as are also the brachials.

This species resembles *H. discoidalis* and *H. crassidiscus*. From the former it may be distinguished by its larger size, more convex plates, granulose surface, and the shape and arrangement of the azygous plates. The azygous basal in *H. patulus* is differently shaped, so that it is in contact at the right with the radial, thus separating the second azygous plate from the adjacent basal on that side.

The relationship is rather closer with *H. crassidiscus*, all the basals ("subradials") of which, however, are described as hexagonal, whereas those of *H. patulus* are five-sided except the azygous one, which is seven-sided. The azygous basal in *H. crassidiscus* does not reach the second basal, "as is usual in this genus." Furthermore, in the present species the second azygous plate intervenes between the first and the radial to the right.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

ECHINOIDEA.

Family ARCHÆOCIDARIDÆ.

Genus ECHINOCRINUS Agassiz.

ECHINOCRINUS aff. E. CRATIS White.[1]

Plate IV, figure 1.

Echinoids are represented in the Wewoka fauna by both spines and plates, but rather sparingly. One well-preserved plate is 7 millimeters long and 5 millimeters wide, and is thus somewhat elliptical, but its ends are very obtuse, so that it really has the form of a long

[1] Powell, J. W., Report on the geology of the eastern portion of the Uinta Mountains, U. S. Geol. and Geog. Survey Terr., 2d div., 1876, p. 109.

bilateral hexagon. It has an elevated rim which bears a row of rather large granules and is more prominent at the ends than at the sides. The mamelon is perforated, and is surrounded on the boss by a circular furrow. The boss itself is smooth and is mounted on a low platform in the scrobicule, the platform being defined by a shallow groove.

The foregoing description is based on an isolated plate from station 2005B, but fragmentary plates of the same general character have been found at station 2001, where they are associated with spines whose size and other characters indicate that they may belong to the same species. These spines are rather abundant, but all the specimens seen are fragmentary. The largest is 37 millimeters long and is incomplete at both ends. These spines have a long, rather slender shaft which gives off moderately large lateral spines. The arrangement of the lateral spines varies greatly, so that the most marked types might be referred to different species according to the criteria by which species are recognized in this group, but the specimens seem to show so much intergradation that separation into species would be practically impossible or at least unsatisfactory.

In one type the spines are given off alternately on opposite sides of the long shaft. They are strongly oblique and occur at long intervals. In other specimens the spines on opposite sides are close together, but are separated from the next group above or below by long intervals, as in the former type. In still other specimens the spines are much more closely arranged, and in others they are essentially opposite, but even more closely arranged. If they are developed opposite or nearly opposite, the shaft appears considerably enlarged and also compressed, a feature which is much less apparent if the spines are alternating. If the lateral spines are opposite, the shaft presents much the appearance of *E. triplex,* except that the lower side should be angulated, whereas the evidence at hand indicates that it is not.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (station 2005); Coalgate quadrangle, Okla. (stations 2001 and 7193).

ANNELIDA.

TUBICOLA.

Genus ENCHOSTOMA Miller.

ENCHOSTOMA SERPULIFORME Girty.

Plate XXVI, figures 8, 8a.

1911. *Enchostoma serpuliforme.* Girty, New York Acad. Sci. Annals, vol. 21, p. 123. Wewoka formation: Wewoka quadrangle, Okla.

Attached to a large Orthoceras which I have distinguished as *Orthoceras* sp. C are some slender tubular organisms seeming to belong to the genus Enchostoma. One, from which the present description is drawn, has a diameter of 1 millimeter or less and winds about on the Orthoceras to a length of almost 140 millimeters without appreciably increasing its diameter. Neither the initial point nor the true aperture appear to be shown. The cross section must have been nearly circular. The shell substance that has been preserved appears to be lamellose, phosphatic, of light-bluish color, and in places distinctly nacreous. For the most part, however, the shell appears to be missing and only the muddy infilling of the tube remains. This is of a rusty color and is partly covered with a dark limonitic coating. Where the entire organism as well as the true shell have been lost their place is represented by a groove. As the original test of the Orthoceras is now absent, this groove naturally occurs on the mold of the inside, and the explanation of the phenomenon is difficult. The septa seem to bar the assumption that the organism was originally attached to the inside of the Orthoceras. It may, however, have been attached to the outside or have been partly embedded in the shell, through the gradual solution of which these external bodies, insoluble under prevailing conditions, were brought into contact with the mud which filled the interior. This hypothesis, however, is unsatisfactory because the specimen is not bent but broken by the compression which it has suffered, showing that it was rigid when the force was applied.

The shape and phosphatic appearance of this organism are characteristic of Enchostoma, but such Enchostomas as I have heretofore seen are free and are larger than this form. The small size, sessile condition, and probably false appearance of having been partly embedded in the shell of its host are very suggestive of the organism which I have here called *Serpulopsis insita,* but the specimens of Serpulopsis show no evidence of having had phosphatic shells, and are also smaller and very much shorter. The relationship of this form and its position in the animal kingdom remain undetermined.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

ENCHOSTOMA sp.

Plate V, figure 6.

This form is fairly abundant at station 2001, where it occurs as narrow ribbon-like strips of whitish or bluish phosphatic material that pass over and through the concretionary lumps of mud and shells which is the mode of occurrence of the fossils at that locality. The specimens, though fairly abundant, are fragmentary, only short and imperfect pieces being exposed at one time. Much diversity is shown in the size and shape of these pieces, and it is difficult to determine how far this is due to fossilization and how far to differences in the stage of growth. For the present all the specimens are referred to one species. The widest are 5 millimeters across, and on those which are best preserved it is possible to see that two bands of material, thicker and stiffer than the rest, originally ran up opposite sides of the tube. Some of these bands have sharply defined boundaries and resist compression. Thus, if the organism lies symmetrically in the bedding the cross section is elliptical in outline, the ends of the ellipse being thickened and rigid and the much broader sides flattened and wrinkled in such a way as to show that they were flexible. The demarcation between the sides and the ends is defined by a groove. In some specimens the sides are marked by regular transverse striæ.

It is evident that by the crumpling up of the thin sides or by the tearing away of the stiff ends, much diversity of width and of general appearance might be produced, but certain appearances can hardly be accounted for in this way. Thus, some specimens are strongly elliptical in section, but the sides do not appear to be membranous nor are the ends conspicuously thickened. Still others are nearly circular in section, a fact that suggests a uniform thickness of the test—a suggestion that observation seems not to contradict—and even if compressed would still be appreciably smaller than the rest. The small specimens with rounded section possibly belong to *E. serpuliforme*, and may be specifically distinct from the large specimens with membranous sides, or they may be only immature forms of the same species, but if so the organism must have been extremely long for the size of the tube. These different forms might be regarded as distinct species were it not that a few specimens seem to show a transition from the first type to the second, or from the second to the third. The significance of this is not apparent to me. I may add that some of the narrow specimens lie in the rock in such a way as to suggest that they branched from the broad ones. From the evidence at hand this appearance can be explained as produced either by a drifting of specimens over one another or by a tearing away of the lateral connecting tissue so as to leave the stiff sides projecting. This form is of the type of *E. bicarinatus*, but the larger pieces are much broader.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Genus SERPULOPSIS Girty.

1911. Serpulopsis. Girty, New York Acad. Sci. Annals, vol. 21, p. 124.

This name is introduced for some small tubular organisms which enlarge very gradually and many of which are much contorted during part of their growth. They have the habit of attaching themselves to other organisms and are more or less embedded in the shell of the host, keeping near the surface, but are perhaps as seldom completely superficial as they are completely embedded.

I can scarcely doubt that the fossils on which this genus is founded belong to White's *Serpula insita*, which, consequently, is taken as the type.

Serpulopsis is distinguished from Serpula by its burrowing habit, which is in fact abnormal for the annelids. Even if the excavations alone and not the tubes which ordinarily occupy them were known, it would be impossible to refer these structures to the boring sponges, which they somewhat suggest, because of their strictly superficial, linear, and not inosculating character. In some respects they suggest Rhopalonaria among the Bryozoa, but, though specimens occur together in considerable numbers, they appear to form groups of independent individuals and not colonies; nor is there any evidence that the individual tubes were composite. On the whole, therefore, it seems more probable that this fossil was an abnormal type of annelid.

Type species.—Serpulopsis insita.

SERPULOPSIS INSITA White.

Plate V, figures 7, 8; Plate VI, figure 13.

878. *Serpula Insita.* White, Acad. Nat. Sci. Philadelphia Proc., p. 37.
Coal Measures: Newport, Vermilion County, Ind.

1880. *Serpula insita.* White, U. S. Geol. and Geog. Survey Terr. (Extract Twelfth Ann. Rept., for 1878), Contrib. Inv. Pal., No. 8, p. 171, pl. 42, fig. 8a.
Coal Measures: Newport, Vermilion County, Ind.

1883. *Serpula insita.* White, U. S. Geol. and Geog. Survey Terr. (Extract Twelfth Ann. Rept., for 1878), pt. 1, p. 171, pl. 42, fig. 8a.
Coal Measures: Newport, Vermilion County, Ind.

As described by White, this organism consists of slender tubes attached to other fossils. His very brief description covers about all that may fairly be said of it. He characterizes it as minute, sessile or free, tortuous, and cylindrical. My specimens show considerable variation in point of size, and of course the initial portion of each individual is smaller than the distal portion.

S. insita has not been described or figured since it was first established, probably by neglect rather than because of the rarity of the organisms themselves. At all events, they are extremely abundant in the Wewoka formation. Perhaps from the nature of the occurrence of the fossils in this formation only sessile or attached examples have been observed, but it is probably no great exaggeration to say that 50 per cent of the Wewoka fossils have one or more of these small contorted tubes adhering to them, and some are literally covered with them.

After careful investigation I am including under *S. insita* a class of fossils which at first seemed to show very different affinities. I refer to certain fine channelings in the tests of corals and brachiopods. When I first discovered these I took them to be the product of some boring Bryozoa of the nature of Rhopalonaria, but that they could not be placed with Rhopalonaria itself was proved by the fact that the excavations failed to show the characteristic enlargements. The organism which produced them must have had a regularly tubular shape instead of being composed of zoœcia connected by stolons. On further investigation some specimens were found in which these excavations were in part occupied by tubes of *S. insita* and were in part vacant, a certain portion of the organism having been broken away. This helped to explain also an observation which I had made on *S. insita* itself without, however, grasping its significance, namely, that many of the tubes, instead of rising above the surface of the shell to which they were attached, to a height corresponding to their width, were nearly flush with its surface, as if they had been flattened or crushed. By cutting into such specimens I was able to assure myself that a portion of the bulk lay below the surface of the host.

These molds extend along the surface, varying somewhat in depth but being almost always open on the upper side, though rarely and for short distances the shell of the host passes above and incloses them. They are generally almost straight or slightly curved and some appear to bifurcate. Bifurcation has not been observed in the tubes themselves and I do not know how to explain it in the excavations. It is true, however, that some of the tubes are so laced together that they cross one another. Some apparent transgressions may in fact be bifurcations, or, on the other hand, some apparent bifurcations may be due to two tubes lying across one another. It is strange also that the excavations do not show the highly contorted shape of some of the tubes, though this may be explained by the fact that the excavations from which the tubes have broken out are much less numerous than those in which the tubes still remain and that probably the tubes broke out more readily from a straight excavation than from a contorted one.

Although it is possible that these excavations were made by two distinct organisms whose traces look very much alike, it seems certain that they were made by an organism that secreted a tube indistinguishable from *S. insita* and it appears probable to me that all the tubes and excavations were really produced by a single type of animal.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193); and most of the other localities where fossils have been obtained.

Family CONULARIIDÆ.

Genus CONULARIA Miller.

CONULARIA CRUSTULA White.

Plate V, figures 4, 5.

1880. *Conularia crustula.* White, U. S. Geol. and Geog. Survey Terr. (Extract Twelfth Ann. Rept., for 1878), Contrib. Inv. Pal., p. 170, pl. 42, fig. 4a.
Coal Measures: Kansas City, Mo.; near Taos, N. Mex.

1881. *Conularia crustula.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 3, Supp., Appendix, p. xxviii, pl. 3, figs. 4a, 4b.
Carboniferous: Near Taos, N. Mex.

1883. *Conularia crustula.* White, U. S. Geol. and Geog. Survey Terr. Twelfth Ann. Rept., for 1878, pt. 1, p. 170, pl. 42, fig. 4a.
Coal Measures: Kansas City, Mo.; near Taos, N. Mex.

1895. *Conularia crustula.* Keyes, Missouri Geol. Survey, vol. 5, p. 219, pl. 35, fig. 2. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1896. *Conularia* conf. *crustula.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 41.
Coal Measures: Scott County, Ark.

1897. *Conularia* cf. *crustula.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab., No. 9, p. 41.
Coal Measures: Scott County, Ark.

1903. *Conularia crustula.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 332.
Hermosa formation: San Juan region, Colo.
Grand River region, Colo.

This species is relatively abundant in the Wewoka formation. All the specimens seem to be small, the largest observed having a diameter of about 16 millimeters, but some forms from Colorado that have been tentatively referred to this species are considerably larger and more coarsely ornamented. The shape is regularly conical, the sides are nearly flat, and the cross section is square. The angles are strongly indented and a rib runs longitudinally down the middle of each side. This rib is more projecting on the interior than on the exterior and on exfoliated specimens it may appear as a groove, as described by White, but in the most perfect examples it appears as a narrow, slightly elevated ridge. The transverse costæ are rather coarse, about 8 (7 to 9) in 5 millimeters, but they are, of course, more closely arranged toward the apex. They are strongly convex outwardly and are evidently made up of 8 more or less independent sections, 2 to each face. These tend to meet at the four angles and down the four median lines, but are occasionally alternating. They generally die out at the angles and are exceptionally replaced by sharp striæ which form V-shaped depressions one above another. The costæ are subangular and the interspaces more or less flat. If they are well preserved or preserved as internal molds it is possible to observe that the crest is marked by a row of closely arranged nodes. Most specimens bear scarcely any trace of this feature, which was not retained on the typical examples, but was noted by White in others from New Mexico, that he believed to belong to the same species. The concave spaces between the costæ are marked by incremental lines and in some specimens those near the aperture are marked by more or less regular oblique wrinkles.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

CONULARIA CRUSTULA var. HOLDENVILLÆ Girty.

Plate V, figures 1-3.

1911. *Conularia crustula* var. *holdenvillæ*. Girty, New York Acad. Sci. Annals, vol. 21, p. 125.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

A few specimens from the Wewoka agree in a general way with *Conularia crustula* but differ from it in having much finer sculpture. Unlike typical *crustula*, which apparently had an unusually thick rigid test, these specimens are also more or less compressed and distorted. The costæ number about 25 in a linear distance of 5 millimeters and are thus much more closely spaced than in the typical form.

Among the specimens examined this form is readily distinguished by its sculpture, the difference being so great that it seems desirable to discriminate it as a new variety if not as a new species. It may possibly be a young stage of *C. rœperi*, the only other Pennsylvanian Conularia which has been described, although it tapers more rapidly than *C. rœperi*, which has nearly parallel sides.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (station 2006); Coalgate quadrangle, Okla. (station 2004).

MOLLUSCOIDEA.

BRYOZOA.

Family FISTULIPORIDÆ.

Genus FISTULIPORA McCoy.

FISTULIPORA CARBONARIA Ulrich.

Plate XXVI, figure 5.

1884. *Fistulipora carbonaria*. Ulrich, Cincinnati Soc. Nat. Hist. Jour., vol. 7, p. 45, pl. 3, figs. 1, 1a.
Upper Coal Measures: Kansas City, Mo.

1895. *Fistulipora carbonaria*. Keyes, Missouri Geol. Survey, vol. 5, p. 16. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1903. *Fistulipora carbonaria*. Girty, U. S. Geol. Survey Prof. Paper 16, p. 334.
Hermosa formation: San Juan region, Colo.

1903. *Fistulipora carbonaria*. Condra, Nebraska Geol. Survey, vol. 2, pt. 1, p. 32, pl. 1, figs. 6-10.
Coal Measures: Kansas City, Mo.; Manhattan, Kans.; and many localities in Nebraska.

Specimens of *Fistulipora carbonaria* are more abundant than the Stenoporas with which they are associated but, for much the same reason—the small size of the colonies and their imperfect preservation—they have not been studied in thin section. The colonies have an explanate, incrusting mode of growth, and the largest measures 30 millimeters in longest diameter. Most of the individuals are very thin, less than 1 millimeter in height, but one has a thickness in one place of almost 3 millimeters.

In a young colony there are conspicuous maculæ formed by noncelluliferous, somewhat elongated spots, from which the cells are directed obliquely outward in a radial direction. The maculæ tend to be arranged in alternating rows, those in the same row being about 6 millimeters apart, though the rows themselves are rather more closely arranged. The young cells have elevated peristomes which project much more on one side than on the other and give the zoœcia an oblique and hooded appearance. The zoœcia are nearly in contact and the spaces between, as well as the macular areas, are granulose.

In the best-preserved mature specimen the zoœcia are more or less circular and have a diameter of about 0.3 millimeter, or more in those near the maculæ. The peristome is sharply and equally elevated, the hooded appearance being absent, possibly through erosion. For the same reason, perhaps, the maculæ are less conspicuous. The lunarium is distinct. The cells are occasionally in contact but usually separated by intervals of less than their own diameter. In slightly worn specimens the intervals are filled by vesicles, usually in a single series. Diaphragms are fairly abundant in the mature zoœcia, though in the thin colonies probably none at all are developed.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (station 7193).

FISTULIPORA CARBONARIA var. NEBRASKENSIS Condra.

Plate XXVI, figures 6, 7.

1902. *Fistulipora carbonaria* var. *nebrascensis*. Condra, Am. Geologist, vol. 30, p. 337, pl. 18, figs. 1, 2.
Coal Measures: Louisville, Nebr.

1903. *Fistulipora carbonaria-nebrascensis*. Condra, Nebraska Geol. Survey, vol. 2, pt. 1, p. 33, pl. 2, figs. 1, 2.
Coal Measures: Louisville, Nebr.

Associated with the zoaria referred to *F. carbonaria* are others, which are distinguished by having the zoœcia conspicuously smaller and more widely separated. They stand about their own diameter apart and measure about 0.2 millimeter across. The lunarium is conspicuous.

Neither for the present form nor for that referred to *F. carbonaria* do my measurements quite agree with Condra's, who gives the zoœcia of *F. carbonaria* a diameter of 0.35 millimeter and those of the variety *nebraskensis* a diameter of 0.28 millimeter. My measurements for both are rather smaller, but it should be remembered that they were not made from thin sections, whereas Condra's probably were.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Family BATOSTOMELLIDÆ.

Genus STENOPORA Lonsdale.

STENOPORA aff. S. DISTANS Condra.[1]

This species is represented by two specimens, one of which especially is small and fragmentary. Both are incrusting on crinoid stems and have a very explanate growth, their thickness being but 1 millimeter or a little more. The surface is marked by maculæ and low monticules. The walls are much thickened above, so that the zoœcial apertures are subcircular. The tops of the walls appear to be finely granulose and large acanthopores occur at the angles of the cells. When viewed longitudinally the walls are seen to be strongly annulated. The zoœcia are erect for most of their length, the outer portion being intersected by a few diaphragms. Some 8 or 9 apertures occur in 3 millimeters.

Nine species of Stenopora have been described from the American Pennsylvanian rocks, most of which have a ramose mode of growth. *Stenopora carbonaria* and its two varieties form large branches (10 to 15 millimeters in diameter), whereas *S. ohioensis*, *S. polyspinosa*, and *S. spissa* have small branches (4 to 8 millimeters in diameter). To this group probably belongs also *S. spinulosa*, which is described as incrusting, but from which cylindrical stems, 2 millimeters in diameter, are said to proceed. This species would appear to be merely the basal expansion of one of the ramose group. *S. spissa*, however, as shown by the sections illustrated, is suggestive rather of a Lioclema than of a Stenopora.

Of the two remaining species, *S. distans* is described as incrusting and *S. heteropora* as massive, but as *heteropora* is said and is shown by the illustrations to have short zoœcial tubes (3 millimeters long) of the same length as *S. distans*, the reason for this distinction is not apparent. The Wewoka form, therefore, appears to be allied to both of the species from Nebraska, though it is even more explanate in its manner of growth; but I have not satisfactorily determined the degree of relationship by means of thin sections, both because my material is scanty and because it has undergone replacement, so that it does not yield the best results under the microscope.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Family RHABDOMESIDÆ.

Genus RHOMBOPORA Meek.

RHOMBOPORA LEPIDODENDROIDES Meek?

1866. *Stenopora columnaris*. Geinitz (pars), Carb. und Dyas in Nebraska, p. 66. (Not Schlotheim, 1813.)
Upper Coal Measures: Nebraska City, Bennetts Mill, and Wyoming, Nebr.

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[1] Am. Geologist, vol. 30, p. 341, pl. 20, figs. 3–5.

1872. *Rhombopora lepidodendroides.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 141, pl. 7, figs. 2a–f.
Upper Coal Measures: Nebraska City, Bennetts Mill, Wyoming, Rock Bluff, and Plattsmouth, Nebr.; Kansas; Iowa; Missouri; Illinois.
1877. *Rhombipora lepidodendroides.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, pt. 1, p. 99, pl. 6, figs. 5a–d.
Carboniferous: West face of Oquirrh Range, near "E. T. City," Utah, and at confluence of White Mountain and Black rivers, Ariz.
1884. *Rhombopora lepidodendroidea.* Ulrich, Cincinnati Soc. Nat. Hist. Jour., vol. 7, p. 27, pl. 1, figs. 1–1b.
Upper Coal Measures: Kansas City, Mo.; Nebraska City and Wyoming, Nebr.
1887. *Rhombopora lepidodendroidea.* Foerste, Denison Univ. Sci. Lab. Bull., vol. 2, p. 73, pl. 7, figs. 3a, 3b.
Coal Measures: Flint Ridge and Bald Hill, Ohio.
1887. *Rhombopora* ———. Foerste, idem, p. 74, pl. 7, figs. 5a–c.
Coal Measures: Flint Ridge, Ohio.
1888. *Rhombopora lepidodendroides.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 225. (Date of imprint, 1899.)
Lower Coal Measures: Des Moines, Iowa.
1895. *Rhombopora lepidodendroides.* Keyes, Missouri Geol. Survey, vol. 5, p. 35, pl. 33, figs. 4a, 4b. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.
1896. *Rhombopora lepidodendroides.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 237.
Upper Coal Measures: Poteau Mountain, Okla.
1897. *Rhombopora lepidodendroides.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab., No. 9, p. 27.
Upper Coal Measures: Poteau Mountain, Okla.
1903. *Rhombopora lepidodendroides.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 341.
Molas and Hermosa formations: San Juan region, Colo.
Weber formation: Leadville district, Colo.
Carboniferous: Grand River and Uinta Mountain regions, Colo.
1903. *Rhombopora lepidodendroides.* Condra, Nebraska Geol. Survey, vol. 2, pt. 1, p. 99, pl. 6, figs. 2–4; pl. 7, figs. 1–12.
Coal Measures: Nebraska (20 localities).
Permian: Blue Springs and Wymore, Nebr.
1903. *Rhombopora lepidodendroides.* Condra, Am. Geologist, vol. 31, p. 22, pl. 2.
Permian: Numerous localities in Nebraska.
Permian: Kansas.
1906. *Rhombopora lepidodendroides.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, pl. 9, figs. 2–4.
Carboniferous: Nebraska.
1908. *Rhombopora* aff. *R. lepidodendroides.* Girty, U. S. Geol. Survey Prof. Paper 58, p. 153, pl. 31, fig. 17.
Delaware Mountain formation: Mountains northwest of Marathon, Tex.

This species is represented by two small fragments, the largest of which has a length of 7 millimeters and a diameter of 1 millimeter. The cells are regularly arranged in oblique rows and a relatively large spine is situated between each couple longitudinally.

In as far as it goes this agrees reasonably well with *R. lepidodendroides,* but in view of the unsatisfactory status of that species and the scanty material from the Wewoka formation it does not seem advisable to attempt final identification.

I am also provisionally including here what appears to be a basal expansion of the same form. Its mode of growth is incrusting and, for a distance of 14 millimeters at the longest point, it completely covers a crinoid stem having a diameter of 3½ millimeters. The thickness of the zoarium is slight. Small cells (mesopores?) are rather sparingly distributed over it, but there are also maculæ caused by assemblages of a number of such mesopores. Monticules are also developed. At one point the zoarium was produced into a slender branch (now broken off all but the base) which appears to have had the character of the stems provisionally identified as *R. lepidodendroides*. The walls are rather thick and their edges are covered with fine granules, some of the larger ones being at the ends of the slightly elongated cells. Instead of the large granule a minute depression resembling a mesopore sometimes appears at this point. Some of the maculæ appear to consist of these granules or of the minute depressions, but others are composed of larger mesopores.

It is not probable that all the works cited belong in the synonymy of Meek's species, and I can not but suspect that some of them include more than a single species under the title.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Family PHYLLOPORINIDÆ.

Genus CHAINODICTYON Foerste.

CHAINODICTYON LAXUM Foerste?

1887. *Chainodictyon laxum.* Foerste, Denison Univ. Sci. Lab. Bull., vol. 2, p. 81, pl. 7, figs. 8a–c.
Coal Measures: Flint Ridge, Ohio.

1887. *Chainodictyon laxum.* Ulrich, idem, p. 87.
Coal Measures: Seville, Ill.

1888. *Chainodictyon laxum.* Foerste, idem, vol. 3, p. 135.

1903. *Chainodictyon laxum.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 337.
Hermosa formation: San Juan region, Colo.

This interesting species is represented by a single ill-preserved fragment, measuring approximately 9 millimeters in diameter. The character of neither surface is shown. The branches are about 5 millimeters in diameter, but expand toward the points of anastomosis. They form a rather regular network, with elliptical to subcircular openings which have a length of about 2 millimeters and a width of about 1½ millimeters. The zoœcial tubes are short and occur in three or four longitudinal rows.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

BRACHIOPODA.

Family LINGULIDÆ.

Genus LINGULA Bruguière.

LINGULA CARBONARIA Shumard?

1858. *Lingula carbonaria.* Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 215.
Coal Measures: Clark County, Mo.

1873. *Lingula mytiloides?* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 572, pl. 25, fig. 2.
Coal Measures: Illinois.

1899. *Lingula mytiloides?* Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 575.
Upper Coal Measures: Atoka quadrangle, Hartshorne, Okla.; roof shale of the Grady or Hartshorne coal.

1903. *Lingula carbonaria.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 342.
Weber formation: Leadville district, Colo.

Shumard described this species without figuring it. Later Meek and Worthen figured a shell from Illinois which they doubtfully identified with the English form *Lingula mytiloides.* I believe, however, that their form is probably *L. carbonaria* of Shumard and I am provisionally employing Meek's figures to supplement Shumard's description.

The material under consideration consists of two specimens from Oklahoma in an imperfect state of preservation. So far as can be observed both have a regular, elongate-ovate shape. The specimen from station 7189 is of large size, having a length of 18 millimeters, almost the same size and very nearly the same proportions as the largest of Meek and Worthen's figures, which may be an enlargement of one of their smaller illustrations. The surface is not well shown, but appears to be nearly smooth or obscurely striated.

The second specimen (from station 7195) appears to have been somewhat smaller. It is very imperfect but has the surface well preserved, showing very fine, closely arranged, raised lines, with much broader and flat interspaces. This sculpture, which is of microscopic proportions, is less like what I have reason to believe is found on typical *L. carbonaria* (from Illinois) than that on the specimen from station 7189.

These shells are too poorly preserved for satisfactory description or identification, but it is at least certain that they belong to an altogether different group from *Lingulipora nebraskensis.* It is possible also that they may not represent the same species, but their condition does not seem to warrant separating them. To some extent the sculpture of the specimen from station 7195 suggests a distinction from the other.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

Genus LINGULIPORA Girty.

LINGULIPORA NEBRASKENSIS Meek.

Plate VI, figures 11, 11a.

1872. *Lingula Scotica* var. *Nebrascensis*. Meek, U. S. Geol. Survey Nebraska Final Rept., p. 158, pl. 8, figs. 3a, 3b.
Upper Coal Measures: Nebraska City, Nebr.
1889. *Lingula nebraskensis*. Miller, North American geology and paleontology, p. 350.
1897. *Glossina nebraskensis*. Schuchert, U. S. Geol. Survey Bull. 87, p. 224.

This rare species is represented in our collection by some half dozen specimens, each from a different locality and all more or less fragmentary. They are characterized by their broadly cuneate shape and coarse concentric sculpture. The most perfect specimen is only a little longer than wide. The sides and front are gently convex and the anterolateral angles are abruptly rounded. The greatest width is situated not far from the anterior margin. The convexity is low.

The sculpture consists of regularly arranged, abruptly elevated, concentric liræ, which leave between them relatively broad, flat interspaces. The interspaces themselves are rather finely and regularly striated.

The shell structure is finely punctate.

This form is in very close agreement with *L. scotica* var. *nebraskensis* of Meek, differing only in being slightly larger and slightly more transverse, although it is not certain that either difference is constant. I can not feel much doubt that the two forms belong to the same species.

By reason of its punctate shell this species should be placed with the group for which I introduced the subgeneric name Lingulipora, but its shape is characteristic of the group for which Glossina has been employed. Which classification should be adopted is therefore open to some argument. As there are both punctate and impunctate (?) Glossinas and punctate and impunctate Lingulas, it might be practical to employ both fundamenta divisionis and thus have four groups. It seems to me, however, that the character of the shell structure is a more fundamental difference and one more practicable of application than the shape, of which all gradations exist, and I am therefore using it to the exclusion of the other as a taxonomic feature.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (station 2004).

Family DISCINIDÆ.

Genus RŒMERELLA Hall and Clarke.

RŒMERELLA PATULA Girty.

Plate VI, figures 1–9; Plate X, figures 14a, 14b.

1911. *Rœmerella patula.* Girty, New York Acad. Sci. Annals, vol. 21, p. 125. Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell rather small for the genus, rarely exceeding 18 millimeters in diameter, though one specimen reaches nearly 30 millimeters. Shape slightly oval in some specimens, apparently circular in others.

Convexity of dorsal valve low, regular. Apex small, slightly though conspicuously eccentric, situated about two-thirds of a radius from the posterior margin. The outline from the apex to the front is slightly curved, so that the shape is not truly conical, being somewhat inflated in the apical portion.

The curvature of the ventral valve is usually compound, more or less strongly convex over the posterior portion and more or less strongly concave at the front and sides. The prominent portion projects above the reflexed rim. The point of highest convexity is usually well marked and is diametrically opposite to that of the dorsal valve, or about two-thirds of a radius forward from the posterior margin. The pedicle fissure is situated on the slope posterior to the point of greatest elevation. It is a conspicuous feature, rather long and narrow, with strongly introverted sides. It extends in mature shells from the point of greatest elevation halfway to the posterior margin and the characteristic sculpture passes around it without interruption.

The sculpture, as usual, consists of narrow, sharply raised concentric liræ with considerably wider flattened interspaces which are also finely striated. The liræ are somewhat irregular and are probably stronger and more persistent on the ventral than on the dorsal valve, on which they are often evanescent about the margins for a greater or less distance. They vary considerably in different specimens, being more closely arranged in some than in others; from 9 to 11 occur in 3 millimeters. They also vary on the same specimen in proportion to their distance from the apex, and are more crowded on the posterior than on the anterior side; consequently the measurement given above is a relative one, representing the condition toward the front in well-grown specimens. Exfoliation obliterates much of the concentric marking and instead often brings to view fine radial lines and striæ, probably due to setæ which projected from the margin of the shell.

On the interior the dorsal valve has a short septum passing longitudinally through the apex, and extending farther on the anterior than on the posterior side of it. There are also two symmetrical ridges, straight, parallel, and close together for some distance anterior to the apex and rapidly diverging and somewhat curved near it so as partly to surround it. Between the straight extended anterior portion of these arms there is a median groove which extends backward and graduates into the septum, which has depressed sides. The curved armlike markings probably represent the boundary of a line of muscular attachment. In one specimen these lines, near the apex, distinctly expand into oval areas, one on each side, each of which is separated by an oblique line of division into two scars. These areas, without much question, are the loci of pairs of muscles.

The internal markings of the dorsal valve described above are conspicuous on most of the specimens examined, many of which are preserved as internal molds. The markings differ in detail in different specimens. This peculiar structure seems to be identical with that on which Hall and Clarke based the subgenus Rœmerella, and though there may be a little doubt as to its subgeneric value, it serves, together with the configuration, readily to distinguish this form from other Pennsylvanian discinoids. Some specimens, however, especially those that are incompletely exfoliated, fail to show this structure.

Rœmerella patula is rather abundant in the Wewoka formation, most of the specimens occurring as dissociated valves in small concretions. Occasionally, however, the two valves are found in conjunction, though usually they are more or less displaced.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2004 and 7193).

RŒMERELLA ? sp.

Plate VI, figures 10, 10a.

A few dorsal valves associated with *R. patula* are distinguished by being much more strongly convex. This difference is perhaps somewhat exaggerated by the flattening which many specimens of *R. meniscus* have suffered, as indicated by radiating cracks around the margin. Correlated with the greater height are other differences, all the examples observed being of small size and having the apex more marginal as well as more elevated. A ventral valve belonging to one specimen is less convex than in *R. patula*, being, in fact, flat, or even concave.

These specimens show a median ridge or septum but, so far as observed, no armlike lateral ridges. It is somewhat uncertain, therefore, whether they belong with Rœmerella or with Lingulidiscina, the evidence afforded by the four specimens thus far obtained not being conclusive. I am also in doubt as to whether they should be considered a variety of *R. patula* or a distinct species.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (stations 2001 and 2004).

Family CRANIIDÆ.

Genus CRANIA Retzius.

CRANIA MODESTA White and St. John.

Plate VI, figures 12-14.

1868. *Crania modesta.* White and St. John, Chicago Acad. Sci. Trans., vol. 1, p. 118.
Upper Coal Measures: Fremont County, Iowa.

1882. *Crania carbonaria.* Whitfield, New York Acad. Sci. Annals, vol. 2, p. 229.
Coal Measures: Carbon Hill, Hocking County, Ohio.

1884. *Crania modesta.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 121, pl. 35, fig. 9; pl. 36, fig. 5.
Coal Measures: Eugene and Newport, Vermilion County, and Merom, Sullivan County, Ind.

1891. *Crania carbonaria.* Whitfield, New York Acad. Sci. Annals, vol. 5, p. 599, pl. 15, figs. 11, 12.
Coal Measures: Carbon Hill, Hocking County, Ohio.

1895. *Crania carbonaria.* Whitfield, Ohio Geol. Survey Rept., vol. 7, p. 484, pl. 11, figs. 11, 12. (Date of imprint, 1893.)
Coal Measures: Carbon Hill, Hocking County, Ohio.

1900. *Crania modesta.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 57, pl. 8, fig. 4.
Upper Coal Measures: Kansas City, Eudora, Grand Summit, Kans.

1901. *Crania modesta.* Rowley, in Greene, Contrib. Indiana Paleontology, pt. 7, p. 60, pl. 21, figs. 23-24.
Upper Coal Measures: Hooser, Kans.

This species is rather rare in the Wewoka formation, but where it occurs at all it seems to be abundant; that is, each host carries two or more individuals. Most of the specimens observed are lower valves and are attached to shells of *Composita subtilita* and *Lophophyllum profundum.* In shape they are subcircular or subpolygonal with diameters up to 12 millimeters, but tend more or less strongly to contract posteriorly and to have that portion of their outline somewhat rectilinear. The shell substance is extremely tenuous, except for the muscle scars and a thickened rim outlining the specimen. The posterior adductors are large and situated on elevated bosses. There is also a subcentral elevation, which is probably the locus of the central adductors. Far from showing traces of two distinct muscles, this elevation is in many specimens more or less pointed and without traces of muscular attachment; in fact, it looks so much like the apex of a conical upper valve as to suggest that we really have here two very thin valves pressed one upon the other. In some specimens, however, this central elevation is bipartite, and it should probably be interpreted as representing the site of the confluent central adductors.

The surface is smooth except for more or less obscure concentric irregularities, some of which on some specimens are sublamellose. In specimens attached to rugose corals the costæ of the host are clearly expressed on the parasitic form.

There can be little doubt that this is the same shell that White identified in Indiana as *Crania robusta.* His specimens, like these, were ventral valves, whereas the type shell was a dorsal valve.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Family STROPHOMENIDÆ.

Genus DERBYA Waagen.

DERBYA CRASSA Meek and Hayden.

Plate VII, figures 1–1c.

1852. *Orthis umbraculum?* Hall, Stansbury's Expl. and Survey Great Salt Lake of Utah, p. 412, pl. 3, fig. 6. (Another edition was printed in Washington with the imprint date 1853, and a third, printed like the first in Philadelphia, bears the imprint 1855. The pagination is the same in all.)
Carboniferous: Missouri River, above Fort Leavenworth, Kans.

1852. *Orthis umbraculum?* Owen, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, pl. 5, fig. 11.
Carboniferous: Missouri River, near mouth of Keg Creek and at Council Bluffs, Iowa.

1852. *Orthis arachnoidea.* Roemer, Kreid. von Texas, p. 89, pl. 11, figs. 9a, 9b.
Carboniferous: San Saba Valley, Tex.

?1857. *Orthis arachnoidea.* Hall, United States and Mexican Boundary Survey Rept., vol. 1, pl. 20, fig. 3.

1858. *Orthisina crassa.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 261.
Coal Measures: Leavenworth, Kans.

?1858. *Orthis crenistria.* Marcou, Geology of North America, p. 49.
Mountain limestone: Pecos village, N. Mex.

1860. *Orthis lasallensis.* McChesney, Desc. New Spec. Foss., p. 32. (Date of imprint, 1859.)
Upper Coal Measures: Lasalle, Ill.

1860. *Orthis richmonda.* McChesney, idem, p. 32.
Coal Measures: Twelve miles northwest of Richmond, Mo.

?1860. *Orthis pratteni.* McChesney, idem, p. 33.
Coal Measures: Charboniere, Mo.

?1861. *Streptorhynchus umbraculum.* Newberry, Ives's Rept. Colorado River of the West, pt. 3, p. 125.
Upper Carboniferous (Cherty limestone): Canyon of Cascade River near the junction of the Colorado Chiquito with the Colorado; at Agua Azul; east of Fort Defiance; at Santa Fe; at Ojo Vernal, and on Cottonwood Creek, Kans.

1864. *Hemipronites crassus.* Meek and Hayden, Smithsonian Contrib. Knowledge (vol. 14), No. 172, p. 26, pl. 1, figs. 7a–d.
Coal Measures: Leavenworth, Kans.

1865. *Orthis richmonda.* McChesney, Illus. New Spec. Foss., pl. 1, figs. 5a–c.

1865. *Orthis lasallensis.* McChesney, idem, pl. 1, figs. 6a, 6b.

1866. *Orthis crenistria.* Geinitz, Carb. und Dyas in Nebraska, p. 46, pl. 3, figs. 20, 21.
Upper Coal Measures: Bellevue and Plattsmouth, Nebr.; Stage Bb, at Bennetts Mill, southwest of Nebraska City; Stages Bb^{iv}, Cc^{ii}, Cc^{v}, at Nebraska City, Nebr.

1868. *Hemipronites lasallensis.* McChesney, Chicago Acad. Sci. Trans., vol. 1, p. 28, pl. 1, figs. 6a, 6b.
Upper Coal Measures: La Salle, Ill.

1868. *Hemipronites crassus.* McChesney, idem, vol. 1, p. 28, pl. 1, figs. 5a–c.
Coal Measures: 12 miles northeast of Richmond, Mo.

1872. *Hemipronites crassus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 174, pl. 5, figs. 10a–c; pl. 8, fig. 1.
Upper Coal Measures: Nebraska City, Bennetts Mill, Wyoming, Cedar Bluff, Rock Bluff, Plattsmouth, Bellevue, Omaha, Peru, Rulo, and Brownsville, Nebr.
Coal Measures: Kansas, Iowa, Missouri, Illinois.
Chester limestone: West Virginia.

1873. *Hemipronites crassus.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 570, pl. 25, fig. 12.
Upper Coal Measures: La Salle, Ill.

1875. *Hemipronites crinistria.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 124, pl. 10, fig. 9a. (Whole volume published in 1877.)
Carboniferous: Meadow Creek, south of Fillmore; Star district, Picacho Range; North Fork of Lewiston Canyon, Oquirrh Range; below Ophir City, Kanab Canyon, Wasatch Range; pass between Rush and Cedar valleys; and east side of Mount Nebo, Utah; top of Grass Mountain, Ely Range; Fossil Hill; Camp Apache; Old Potosi mine; Tenney's ranch; Kaibab Plateau; and at confluence of White Mountain and Black rivers, Nev.

1876. *Hemipronites crenistria.* White, U. S. Geog. Survey Terr., 2d div., Powell's Rept. Geology Uinta Mountains, pp. 90, 91.
Lower Aubrey group; Near Echo Park and at confluence of Grand and Green rivers, Utah.
Upper Aubrey group; Beehive Point, near Horseshoe Canyon, Utah.

1883. *Streptorhynchus Richmondi.* Hall, New York State Geologist Rept., 1882, pl. (10) 40, figs. 10, 11.
Coal Measures: Iowa.

1884. *Hemipronites crassus.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 129, pl. 26, figs. 4–11.
Coal Measures: Lodi, Eugene, Perrysville, Merom, Big Creek, and New Harmony, Ind.

1884. *Derbyia crassa.* Waagen, India Geol. Survey Mem., Palæontologia Indica, ser. 13, vol. 1, p. 592.

1887. *Hemipronites crassus.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 50, pl. 2, fig. 19.
Coal Measures: Flint Ridge, Ohio.

1888. *Streptorhynchus crenistria.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 229.
Lower Coal Measures: Des Moines, Iowa.

?1891. *Streptorhynchus crassum.* Whitfield, New York Acad. Sci. Annals, vol. 5, p. 580, pl. 13, figs. 11, 12.
Maxville limestone: Ohio.

1892. *Derbya crassa.* Hall and Clarke, New York State Geologist Eleventh Ann. Rept., for 1891, pl. 17, figs. 1–4, 9.
Upper Coal Measures: Kansas City, Mo.; Winterset, Iowa.

1892. *Derbyia crassa.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 1, pl. 10, figs. 10, 11; pl. 11A, figs, 28–33; pl. 11B, figs. 23, 24; pl. 20, figs. 12, 13.
Upper Coal Measures: Near Kansas City, Mo., and Winterset, Iowa.

?1893. *Streptorhynchus crassum.* Whitfield, Ohio Geol. Survey Rept., vol. 7, p. 468, pl. 9, figs. 11, 12.
Maxville limestone: Ohio.

1894. *Derbya crassa.* Hall and Clarke, Introd. Study Brach., pt. 1, pl. 17, figs. 1–4, 9.
Upper Coal Measures: Kansas City, Mo.; Winterset, Iowa.

1895. *Streptorhynchus crenistria.* Keyes, Missouri Geol. Survey, vol. 5, p. 67, pl. 38, figs. 8a–h. (Date of imprint, 1894.)
Coal Measures: Kansas City, Clinton, and Lexington, Mo.

1896. *Derbyia crassa.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 28.
Upper Coal Measures: Poteau Mountain, Okla.
Lower Coal Measures: Conway County, Ark.

1896. *Derbyia crassa.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 238.
Upper Coal Measures: Poteau Mountain, Okla.
Lower Coal Measures: Conway County, Ark.

1900. *Derbya crassa.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 62, pl. 8, figs. 11, 11b.
Upper and Lower Coal Measures: Fort Scott, Kansas City, Lawrence, Topeka, Kans.

1900. *Derbia (Hemipronites) crassus.* Herrick and Bendrat, Am. Geologist, vol. 25, No. 4, p. 240.
Coal Measures: Sandia Mountains, N. Mex.

1903. *Derbya crassa.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 347.
Hermosa formation: Ouray and San Juan region, Colo.
Weber formation: Crested Butte and Leadville districts, Colo.
Maroon formation: Crested Butte district, Colo.
Carboniferous: Glenwood Springs, Colo.

1904. *Derbya crassa.* Girty, U. S. Geol. Survey Prof. Paper 21, p. 52, pl. 11, fig. 3.
Pennsylvanian (Naco limestone): Bisbee quadrangle, Ariz.

1906. *Derbya crassa.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 276, pl. 12, fig. 10.
Carboniferous: Weeping Water, Cedar Creek, Nehawka, and Rock Bluff, Nebr.

Strophomenoid shells are rare in the Wewoka formation. The Survey collection contains only one nearly perfect and finely preserved example and a few fragments from three other localities. The fragments indicate a size much greater than that of the specimen on which the identification of *D. crassa* is based, a size as great as *D. robusta* or any other large Pennsylvanian species. They are too imperfect, however, to allow me to point out differences, other than size, by which they can be distinguished from the more perfect specimen.

The single specimen definitely referred to *D. crassa* is subcircular and somewhat transverse. The outline contracts considerably at the hinge. The cardinal slopes of the ventral valve meet very obtusely and do not form conspicuous cardinal angles at their junction with the sides.

The ventral valve is gently convex with beak somewhat projecting, somewhat depressed and somewhat twisted. The area is low, projecting rather strongly backward, and it is much shorter than the width of the shell in front. The pseudodeltidium is higher than wide, moderately projecting, and slightly depressed along its center.

The dorsal valve is moderately convex. The beak is small and depressed, with depressed and flattened areas on either side of it.

Both valves are more or less undulating and contorted and are marked by several varices of growth. The surface is marked by thin, strongly and abruptly elevated liræ, separated by relatively broad flat interspaces. The liræ are more or less regularly alternating or unequal, of two, three, or even four series. Eight or nine occur in 5 millimeters. The surface is also crossed by regular, fine, crenulating lamellæ, which occur both on the interspaces and on the radii, where they are apt to be a little stronger, producing scalelike projections.

This form agrees so closely with Meek's description and also with specimens which can safely be referred to *D. crassa* that there can be little doubt of the identification.

In proportion as it is difficult to discriminate species in the genus Derbya and related groups, so is it hard to assemble the synonymy of one of them in any but an undiscriminating and mechanical way. The synonymy printed here is in the main that which is generally accepted. It seems rather doubtful, however, whether any of the Mississippian identifications,[1] even those from the higher horizons, will eventually be referred to the Pennsylvanian species. The improbability is so great in the case of Lane and Cooper's[2] identification from the lower Mississippian at Point aux Barques, Mich., that it is reasonably safe to remove that citation from the synonymy.

Another citation which can be dropped is that by Meek and Hayden in 1859,[3] under the title *Orthisina umbraculum?* from the "Upper Coal Measures" of Kansas. For that type they suggested the reversional name *multistriata*, and it is highly probable that their form is distinct from *D. crassa* as well as from the European species with which they provisionally identified it.

It also seems somewhat doubtful whether *Hemipronites* or *Orthis lasallensis* of McChesney (of the dates 1860, 1865, and 1868) belongs to this species.

Certain citations from localities in the far West (as Hall 1857, Marcou 1858, Newberry 1861, White 1875, and perhaps my own citations in 1903 and 1904), where the association is with a widely different fauna from that of typical *D. crassa*, may for that reason be held doubtful until some one shall have investigated the matter.

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[1] As *Hemipronites crassus* Meek (pars) 1872 and *Streptorhynchus crassum* Whitfield 1893.

[2] Lane and Cooper, Michigan Geol. Survey, vol. 7, pt. 2, 1900, p. 259.

[3] Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., 1859, p. 26.

A few of the forms to which references are retained in the synonymy are of unusual size and some may belong to the related species which Hall described as *D. robusta* (cf. Hall 1852, Owen 1852, and Keyes 1858).

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005? 2006?); Coalgate quadrangle, Okla. (stations 2001? and 2004).

Genus STREPTORHYNCHUS King.

STREPTORHYNCHUS OKLAHOMÆ Girty.

Plate VI, figures 15–15b.

1911. *Streptorhynchus oklahomæ.* Girty, New York Acad. Sci. Annals, vol. 21, p. 126. Wewoka formation: Coalgate quadrangle, Okla.

The Wewoka collections include two specimens that appear to belong to the genus Streptorhynchus. They are preserved as internal molds and show dental callosities in the ventral valve without any trace of a septum. In the dorsal valve the socket plates are fairly well developed and one specimen has a low dorsal septum. In point of convexity the dorsal valve is only gently arched, the ventral rather high and more or less contorted. The shell contracts at the hinge, the area being moderately high and strongly inclined backward. The sculpture consists of fine, regular, subequal liræ, which in one specimen are more or less distinctly alternating. In the specimen figured the liræ are equal over the median portion and are separated by intervals slightly greater than their own width; 10 of them occur in 5 millimeters. Toward the sides they are rather more distantly spaced and alternate in size.

The rarity of this genus in the American Pennsylvanian rocks constitutes an a priori argument against the assignment of these specimens to Streptorhynchus. On the other hand, it is difficult to understand how the process of fossilization could permit the dental callosities to be preserved and could yet obliterate all trace of the septum.

It is possible that one or two of the specimens assigned to *Derbya crassa* may really belong to *Streptorhynchus oklahomæ,* but I could not determine that fact without mutilating them, which I was unwilling to do.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Family PRODUCTIDÆ.

Genus CHONETES Fischer-de-Waldheim.

CHONETES GRANULIFER Owen.

Plate VII, figures 12–13b.

1852. *Chonetes granulifera.* Owen, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, p. 583, pl. 5, fig. 12.
Carboniferous limestone: Near mouth of Keg Creek, Mo.
1854. *Chonetes Smithii.* Norwood and Pratten, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 24, pl. 2, figs. 2a-d. (Entire volume bears imprint 1855.)
Coal Measures: Belleville, Ill.
1854. *Chonetes Granulifera.* Norwood and Pratten, idem, p. 24.
Coal Measures: Belleville, Ill.; Keg Creek, Mo.
1854. *Chonetes Flemingii.* Norwood and Pratten, idem, p. 26, pl. 2, figs. 5a–c.
[Coal Measures:] Ten miles northwest of Richmond, Mo.
1873. *Chonetes Smithii.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 570, pl. 25, fig. 11.
Coal Measures: St. Clair County, Ill.
?1875. *Chonetes granulifera.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, pt. 1, p. 122, pl. 9, figs. 8a–c. (Volume bears imprint 1877.)
Carboniferous (Upper Aubrey limestone): Kanab Canyon, Ariz.
?1876. *Chonetes granulifera.* White, U. S. Geol. and Geog. Survey Terr., 2d div., Powell's Rept. Geology Uinta Mountains, p. 90.
Lower Aubrey group: Confluence of Grand and Green rivers, Utah.
1891. *Chonetes flemingi.* Keyes (pars, non *C. verneuilianus*), Acad. Nat. Sci. Philadelphia Proc., p. 247.
Lower Coal Measures: Des Moines, Iowa.
1892. *Chonetes Smithi.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 1, pl. 15B, fig. 12.
Coal Measures: Illinois.
?1895. *Chonetes granulifera.* Keyes, Missouri Geol. Survey, vol. 5, p. 56. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.
1903. *Chonetes flemingi.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 352, pl. 1, figs. 17, 18, 18a.
Weber limestone and Maroon formation: Crested Butte district, Colo.
Hermosa formation: Ouray, Colo.
Carboniferous: Glenwood Springs, Colo.
1908. *Chonetes granulifer.* Greene (pars?), Jour. Geology, vol. 16, p. 654.
Pennsylvanian and Permian: Kansas.

In the Pennsylvanian rocks of the Mississippi Valley there occur two closely related species of Chonetes which I have heretofore tried to discriminate under the names *C. granulifer* Owen and *C. flemingi* Norwood and Pratten. *C. flemingi* appears to be best developed in the lower beds if not restricted to them, but *C. granulifer* is best developed in the upper beds. Both are marked by regular radiating liræ of about the same degree of fineness, and they are chiefly distinguished by their shape, *C. granulifer* being, as a rule, larger, flatter, and more extended on the hinge, with a narrower cardinal area, a less prominent ventral beak, and less distinct and in some specimens evanescent sinus. *C. flemingi* also shows greater inequality in the curvature of the two valves. As both species vary somewhat, these differences do not hold in all specimens. *C. flemingi* is covered with numerous small spines, a feature which is less conspicuous in the specimens of *C. granulifer* that I have examined but is certainly present and possibly was observed and figured by Meek,[1] though the structures shown in his figure may represent the pores that occur between instead of the spines that occur on the liræ, which are numerous, and, where the shell is exfoliated, are very conspicuous. The two forms should probably be regarded as distinct varieties, though possibly not as distinct species.

The names which should be employed for them are somewhat doubtful. Meek and Hayden described the large mucronate type as *Chonetes mucronatus* but later placed that species in the synonymy of *C. granulifer* Owen and consequently are responsible for the general application of the name *C. granulifer* to the spreading mucronate type of shell. From Owen's very poor description and figures, however, it appears that he was considering a subquadrate shell like *C. flemingi*, rather than an extended one like *C. mucronatus*. Therefore I should be disposed to associate the name *C. granulifer* rather with the type of shell which Norwood and Pratten called *C. flemingi*. It is unfortunate that the appropriate and well-defined term *C. mucronatus* was preoccupied by *Strophomena* (= *Chonetes*) *mucronata* Hall, 1843, for it is in consequence unavailable. Another species that is commonly placed in the synonymy of *C. granulifer* is *C. smithii*, but this also appears to be one of the subquadrate, strongly arched shells, related rather to *C. flemingi* and typical *C. granulifer* than to *C. mucronatus*. Thus, in so far as the facts are known to me, the transverse form which Meek and Hayden call *C. mucronatus* is discriminable from *C. granulifer* Owen, and stands at present without a distinguishing name. The name *C. meekanus* is herewith proposed for it.

For the other form, *C. granulifer* evidently has priority, and it should probably be substituted for *C. flemingi*. Several other species may tentatively be placed in this synonymy. In their monograph on the genus Chonetes, Norwood and Pratten recognize *C. granulifer*, and describe amongst new species *C. flemingi*, *C. smithii*, and *C. verneuilianus*, all of which appear to be closely related. It is unfortunate and somewhat surprising that these authors do not discuss the relationship between these kindred forms. As already remarked, I can not but feel it to be highly probable that *C. flemingi* and *C. granulifer* are the same species. It also seems probable that *C.*

[1] Meek, F. B., U. S. Geol. Survey Nebraska Final Rept., 1872, Pl. VIII, fig. 7.

flemingi and *C. smithii* are the same. The only obvious difference lies in the little pores or spine bases which Norwood and Pratten describe as characteristic of *C. smithii;* but this is really a feature which I have observed in a number of species and believe to belong to all forms of the group to a greater or less extent. It is extremely liable to the accidents of preservation, and may be well shown by specimens from one locality and obscured in specimens from another. In size and external form *C. smithii* is singularly close to *C. granulifer* as figured by Owen, and tentatively I shall include both species in the same synonymy. It is possible that all these forms will prove to be the same as *C. variolatus* D'Orbigny, of which *C. flemingi* has sometimes been considered a synonym. Authors have apparently been influenced in this by the interlira pores which both D'Orbigny and Norwood and Pratten describe as distinguishing characters of either species, but which I believe are common to all or nearly all species of the genus, their conspicuousness being largely determined by preservation, though many well-preserved specimens do not show them. The pores appear as lines of minute perforations following the striæ that are characteristic of at least one extensive group of the genus and they are best shown when the surface is somewhat exfoliated. A deeper exfoliation brings to light considerably larger and less numerous openings, less conspicuously arranged in rows also, which are indicative of the small internal spines or pustules characteristic of the genus.

C. verneuilianus, though related to the other species, is probably a distinguishable form. I have heretofore regarded it as a variety of the *C. flemingi*, and consequently assume it to occupy a similar relationship to *C. granulifer*.

For the present, therefore, I am using the name *C. granulifer* for the subquadrate, strongly arched type of Chonetes, while recognizing that the name may have to be superseded by *C. variolatus* D'Orbigny.

As represented in the Wewoka formation this species seems persistently to accompany *C. mesolobus* var. *decipiens*, but though it occurs at many localities it is rare at all of them, only two or three specimens having been obtained at each. Most of the specimens are small and as a rule are not very perfect, but so far as their characters are shown, they agree with specimens from the Mississippi Valley which I regard as characteristic *C. granulifer*. They are readily distinguishable from *C. mesolobus* by their striated sculpture and by their configuration.

Mr. F. C. Greene has made an elaborate study of this species based on extensive collections from a wide range of horizons. Speaking without nearly so thorough an investigation, I hesitate to accept entirely his conclusions as to specific limits in this group, if I understand them aright. He appears to attach more importance to proportional length and breadth than a priori seems to me wise, and he seems inclined to assemble under *C. granulifer* modifications which I should be disposed to discriminate.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

CHONETES GRANULIFER var. ARMATUS Girty.

Plate VII, figures 2–4.

1911. *Chonetes granulifer* var. *armatus*. Girty, New York Acad. Sci. Annals, vol. 21, p. 127.
Wewoka formation: Coalgate quadrangle, Okla.

The fossils included under this title occur associated with *C. mesolobus* var. *decipiens*, and with the more closely related *C. granulifer*. They are small, 15 millimeters being the maximum width observed, moderately convex if not compressed, subquadrate in shape, and have rather prominent beaks and faint though distinct insinuations. About seven cardinal spines occur on each side.

The surface is marked by obsolescent liræ and by numerous small though prominent spines.

This variety is distinguished from the closely related *C. granulifer* by its smaller and less projecting beak, its nearly obsolete liration, and the number and prominence of its surface spines, although the latter character may be to some extent the result of preservation. With the evidence at hand, however, I would not feel justified in regarding these shells as true representatives of *C. granulifer*.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

CHONETES MESOLOBUS var. DECIPIENS Girty.

Plate VII, figures 5–7a.

1899. *Chonetes mesolobus*. Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 576.
Upper Coal Measures: Atoka quadrangle, Okla.

1903. *Chonetes mesolobus*. Girty, U. S. Geol. Survey Prof. Paper 16, p. 357, pl. 1, figs. 20–23.
Hermoso formation: San Juan region, Colo.
Rico formation: San Juan region, Colo.
Maroon formation: Crested Butte district, Colo.
Carboniferous: Grand River region, Colo.

1911. *Chonetes mesolobus* var. *decipiens*. Girty, New York Acad. Sci. Annals, vol. 21, p. 127.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

This form differs from typical *C. mesolobus* in having a smooth instead of a striated surface. Though I was at first disposed to describe it as a new species rather than a new variety, the lower taxonomic rank is probably more in accordance with the facts.

The peculiar configuration of *C. mesolobus* is well known. The typical form is described as possessing fine, radiating striæ. Some well-preserved specimens from Ohio show this feature very clearly. The liræ are fine and moderately strong; and they give rise to a large number of minute spines, a feature not mentioned by Norwood and Pratten, though perhaps represented in one of their figures. Mr. Beede[1] also appears to record it when he describes the surface as "coarsely punctate." He may, however, be referring to another and altogether different feature, namely, to more numerous perforations, which occur between the striæ instead of on them and which project as rows of spinules or pustules on the inside of the shell. These are best shown on exfoliated specimens or internal molds. The structures to which I refer also resemble punctæ where the surface is worn, but where it is better preserved they show projecting edges, as of downward pointing spines, very similar to the minute spines found on many orthoids.

This variety has the characteristic configuration of *C. mesolobus*, but the surface is entirely without radiating sculpture and is marked only on the best specimens by fine growth lines. The absence of radial striation is not due to erosion nor to any circumstance or condition of fossilization, for it persists through an extensive series of specimens from many localities. Furthermore, the radial markings could hardly have been lost when the more delicate growth lines had been retained.

In characteristic specimens this difference is so strongly marked that one would be led to refer the two forms to altogether different groups, and as already noted I was at first disposed to regard them as distinct species. When large series of specimens from different horizons are examined, however, individuals more or less intermediate in character are found. That is, associated with the smooth variety are a few shells which show faint yet unmistakable traces of radial sculpture. Such specimens must be carefully examined, however, to determine whether this character is not adventitious, for under exfoliation the rows of internal spinules which have oblique pores connecting with them form little grooves and produce a fine, more or less regular radiating striæ.

The shells belonging to the smooth variety rarely show traces of the spines found on the other. Except for a few incremental lines the surface is usually featureless.

C. mesolobus var. *decipiens* is very abundant in the Wewoka formation. It is also abundant in some of the earlier Pennsylvanian deposits of the Kansas section at about the horizon of the Parsons formation.

In the literature no citation can definitely be included in the synonymy except my own identifications of specimens obtained in

[1] Kansas Univ. Geol. Survey, vol. 6, p. 71, 1900.

Oklahoma and in Colorado. When I remarked of the form from Colorado that the specimens were characteristic in every way, I had for comparison not typical striated *C. mesolobus* but specimens of the present variety.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005? and 2007); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

CHONETES MESOLOBUS var. EUAMPYGUS Girty.

Plate VII, figures 8–9c.

1911. *Chonetes mesolobus* var. *euampygus*. Girty, New York Acad. Sci. Annals, vol. 21, p. 129.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shells of the *mesolobus* group vary considerably in the development of the characteristic lobation. In some of the larger individuals especially it can hardly be distinguished at all, and such of these specimens as belong to the smooth or *decipiens* type simulate *C. geinitzianus* very closely. *C. geinitzianus* may possibly have had this derivation, though one would have said a priori that such phylogeny was of all the least probable.

The strength of the lobation generally varies inversely as the size of the individual. At all events one group of shells, here discriminated as var. *euampygus*, stands out strongly and distinctly by reason of their small size and deep lobation. That they are mature shells is indicated by their strong convexity and by the fact that young individuals of the larger form would be more faintly lobed. Though they intergrade with the larger, less strongly lobate shells through larger examples which have an almost equal strength of lobation, they form a distinct and as a rule an easily discriminated group which in places occur alone to the exclusion of the typical variety. In sculpture these shells seem to be allied to the variety *decipiens*. They are usually unstriated but show traces of striæ more frequently than *decipiens*. Seldom, if ever, is the striation as strong as in well-characterized specimens of *C. mesolobus* s. s.

None of the specimens referred to here exceeds 10 millimeters in width, and they average nearer 7 millimeters.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (station 2001).

Genus **PRODUCTUS** Sowerby.

PRODUCTUS INFLATUS var. COLORADOENSIS n. var.

Plate VIII, figures 1, 2.

?1890. *Productus Boliviensis* (non D'Orbigny). Nikitin, Com. Géol. [Russia] Mém., vol. 5, No. 5, p. 57, pl. 1, figs. 4a–c.
Gschelstufe: Near Moscow, Russia.

?1902. *Productus inflatus* (non McChesney). Tschernyschew, Com. Géol. [Russia] Mém., vol. 16, No. 2, p. 261, 612, pl. 28, figs. 1-6.
Gschelstufe: Ural and Timan mountains, Russia.

1903. *Productus inflatus* (non McChesney). Girty, U. S. Geol. Survey Prof. Paper 16, p. 359, pl. 3, figs, 1-1b, 2, 2a, 3.
Hermosa formation: San Juan region and Ouray, Colo.
Weber limestone: Crested Butte and Leadville districts, Colo.
Carboniferous: Glenwood Springs, Colo.

1904. *Productus inflatus?* (non McChesney). Girty, U. S. Geol. Survey Prof. Paper 21, p. 52, pl. 11, figs, 5, 6.
Pennsylvanian (Naco limestone): Bisbee quadrangle, Ariz.

Under this title are included a few not very perfect specimens of the usual *semireticulatus* type. They are characterized by medium size, medium convexity, distinct though not strong insinuation, moderately fine liration, moderately fine and strong concentric wrinkles, and a moderate number of spines of moderate size.

Of the more or less similar species with which they are associated they resemble especially *Marginifera lasallensis*. It is not certain that the fossils referred to this variety have the internal characters of Productus or that the fossils referred to *M. lasallensis* have the internal characters of Marginifera, but, if they have, this fact would assign them to very distinct groups. In point of appearance, however, external characters being all that are plainly shown, no clear-cut differences exist. The most characteristic examples of each show that the present form is larger and less strongly sinuate, but many specimens can not be satisfactorily assigned to one group or the other, either because they are actually intermediate or, more commonly, because they are so imperfect that the characters are not well shown.

The best and most characteristic specimens referred to this variety resemble the form from Colorado identified by me as *P. inflatus* rather than the one described as *P. semireticulatus* var. *hermosanus*. Having had an opportunity to study what are probably characteristic specimens of *P. inflatus*, I have reached the conclusion that the shell from Colorado is a distinct form and propose for it the varietal name *coloradoensis*.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (stations 2001 and 7193).

Productus nebraskensis Owen.

Plate X, figures 6, 6a, 7.

1852. *Productus nebrascensis*. Owen, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, p. 584, pl. 5, fig. 3.
Carboniferous limestone: Bellevue, Missouri River, Nebr.

1854. *Productus Rogersii*. Norwood and Pratten, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 9, pl. 1, figs. 3a-c. (Whole volume appeared in 1855.)
Coal Measures: Near Huntsville, Mo.

1854. *Productus Nebrascensis.* Norwood and Pratten, idem, p. 21.
Coal Measures: Crossing of Big Nemaha, Nebraska Terr.

1856. *Productus Rogersi.* Hall, Pacific Railroad Rept., vol. 3, pt. 4, p. 104, pl. 2, figs. 14, 15.
Carboniferous limestone: Pecos village, N. Mex.

1859. *Productus Rogersi.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 26. (Imprint of entire volume, 1860.)
Upper Coal Measures: Kansas River valley, below mouth of Blue River, Kans.

1859. *Productus asperus.* McChesney, Desc. New Spec. Foss., p. 34.
Coal Measures: La Salle and Springfield, Ill.

1861. *Productus Rogersi.* Newberry, Ives's Rept. Colorado River of the West, pt. 3, p. 121.
Coal Measures: Pecos village and Kansas.

1865. *Productus asperus.* McChesney, Illus. New Spec. Foss., pl. 1, figs. 7a, 7b.

1866. *Strophalosia horrescens.* Geinitz, Carb. und Dyas in Nebraska, p. 49.
Coal Measures: Bellevue, Plattsmouth, Nebraska City, and Bennetts Mill, Nebr.

1868. *Productus nebrascensis.* McChesney, Chicago Acad. Sci. Trans., vol. 1, p. 24, pl. 1, figs. 7a, 7b. (Date of imprint, 1867.)
Coal Measures: La Salle and Springfield, Ill.

1872. *Productus Nebrascensis.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 165, pl. 2, fig. 2; pl. 4, fig. 6; pl. 5, figs. 11a–c.
Upper Coal Measures: Nebraska City, Wyo.; Bennetts Mill, Rock Bluff, Plattsmouth, Bellevue, and Omaha, Nebr.
Coal Measures: Illinois, Missouri, Iowa, Kansas, and New Mexico.

1873. *Productus Nebrascensis.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 569, pl. 25, fig. 8.
Coal Measures: Sangamon and La Salle counties, Ill.

1875. *Productus Nebrascensis.* White, U. S. Geog. Surveys W. 100th Mer. Rept., pt. 1, vol. 4, p. 116, pl. 8, figs. 3a–d. (Whole volume published in 1877.)
Carboniferous: Camp Apache and Carrizo Creek, Maricopa County, Ariz.; Rubyville, Schell Creek Range, and top of Grass Mountain, Ely Range, Nev.; Meadow Creek, south of Fillmore, Utah. (Specimens figured from Santa Fe, N. Mex., and from Nebraska.)

1876. *Productus Nebrascensis.* White, U. S. Geol. and Geog. Survey Terr., 2d div.; Powell's Rept. Geology Uinta Mountains, p. 90.
Lower Aubrey group: Confluence of Grand and Green rivers.

1877. *Productus Nebrascensis.* Meek, U. S. Geol. Expl. 40th Par., Rept., vol. 4, p. 65.

1883. *Productus aspersus.* Hall, New York State Geologist [Second Ann.] Rept. for 1882, pl. (19) 50, figs. 5–7.
Coal Measures: La Salle, Ill.

1884. *Productus Nebrascensis.* White, Dept. Geology and Nat. Hist. Indiana Thirteenth Ann. Rept., for 1883, pt. 2, p. 122, pl. 24, figs. 7–9.
Coal Measures: Fountain, Vermilion, Parke, and Vigo counties, Ind.

1886. *Productus Nebrascensis?* Heilprin, Pennsylvania [Second] Geol. Survey Ann. Rept. for 1885, p. 453, fig. 4c, p. 440, figs. 4–4b.
Upper Coal Measures, Mill Creek limestone: Wilkes-Barre, Pa.

1886. *Productus Nebrascensis?* Heilprin, Wyoming Hist. and Geol. Soc. Proc. and Coll., vol. 2, pt. 2, p. 268, figs. 4, 4b.
Upper Coal Measures, Mill Creek limestone: Wilkes-Barre, Pa.

1887. *Productus Nebrascensis.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 49, pl. 2, fig. 30.
Coal Measures: Flint Ridge, Ohio.

1892. *Productus Nebrascensis.* Hall and Clarke, New York State Geologist Eleventh Ann. Rept., for 1891, p. 22, fig. 7.
Coal Measures: La Salle, Ill.
1892. *Productus Nebrascensis.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 1, pl. 19, figs. 5–7.
Coal Measures: La Salle, Ill.
1894. *Productus Nebrascensis.* Hall and Clarke, Introd. Study Brach., pt. 1, pl. 22, fig. 7.
Coal Measures: La Salle, Ill.
1895. *Productus nebrascensis.* Keyes, Missouri Geol. Survey, vol. 5, p. 48, pl. 37, figs. 3a–c. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.
1900. *Productus nebrascensis.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 84, pl. 9, figs. 7–7f.
Upper Coal Measures: Kansas City, Turner, Eudora, Lawrence, Lecompton, Topeka, Manhattan, and Grand Summit, Kans.
1900. *Productus nebrascensis.* Herrick and Bendrat, Am. Geology, vol. 25, No. 4, p. 241.
Coal Measures: Sandia Mountains, N. Mex.
1903. *Productus nebraskensis.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 370, pl. 5, figs. 1, 2, 2a.
Hermosa formation: San Juan region and Ouray, Colo.
Rico formation: San Juan region, Colo.
Weber formation: Leadville district, Colo.
1904. *Productus nebraskensis.* Girty, U. S. Geol. Survey Prof. Paper 21, p. 53, pl. 11, figs. 7–9.
Pennsylvanian (Naco formation): Bisbee quadrangle, Ariz.
1906. *Productus nebrascensis.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 270, pl. 10, fig. 3.
Carboniferous: Weeping Water, Louisville, and Cedar Creek, Nebr.
1909. *Productus nebraskensis.* Girty, U. S. Geol. Survey Bull. 389, p. 62, pl. 7, figs. 5, 6.
Abo sandstone: Abo Canyon, Mesa del Yeso, and Sandia Mountains, N. Mex.
Yeso formation: Mesa del Yeso, N. Mex.

The fossils here included under *Productus nebraskensis* present much variation in matters of detail. Some, though apparently mature, as may be inferred from their convexity, are yet of very small size, having a width of but 16 millimeters or more; others are 35 millimeters across. Most bear at least traces of a sinus, in others it is well marked, and in a few it is entirely absent.

The sculpture also varies. In some specimens the concentric grooves or undulations, which form a rather characteristic feature of the species, are strongly developed. In others they seem to be practically absent, though the fine wrinkles or sublamellose lines of growth are generally distinct. Some specimens are normal in showing conspicuously two different sets of spines, the large ones perpendicular to the surface and the small ones tangent to it, though such an arrangement is not found to be rigidly persistent. In some specimens, on the other hand, the large spines seem to be more sparingly developed and the surface characters have a finer, more even appearance. In others, the small spines seem to be less abundant and the surface has a still different aspect. Generally speaking, however, all the spines seem to be small and oblique in the young stages and the same condition recurs after the shell has passed maturity, the spines being then developed in closely arranged rows and all being of the smaller size. The development of coarse transverse corrugations is commonly correlated with the development of strongly contrasted spines of two orders.

It does not seem to me advisable to subdivide these shells into distinct varieties, and at all events similar modifications are found among typical examples from Kansas and elsewhere.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

PRODUCTUS CORA D'Orbigny.

Plate VIII, figures 4–6.

1842. *Productus cora.* D'Orbigny, Voyage dans l'Amérique méridionale, Paleontology, vol. 3, pt. 4, p. 55.
Carboniferous: Above Patapatani, on an island in Lake Titicaca; Yarbichambi.

1845. *Productus Lyelli.* De Verneuil, Lyell's Travels in North America, vol. 2, p. 187.
Mountain limestone: Windsor, Horton Bluff, Shubenacadie, Gays River, Debert River, Minudie, and Cape Breton.

1847. *Productus cora.* D'Orbigny, idem, vol. 8, pl. 5 (Geology), figs. 8–10.

?1847. *Productus cora.* De Koninck, Soc. Roy. Sci. Liége Mém., vol. 4, p. 148, pl. 4, fig. 4a, 4b; pl. 5, figs. 2a–c. (No plates in the copy seen by me.—G. H. G.) (Date of imprint, 1848–49.)
Lower Carboniferous limestone of Visé, of Chokier, and of Ratingen; in the shales of the median étage near Tournay, and in the upper Carboniferous slates of Epinoy near Binche, Hainaut; banks of the Missouri; Kendal, in Westmoreland; Lowick; Yorkshire; Derbyshire; Ireland; banks of the Wilji, an affluent of the Taroussa; on the banks of the Louja, in the district of Medynsk, province of Kalouga; beyond Cosatchi-Datchi, on the eastern side of the Urals; near Sterlitamack, between Perm and Serebriansk; on the west side of the same chain from Kachira on the Oka and from Unja near Kosimof; Flint Ridge, Zanesville, Guernsey County, Ohio; between New Harmony and Mount Vernon, Ind.; Windsor, Nova Scotia; Leavenworth, Ind.; on the Bolivian plateau, above Patapatani; in one of the islands of Lake Titicaca, and at Yarbichambi, South America.

?1847. *Producta Cora.* De Koninck, Recherches animaux fossiles, pt. 1, p. 50, pl. 4, figs. 4a, 4b; pl. 5, figs. 2a–e.
Carboniferous: Guernsey County, Flint Ridge, and Zanesville, Ohio; between New Harmony and Mount Vernon, Ind.; Leavenworth, Ind.; Windsor, Nova Scotia; Bolivia, etc., South America.

?1848. *Productus Martini.* Christy, Letters on geology, pl. 5, figs. 6, 8, 9.
[Carboniferous:] Pinckneyville, Ill.

1852. *Productus semireticulatus.* Hall, Stansbury's Expl. and Survey Great Salt Lake of Utah, p. 411, pl. 3, figs. 3, 5a, 5b. (No plates in the copy seen by me.—G. H. G.) (Reprinted in Washington in 1853 and in Philadelphia in 1855.)
Carboniferous: Near Fort Laramie and at Flat Rock Point and other places in the neighborhood of Great Salt Lake.

?1852. Productus sp. Hall, Stansbury's Expl. and Survey Great Salt Lake of Utah, p. 411, pl. 3, fig. 4.

1852. *Productus cora.* Owen, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, pp. 103, 136, pl. 5, fig. 1.
Carboniferous: Missouri River, below mouth of Little Platte River.

1852. *Productus Cora.* Roemer, Kreid. von Texas, p. 90.
Carboniferous: San Saba Valley, Tex.

1854. *Productus Prattenianus.* Norwood, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 17, pl. 1, figs. 10a–d. (Date of imprint, 1855–1858.)
Coal Measures: Crossing of Big Nemahaw River, about 85 miles northwest of St. Joseph, Mo.

1855. *Productus cora.* Salter, Belcher's Last of the Arctic voyages, vol. 2, p. 387, pl. 36, fig. 12.
Carboniferous: Top of Exmouth Island.

1855. *Productus Lyelli.* Dawson, Acadian geology, p. 219, fig. 27g.
Lower Carboniferous limestone: Nova Scotia.

1858. *Productus Cora.* Marcou, Geology of North America, p. 45, pl. 6, figs. 4, 4a.
Mountain limestone: Tigeras Canyon of San Antonio; Pecos village; summit of Sierra de Sandia, N. Mex.

1859. *Productus Prattenianus.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 26. (Date of imprint, 1860.)
Coal Measures: Indian Creek and Leavenworth, Kans.

?1863. *Productus Cora.* Davidson, Geol. Soc. London Quart. Jour., vol. 19, p. 174, pl. 9, figs. 22, 23.
Lower Carboniferous limestone: Windsor, Horton Bluff, Shubenacadie, Gays River, Cape Breton, Pugwash, east coast of Cumberland, Lennox Passage, McKenzies Mill, at eastern extremity of Wallace Harbor, etc., Nova Scotia.

1866. *Productus Flemingi.* Geinitz, Carb. und Dyas in Nebraska, p. 52, tab. 4, figs. 1–4. (Not *P. flemingi* De Koninck.)
Upper Coal Measures: Bellevue, Plattsmouth, and Nebraska City, Nebr.

1866. *Productus Koninckianus?* Geinitz, idem, p. 53, tab. 4, fig. 5. (Not *P. Koninckianus* De Verneuil.)
Upper Coal Measures: Nebraska City, Bennetts Mill, Nebr.

1866. *Productus Calhounianus.* Geinitz, idem, p. 53. (Not *P. Calhounianus* Swallow.)
Upper Coal Measures: Diamond Spring, Santa Fe, Kans.

1866. *Productus Cora.* Geinitz, idem, p. 50.
Carboniferous limestone and shales: Germany, Belgium, England, Ireland, Spain, Russia, North America, Bolivia, etc. Belleview, Plattsmouth, Nebr.

?1868. *Productus cora.* Dawson, Acadian geology, p. 297, figs. 98a, 98b.
Carboniferous limestone: Windsor, Norton Bluff, Shubenacadie, Gays River, Minudie, Cape Breton, Pugwash on the east coast of Cumberland, Lennox Passage, McKenzies Mill, and Wallace Harbor, Nova Scotia.

1869. *Productus* cf. *cora.* Toula, K. Akad. Wiss. Wien, Math. naturw. Classe, Sitzungsber, vol. 59, Abth. 1, p. 441.
Carboniferous limestone: 10 miles from Cochabamba, Bolivia.

1872. *Productus Prattenianus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 163, pl. 2, figs. 5a–c; pl. 5, fig. 13; pl. 8, figs. 10a, 10b.
Upper Coal Measures: Nebraska City, Bennetts Mill, Cedar Bluff, Plattsmouth, Bellevue, and Omaha, Nebr.; Kansas; Iowa; Illinois.
Lower Coal Measures: Illinois.

1874. *Productus Cora (?).* Derby, Cornell Univ. (Science) Bull., vol. 1, No. 2, p. 49, pl. 2, fig. 17; pl. 6, fig. 17.
Coal Measures: Itaituba and Barreirinha, Brazil.

1875. *Productus Pratteniarus.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 113, pl. 7, figs. 1a–c. (Entire volume published in 1877.)
Carboniferous: Near Santa Fe and Sandia Mountains, N. Mex.; Piloncillo Range near Gavilan Peak, and at the confluence of White Mountain and Black rivers, Ariz.; Egan Range, 35 miles south of Egan Pass; Fossil Hill, White Pine County; Roberts Creek Range, Lander County, and top of Grass Mountain, Ely Range, 35 miles north of Pioche, Nev.; near Beckwith Spring, Cedar Range; near top of Mount Nebo, and on west face of Oquirrh Range, Utah.

1876. *Productus Pratteniarus.* White, U. S. Geol. and Geog. Survey Terr., 2d div.; Powell's Rept. Geology Uinta Mountains, p. 90.
Lower Aubrey group: Confluence of Grand and Green rivers, Utah.

1876. *Productus Cora.* Derby, Mus. Comp. Zool. Bull., vol. 3, p. 281.
Coal Measures: Yampopata.

1877. *Productus Pratteniarus.* Meek, U. S. Geol. Expl. 40th Par. Rept., vol. 4, p. 72, pl. 7, fig. 7, 7a.
Carboniferous: Fossil Hill, White Pine district; Railroad Canyon, Diamond Mountains, Nev.

1878. *Productus Cora.* Dawson, Acadian geology, 3d ed., p. 297, fig. 98.
Carboniferous limestone: Windsor, Horton Bluff, Shubenacadie, Gays River, Minudie, and Cape Breton, Nova Scotia; Pugwash, on the eastern coast of Cumberland; Lennox Passage; McKenzies mill and at eastern extremity of Wallace Harbor.

1884. *Productus Cora.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 126, pl. 26, figs. 1–3.
Coal Measures: Fountain, Vermilion, Parke, Montgomery, Clay, Owen, Pike, Dubois, and Warrick counties, Ind.

1886. *Productus Cora.* Heilprin, Pennsylvania [Second] Geol. Survey Ann. Rept. for 1885, p. 452; p. 440, figs. 1, 1a.
Upper Coal Measures, Mill Creek limestone: Wilkes-Barre, Pa.

1886. *Productus Cora.* Heilprin, Wyoming Hist. and Geol. Soc. Proc. and Coll., vol. 2, p. 268, figs. 1, 1a.
Upper Coal Measures, Mill Creek limestone: Wilkes-Barre, Pa.

1887. *Productus cora.* Waagen, India Geol. Survey Mem., Palæontologia Indica, ser. 13, vol. 1, p. 677, pl. 66, fig. 3; pl. 67, figs. 1, 2.
Productus limestone: Katta, Omarkheyl, Shekh Budin, and Jabi, India.

1887. *Productus Cora.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 47, pl. 2, fig. 26.
Coal Measures: Flint Ridge, Ohio.

1888. *Productus cora.* Keyes (pars?), Acad. Nat. Sci. Philadelphia Proc., p. 227. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Productus cora.* Keyes, Missouri Geol. Survey, vol. 5, p. 47, pl. 37, figs. 2a–c. (Date of imprint, 1894.)
Coal Measures: Calhoun and Kansas City, Mo.

1896. *Productus cora.* Smith (pars), Am. Philos. Soc. Proc., vol. 35, p. 238.
Upper Coal Measures: Poteau Mountain, Okla.

1897. *Productus cora.* Smith (pars), reprint of the same, p. 28.
Upper Coal Measures: Poteau Mountain, Okla.

1897. *Productus cora.* Smith (pars), Leland Stanford Junior University Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 28. (Date of imprint, 1896.)
Upper Coal Measures: Poteau Mountain, Okla.

1900. *Productus cora.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 75, pl. 11, figs. 1–1e, 1f (?).
Upper Coal Measures: Kansas City, Eudora, Lawrence, Lecompton, Topeka, Geary County, Melvern, Osage County, Kans.
1900. *Productus cora.* Herrick and Bendrat, Am. Geologist, vol. 25, No. 4, p. 240.
Coal Measures: Sandia Mountains, N. Mex.
1902. *Productus cora.* Tschernyschew, Com. Géol. [Russia] Mém., vol. 16, No. 2, pp. 280, 622.
1903. *Productus cora.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 364, pl. 4, figs. 1–4.
Hermosa formation: San Juan region and Ouray, Colo.
Rico formation: San Juan region, Colo.
Weber and Maroon formations: Crested Butte and Leadville districts, Colo.
1906. *Productus cora.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 270, pl. 11, fig. 1.
Carboniferous: Weeping Water, Nebr.
1909. *Productus cora.* Girty, U. S. Geol. Survey Bull. 389, p. 58.
Abo sandstone: Mesa del Yeso, Abo Canyon, and Sandia Mountains, N. Mex.

This species is so widely distributed and so well known that a description based on the shells under consideration, which are of the usual type, would be of little value. Waagen recognized two groups in the *cora* type, one having a sinus on the visceral portion and the other not. To the latter group *P. cora* itself was assigned. The forms under consideration do not fall quite clearly under either group, for in some of them the shell, which is rather broad, is flattened over the median portion or is obscurely depressed.

The shells from the Wewoka formation do not agree in some respects with those from India described by Waagen as belonging to the same species; he states, for instance, that four to six of the costæ unite at the base of each spine, but they do not so unite in my Wewoka specimens. In most respects, however, his description might have been drawn up from such representatives as have passed under my observation.

Considerable variation is shown in the distribution of the spines, which, though always present in some number, are considerably more numerous in some specimens than in others. Their arrangement is in the main regular, though not mathematically so. They are not very large and are only slightly swollen at the base. They spring from the liræ, seldom from the intervening striæ, and do not greatly interrupt their course. Occasionally two smaller liræ are initiated in front of a spine, which may then be said to mark the point of bifurcation. The enlargement at the base is not elongated, and only exceptionally are the spiniferous liræ larger, more prominent, or otherwise differentiated from those from which no spines derive. Along the hinge some spines are developed, smaller than those over the body of the shell and arranged in one or two irregular rows.

I am referring to this species all the specimens from the shales of the Wewoka formation, although a few of them may possibly belong to the related *P. insinuatus*, specimens of which have been found in a fossiliferous sandstone of the same formation. In so far as I have been able to determine, immature examples of the two species would be scarcely distinguishable. A few specimens from the shales which somewhat suggest *P. insinuatus* do so by reason of their relative lack of spines, or their transverse shape, or their lack of a ventral sinus. These differences are probably not constant for either *P. cora* or *P. insinuatus*, and they do not occur in combination in the specimens referred to. The majority of the shale specimens do not show a tendency to become transverse or to become angular along the median line, and they have larger and more numerous spines than I have observed in any of the specimens of *P. insinuatus*, so that their position with *P. cora* seems secure.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

PRODUCTUS INSINUATUS Girty.

Plate VIII, figures 7, 8; Plate IX, figures 1–3a.

1892. *Productus æquicostatus.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 1, pl. 17A, figs. 22, 23.
Coal Measures: Nebraska.

1892. *Productus æquicostatus.* Hall and Clarke, New York State Geologist Eleventh Ann. Rept., for 1891, pl. 22, figs. 11, 12.
Coal Measures: Nebraska.

1894. *Productus æquicostatus.* Hall and Clarke, Introd. Study Brach., pt. 1, pl. 22, figs. 11, 12.
Coal Measures: Nebraska.

1900. *Productus cora* var. *americanus.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 77, pl. 11, fig. 2.
Upper and Lower Coal Measures: Kansas City, Eudora, Anderson County, Kans.

1906. *Productus cora* var. *americanus.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 270, pl. 11, fig. 2.
Carboniferous: Louisville, Nebr.

1911. *Productus insinuatus.* Girty, New York Acad. Sci. Annals, vol. 21, p. 129.
Wewoka formation: Oklahoma.
Pennsylvanian: Kansas.

Shell of the *cora* type, rather large, widest at the hinge, more or less strongly transverse. The immature form closely resembles *P. cora* itself, being strongly convex and more nearly quadrate. The growth in the maturer forms is more spreading, especially at the sides, and the margins are flatter. Two varieties can be distinguished, one narrow and more highly arched and the other transverse and less convex. In the mature form also the ventral valve is elevated and angular along the median line. Correlated with this character is an inflection of the anterior margin, making a deep sinus in the outline. A sinus or depression in the shell itself is naturally absent.

The surface is marked by fine, even, rigid, rounded costæ having the peculiarities of those of *P. cora*. As in that species, the costæ bifurcate freely and in some specimens simultaneously all around the shell, making the striation for a space much finer about the margin than over the inner portion. In many specimens the costæ close to the carina bend inward toward the median line, which in some individuals appears to be without costæ. Some large plications are found at the sides near the hinge, but few of them pass entirely across the shell. They are rather more persistent on the dorsal valve, however, than on the ventral. Spines are scattered over the surface of the ventral valve, but they are usually small, not causing nodes on the costæ, and they are liable to be overlooked when broken off. They appear to be few in number. A row of larger ones is developed along the cardinal line.

Typical examples of *Productus insinuatus* differ so obviously from typical *P. cora* that it is not necessary to point out the distinguishing characters. It has been distinguished from *P. cora* on the few occasions on which it has been figured, but it has then been referred to *P. æquicostatus* Shumard, or to *P. americanus* Swallow. It is evidently not the same as *P. æquicostatus*, which is probably a synonym of *P. cora*. Its relation to *P. americanus* is not so clear. A careful reading of Swallow's description, which is quoted in full below, fails to show the reason for this identification.[1]

Shell very large, ovate, very convex, strongly arched toward the beak; very much produced in front, costate and striate. Ventral valve very convex in the middle; strongly arched over the umbo to the beak; flattened or concave toward the margins; elevated and rounded from the middle to the anterior margin; flattened or slightly depressed from the middle toward the beak; ears very large, flattened, slightly arched along the cardinal margin; beak small, strongly incurved over the cardinal line, which is as long as the width of the shell. Dorsal valve very concave, closely following the curvatures of the opposite valve; flattened on the visceral region; depressed under the beak; ears well defined and flattened. Surface ornamented with small, round, depressed, crowded, radiating costæ (increased by implantations and by subdivisions); it also has fine raised concentric lines, which are most conspicuous on the costæ; space between the costæ narrow; but when exfoliated the costæ become narrower and the spaces between wider; the costæ often curved and geniculated; ears of the ventral valve marked with large, irregular rugæ, which extend up on to the sides of the valve; somewhat obsolete on the visceral region; ears and visceral region of the dorsal valve marked with unequal rugæ. It also has a row of spines on the cardinal margin.

Length, 3.50; width, 2.60; height, 1.35.

Variety *magistos* is larger, wider, and more depressed; the costæ striate longitudinally when exfoliated.

Length, 4.00; width, 4.00; height, 1.30.

Variety *bombex* smaller, more convex, more strongly arched; whole surface marked with distant, diagonal rows of spines.

This fossil most resembles the *P. æquicostatus* of Dr. Shumard; but it is much larger, longer in proportion, and very differently marked.

These magnificent fossils are abundant in the limestones of the Upper Coal Measures of Harrison County, Mo.

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[1] Swallow, G. C., Acad. Sci. St. Louis Trans., vol. 2, pp. 91-92, 1868.

This description applies to *P. insinuatus* in many respects, just as it applies to many other species of Productus. In fact, the description fails to indicate any distinguishing and peculiar marks in *P. americanus*, and in the absence of figures it is difficult to form an exact idea of the shell which Swallow really had in hand. He compares it with *P. æquicostatus* Shumard, a much more normal representative of the *cora* group than *P. insinuatus*. The only differences he indicates are that it is much larger, longer in proportion, and very differently marked. It is impossible to understand the last statement unless he has reference to the large spines abundantly developed in Shumard's species and apparently absent from his own. One of the most obvious peculiarities of *P. insinuatus* is, of course, the carinated character of the anterior portion of the shell and the concomitant deep sinus in the front margin. Not only does Swallow's description fail to make any mention of these characters (his description of the configuration, however, is not altogether clear), but he fails to mention them as distinguishing *P. americanus* from *P. æquicostatus*, in which they are conspicuously absent. More positively, he gives the shape as much longer than wide, a character mentioned also in his comparison with *P. æquicostatus*, whereas *P. insinuatus* is regularly wider than long, in many specimens much wider. Other less striking differences might also be mentioned, such as the continuation of the transverse wrinkles across the visceral area, but altogether it seems to me clear that Swallow did not propose *P. americanus* for the present species.

Some additional light is thrown on the true character of *P. americanus* by a remark of Meek's,[1] to which Keyes [2] calls attention. Meek thinks that Swallow's species may be the same as his *P. magnus*, basing his opinion on the study of the original description and of tracings of drawings made from Swallow's typical specimens. I need hardly point out that *P. magnus* entirely lacks the peculiar configuration of *P. insinuatus*.

The peculiar configuration of *P. insinuatus* is perhaps of more importance philosophically than practically. The all but universal habit of the brachiopods is to develop a sinus in the ventral valve, and the present species is an exception in having the sinus in the dorsal valve and a corresponding fold in the ventral. Similar departures from this persistent habit have, in other genera of brachiopods, been made the basis for division into subordinate groups, but it is doubtful whether such a course would be practicable with Productus. Indeed, the subordinate groups now recognized are determined by very different characters, though an attempted minor grouping in the *cora* group is based on the presence or absence of a sinus.

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[1] Meek, F. B., Illinois Geol. Survey, vol. 3, 1868, p. 530.
[2] Keyes, C. R., Missouri Geol. Survey, vol. 5, 1894, p. 44.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2009). Fort Scott limestone: Chetopa, Kans. Piqua limestone: Fredonia, Kans.

PRODUCTUS PERTENUIS Meek.

Plate VIII, figures 3, 3a.

1866. *Productus Cancrina.* Geinitz, Carb. und Dyas in Nebraska, p. 54, tab. 4, fig. 6a–d. (Not *P. cancrini* de Verneuil, 1843.)
Upper Coal Measures: Nebraska City, Nebr.

1872. *Productus pertenuis.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 164, pl. 1, figs. 14a–e; pl. 8, figs. 9a–d.
Upper Coal Measures: Nebraska City and Brownville, Nebr.; Grasshopper Creek, 12 miles west of Leavenworth, and at Atchison, Kans.

1898. *Productus pertenuis.* Drake (pars), Am. Philos. Soc. Proc., vol. 36, p. 404. Reprinted without change of date, page, etc., in Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 14.
Lower Coal Measures: 4 miles north of Vinita, Okla.
Upper Coal Measures, Cavinol group: McClellan ford on the Verdigris River; Poteau Group: 6 miles west of South Canadian, Okla.
Permian division, upper bed of sandstone: 4 miles west of McDermitt; Pawhuska sandstone: 5 miles west of Cushing, Okla.

1900. *Productus pertenuis.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 83, pl. 9, figs. 5–5c.
Upper Coal Measures: Kansas City, Eudora, Lawrence, Lecompton, Topeka, Kans.

?1900. *Productella pertenuis?* Herrick and Bendrat, Am. Geologist, vol. 25, No. 4, p. 241.
Coal Measures: Sandia Mountain, N. Mex.

1903. *Productus pertenuis?* Girty, U. S. Geol. Survey Prof. Paper 16, p. 367.
Hermosa formation: San Juan region, Colo.

?1906. *Productus pertenuis.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 272, pl. 10, fig. 10.
Carboniferous: Weeping Water, Nebr.

Productus pertenuis is intimately related to *P. cora,* though in most cases there is no difficulty in distinguishing the two. Its peculiarities are found in *P. cora* to a certain degree. The liration, however, is much finer, some 15 to 18 liræ instead of 7 occurring in 5 millimeters. In *P. cora* the transverse wrinkles are mostly confined to the dorsal valve, only a few rather large ones being normally developed on the ears and sides of the ventral valve; in *P. pertenuis,* practically the entire surface of the ventral valve is covered with fine, more or less irregular wrinkles. In *P. cora* the spines are relatively few and large; in *P. pertenuis* they are small, relative to the much smaller size, are very numerous. In *P. pertenuis* they also have elongated bases and many of them spring from liræ larger and more elevated than the rest. This last feature occurs sporadically in *P. cora* also.

P. pertenuis is much more closely allied to the European *P. cancrini* and *P. cancriniformis,* of which it is doubtless the American representative.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

Genus MARGINIFERA Waagen.

MARGINIFERA SPLENDENS Norwood and Pratten.

Plate X, figures 1–2b.

1854. *Productus splendens.* Norwood and Pratten, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, 1855–1858, p. 11, pl. 1, figs. 5a–d.
Coal Measures: Galatia, Ill.; 6 miles west of Richmond, Mo.; near Big Creek, Posey County, Ind.

?1855. *Productus splendens.* Schiel, Rept. Expl. Survey Mississippi River to Pacific Ocean, vol. 2; Rept. Beckwith's Expl. 41st Par., p. 108, pl. 1, fig. 3.
Carboniferous limestone: 6 miles west of Westport.

?1859. *Productus splendens (?).* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 25.
Upper Coal Measures: Manhattan and Fort Riley, Kans.

?1861. *Productus splendens?* Newberry, Ives's Rept. Colorado River of the West, pt. 3, p. 124.
Coal Measures limestone: Santa Fe road, 10 miles west of Burlingame, Kans.

?1892. *Productus (Marginifera) splendens.* Hall and Clarke, Geol. Survey New York, Paleontology, vol. 8, pt. 1, pl. 19, figs. 1–4.
Upper Coal Measures: Winterset, Iowa.
Coal Measures: La Salle, Ill.

?1892. *Productus (Marginifera) splendens.* Hall and Clarke, New York State Geologist Rept. for 1891, pl. 22, figs. 13, 14.
Upper Coal Measures: Winterset, Iowa.
Coal Measures: La Salle, Ill.

?1894. *Productus (Marginifera) splendens.* Hall and Clarke, Introd. Study Brach., pt. 1, pl. 22, figs. 13, 14.
Upper Coal Measures: Winterset, Iowa.
Coal Measures: La Salle, Ill.

?1896. *Productus (Marginifera) splendens.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 29.
Upper Coal Measures: Sebastian County, Ark., and Poteau Mountain, Okla.

?1897. *Productus (Marginifera) splendens.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 29.
Upper Coal Measures: Sebastian County, Ark., and Poteau Mountain, Okla.

The American Pennsylvanian rocks contain two productoid types whose close relationship to one another and to certain foreign species renders their discrimination and identification difficult. I refer to the shells which have been often identified as *Productus longispinus.* As both the American shells are Marginiferas, and as the English species, according to Waagen, probably does not show the characters of that group, *P. longispinus* can for the present safely be left out of the reckoning.

The two forms in question were, I believe, described by Norwood and Pratten under the names *Productus splendens* and *P. wabashensis,* but they are more closely related than Norwood and Pratten's figures would lead one to expect. As a rule one variety, that which I identify as *Marginifera splendens*, has rather coarser, fainter ribs, which in many specimens are entirely obsolete toward the front or are replaced by relatively coarse plications or folds proceeding from the large spines. The costæ of *M. wabashensis* are finer, stronger, and more persistent. *M. splendens* is, as Norwood and Pratten point out, more extended on the hinge, the cardinal angles of *M. wabashensis* being subquadrate. In *M. wabashensis* also the Marginifera structure is seldom so strikingly developed as it is in *M. splendens*. The spines of *P. wabashensis* are as a rule smaller and more numerous.

On this basis two fairly distinct groups can be separated. Of the shells included in one of them as *M. splendens* but few attained the size of the typical examples which Norwood and Pratten figure. Large specimens agreeing with their figures, however, do not show any appreciable and constant differences from the smaller and more common variety. The larger size, in fact, seems to be due to an anterior prolongation of the shell which must at one time have had the size and configuration of the smaller variety.

As most authors have referred all the shells of this group to a single species, *Productus longispinus*, and as the forms so dealt with are closely related, it is naturally difficult to arrange the synonymy in a satisfactory manner. Of the forms cited under *Productus splendens*, only the original safely belongs in the synonymy. The most doubtful references are the ones which are most complete—those of Hall and Clark. Their form is, it seems highly probable, a *wabashensis*.

The specimens from the Wewoka formation are small, transverse, and extended at the hinge. The ventral valve is strongly convex, flattened across the median portion, falls away abruptly and nearly vertically at the sides, and is almost geniculate around the margin of the visceral area, which has a flattened appearance. A rather narrow, deep sinus is found in the anterior half of the shell, but it hardly extends back of the geniculation. The ears are relatively large, depressed, and extended.

The sculpture consists of rather fine, weak, transverse wrinkles which are confined to the visceral area. Moderately fine, more or less indistinct and irregular costæ are developed over the same region, becoming as a rule obsolete farther forward. The spines are few and rather large and are chiefly developed on the anterior half of the shell, where they sometimes give rise to large longitudinal plications. Smaller spines are sparingly developed on the visceral area and along the hinge.

The dorsal valve is gently concave, and leaves considerable space between its inner surface and the ventral valve; it develops marginally the piled-up leaf-like lamellæ characteristic of the genus. The surface markings on this valve are very obscure.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (stations 2001 and 2004).

MARGINIFERA MURICATA Norwood and Pratten.

Plate X, figures 3–4a.

?1852. *Productus Flemingii.* Roemer (non De Koninck), Kreid. von Texas, p. 89, pl. 11, figs. 8a, 8b.
Carboniferous: San Saba Valley, Tex.

1854. *Productus muricatus.* Norwood and Pratten (not *P. muricatus* Phillips), Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 14, pl. 1, figs. 8a–e. (Date of imprint, 1855–1858.)
Coal Measures: Fishhook Creek, Pike County, Ill.; 6 miles northwest of Richmond, Mo.

1857. *Productus muricatus.* Cox, Geol. Survey Kentucky Rept., vol. 3, p. 573, pl. 9, fig. 6.
Coal Measures: Union County, Ill.; Lewisport, Hancock County, Ky.; Gallatin County, Ill.

1876. *Productus muricatus.* White, U. S. Geol. and Geog. Survey Terr., 2d div., Powell's Rept. Geology Uinta Mountains, p. 90.
Lower Aubrey group: Near Echo Park, Utah.

1877. *Productus muricatus.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 120, pl. 8, figs. 4a–c.
Carboniferous: Rock Creek, Lake County, Colo.

1887. *Productus muricatus.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 49.
Coal Measures: Flint Ridge, Ohio.

1888. *Productus muricatus.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 228. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1900. *Productus longispinus.* Knight, Univ. Wyoming, Wyoming Exp. Sta. Bull. No. 45, pl. 3, fig. 10.

1903. *Marginifera muricata.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 373, pl. 5, figs. 5–5b, 6–6b, 7.
Hermosa formation: San Juan region, Colo.
Weber limestone and Maroon formation: Crested Butte district, Colo.
Carboniferous: Glenwood Springs, Colo.

This species is fairly abundant at two or three localities in the Wewoka formation, though not more than three or four specimens have been obtained at any one locality. The fossils studied, though usually more or less broken, appear to be characteristic in every way. The size is small, the average width being about 20 millimeters. The shape is transverse and semicircular. The hinge line is nearly or quite as long as the greatest width. The ventral valve is moderately convex, the beak small, not much projecting, the ears small, depressed, subquadrate, not well defined. A narrow and undefined sinus is usually but not always present. The surface is marked by relatively coarse, somewhat irregular costæ, by transverse wrinkles, and by spines. The wrinkles are largely confined to the ears, where they are rather fine and moderately distinct. They are fainter over the visceral portion and obsolete over the anterior and lateral areas, which are, however, characterized by fine, more or less sublamellose incremental lines and irregularities of growth. The costæ are indistinct over the posterior portion, where they are subordinate to the transverse wrinkles. Toward the margins they bifurcate and are irregular, some being larger than others and raised above the general level. They are indistinct at the sides toward the hinge line. Twenty to twenty-four are developed on the average specimen, but the size and consequently the number varies considerably in different individuals. The spines are numerous and small, variable in number in different specimens, and variable in size in the same specimen. They seem to be most numerous as a rule over the visceral portion, and on the sides near the ears. In some specimens a curved row of relatively large spines helps define the ears from the vault of the shell.

The dorsal valve is like the ventral in shape, leaving but little space for the soft parts. Of course the beak is hardly perceptible. The sculpture also is like that of the ventral. Small spines are certainly present and numerous on some specimens, perhaps few or absent on others. They are smaller than the spines on the other valve.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

MARGINIFERA LASALLENSIS Worthen?

Plate X, figures 5, 5a.

1873. *Productus Lasallensis.* Worthen, Illinois Geol. Survey, vol. 5, p. 569, pl. 25, fig. 9.
Upper Coal Measures: La Salle, Ill.

1892. *Productus (Marginifera) Lasallensis.* Hall and Clarke, New York State Geologist Eleventh Ann. Rept., for 1891, pl. 22, fig. 15.
Upper Carboniferous: La Salle, Ill.

1892. *Productus (Marginifera) Lasallensis.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 1, pl. 17A, fig. 13.
Upper Carboniferous: La Salle, Ill.

1894. *Productus (Marginifera) Lasallensis.* Hall and Clarke, Introd. Study Brach., pt. 1, pl. 22, fig. 15.
Upper Carboniferous: La Salle, Ill.

1903. *Marginifera lasallensis?* Girty, U. S. Geol. Survey Prof. Paper 16, p. 372, pl. 5, figs. 4, 4a.
Weber limestone: Crested Butte district, Colo.

The identification of most of the material here under consideration has presented difficulties that are practically insuperable and the results are far from satisfactory. The salient difficulty has been the discrimination of *Productus semireticulatus*, or at all events a member of that group, from the semireticulate *Marginifera lasallensis*.

M. lasallensis is the largest American representative of the genus, and the only one having the expression of *Productus semireticulatus*. It is distinguished primarily by its generic characters, and secondarily, in point of external form, by its rather small size and deep insinuation. As for the latter character, it is not readily distinguished from certain forms of Productus s. s. Most of the specimens under consideration are more or less imperfect and fragmentary, and none of them retains the Marginifera characters unmistakably. Some probably belong to Worthen's species; others, from their large size and somewhat different surface characters, can probably best be referred to the *Producti semireticulati*, though satisfactory evidence is not at hand to show that they are not Marginiferas. They are at least very probably distinct from *M. lasallensis*. Most of the specimens, however, are so imperfect that they can not with any certainty be placed in the one group rather than in the other.

The Wewoka fossils referred here to *Marginifera lasallensis* represent a larger and in part a more coarsely ribbed form than the typical specimen. Some are in fact more coarsely ribbed than others and some have the sinus less strongly developed than in the specimen figured. In their imperfect condition, therefore, they are not well differentiated from *Productus inflatus* var. *coloradoensis*, and indeed all may prove to be variants of the one type.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2004 and 7193).

Genus STROPHALOSIA King.

STROPHALOSIA SPONDYLIFORMIS White and St. John?

Plate X, figure 8.

1868. *Aulosteges spondyliformis*. White and St. John, Chicago Acad. Sci. Trans., vol. 1, p. 118, fig. 2.

Upper Coal Measures: Appanoose and Pottawattamie counties, Iowa.

1890. *Strophalosia spondyliformis*. Beecher, Am. Jour. Sci., 3d ser., vol. 40, p. 242.

?1892. *Strophalosia spondyliformis*. Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 1, pl. 17A, figs. 25, 26.

Coal Measures: Missouri.

I have discovered only one specimen of this diminutive species. It is attached to an example of *Lophophyllum profundum*. The body of the shell, represented by a sort of platform or prominence on the surface of the corallum, conforming, however, to the characteristic costæ of the coral, has a subcircular shape and from it the anchoring spines project in an irregular manner. The specimen is so worn or broken that the position of the hinge line can not be determined. If this line was in one place the shape may have been elongate-ovate, like that of White and St. John's species; if it was in another, the shape may have been more transverse, the cardinal area being nearly equal to the greatest width and in excess of the greatest length. However, it is not likely that the shape of true *S. spondyliformis* is constant, as such attached forms usually exhibit great variation in form. It is only on some such hypothesis that Hall and Clarke's reference can properly be included in the synonymy of *S. spondyliformis*. Their figures show a form of quite different shape, which is, moreover, attached only by the umbo, instead of by most of the surface of the ventral valve.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Family RHYNCHONELLIDÆ.

Genus PUGNAX Hall and Clarke.

PUGNAX OSAGENSIS Swallow.

Plate X, figures 11–11c.

1852. *Terebratula pugnus.* Roemer (non Martin), Kreid. von Texas, p. 89.
Carboniferous: San Saba Valley, Tex.

1858. *Rhynconella (Camarophoria) Osagensis.* Swallow, Acad. Sci. St. Louis Trans., vol. 1, p. 219 (date of volume, 1860).
Upper Coal Measures: Missouri and Kansas.

1859. *Rhynchonella Uta.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 27.
Upper Coal Measures: Manhattan, Kans.

?1861. *Rhynchonella uta.* Newberry, Ives's Rept. Colorado River of the West, pt. 3, p. 128.
Upper Carboniferous: Near mouth of Little Colorado River.

?1861. *Rhynchonella* sp. Salter, Geol. Soc. London Quart. Jour., vol. 17, p. 64, pl. 4, fig. 5.
Carboniferous: Isthmus of Copacabana, Lake Titicaca.

1866. *Camarophoria globulina.* Geinitz (non Phillips), Carb. und Dyas in Nebraska, p. 38, pl. 3, figs. 5a–d.
Upper Coal Measures: Bennetts Mill and Nebraska City, Nebr.

1872. *Rhynchonella Osagensis.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 179, pl. 1, figs. 9a, 9b; pl. 6, figs. 2a, 2b.
Upper Coal Measures: Nebraska City, Nebr.
Coal Measures: Iowa, Missouri, Kansas.
Upper, middle, and lower Coal Measures: Illinois.

1873. *Rhynchonella Osagensis.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 571, pl. 26, fig. 22.
Coal Measures: Danville and Fulton County, Ill.

?1875. *Rhynchonella Uta.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 128, pl. 9, figs. 2a–c. (Whole volume published in 1877.)
Carboniferous: North Fork of Lewiston Canyon, Oquirrh Range, and at Meadow Creek, south of Fillmore, Utah.

1884. *Rhynchonella uta.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 132, pl. 25, fig. 6.
Coal Measures: Indiana.

1891. *Rhynchonella uta.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 247.
Lower Coal Measures: Des Moines, Iowa.

1893. *Pugnax Uta.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 204. (Advance distribution in fascicles.)
Coal Measures: Manhattan, Kans.

1894. *Pugnax Utah.* Hall and Clarke, New York State Geologist Thirteenth Ann. Rept., for 1893, pl. 44, figs. 17–19.
Coal Measures: Manhattan, Kans.

1894. *Pugnax uta.* Hall and Clarke, Introd. Study Brach., pt. 2, pl. 44, figs. 17–19.
Coal Measures: Manhattan, Kans.

1895. *Rhynchonella uta.* Keyes, Missouri Geol. Survey, vol. 5, p. 103, pl. 41, fig. 7. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City and Lexington, Mo.

1895. *Pugnax Uta.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 204, pl. 60, figs. 39–42. (Date of imprint, 1894.)
Coal Measures: Manhattan, Kans.

1896. *Rhynchonella uta.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 240.
Upper Coal Measures: Sebastian County, Ark., and Poteau Mountain, Okla.

1897. *Rhynchonella uta.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 30. (Date of imprint, 1896.)
Upper Coal Measures: Sebastian County, Ark., and Poteau Mountain, Okla.

1900. *Pugnax utah.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 93, pl. 12, figs. 7–7c.
Upper Coal Measures: Bronson, Bourbon County, Kansas City, Iola, Olathe, Lawrence, Lecompton, Topeka, Beaumont, Grand Summit, Kans.

1903. *Pugnax utah.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 412, pl. 7, figs. 14–14b.
Maroon formation: Crested Butte district, Colo.

?1904. *Pugnax uta.* Reagan, Indiana Acad. Sci. Proc. for 1903, p. 240, pl., figs. 8a, 8b.
Upper Red Wall: White River, 12 miles southwest of Fort Apache, Ariz.

1906. *Pugnax utah.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 274. Carboniferous: Weeping Water, Louisville, Nehawka, and Rock Bluff, Nebr.

1908. *Pugnax osagensis.* Girty, U. S. Geol. Survey Prof. Paper 58, p. 317, pl. 24, fig. 16.
Dark limestone: Guadalupe Mountains, Tex.
Delaware Mountain formation: Guadalupe Mountains, Delaware Mountains, Tex.
Basal Black limestone: Guadalupe Mountains, Tex.

1910. *Pugnax utah.* Raymond, Carnegie Mus. Annals, vol. 7, No. 1, p. 158, pl. 27, fig. 3.
Ames limestone: Brilliant cut-off, Pittsburgh, Pa.

I am interpreting this species according to Meek's description and figures in his report on the paleontology of eastern Nebraska and am provisionally excluding from the synonymy *P. utah* Marcou, by which name it is more commonly called. In doing this I am following the example of Tschernyschew,[1] and there are certainly differences enough between Marcou's figures and those of the Mississippi Valley form to show that they are distinct species if Marcou's figures can be depended on and if the two types are not too intimately connected by intermediate variations. Tschernyschew, however, claims to have found them in association at Manhattan, Kans.

Thus interpreted, *P. osagensis* comprises small, rather strongly gibbous, transverse, subtriangular to subpentagonal shells, normally with three somewhat rounded costæ on the fold and two or three similar

[1] Tschernyschew, Th., Com. Géol. [Russia] Mém., vol. 16, No. 2, p. 482.

ones on the side. The lateral costæ are not so large nor so strong as the mesial ones.

Only three specimens in the collection under consideration can be referred to *P. osagensis;* one of them is badly compressed but all seem to be in every way characteristic.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005); Coalgate quadrangle, Okla. (station 2001).

PUGNAX OSAGENSIS var. PERCOSTATA Girty.

Plate X, figures 9–10c.

1911. *Pugnax osagensis* var. *percostata.* Girty, New York Acad. Sci. Annals, vol. 21, p. 130.
Wewoka formation: Coalgate quadrangle, Okla.

This form is more abundant in the Wewoka formation than the typical variety. The specimens here referred to it agree in a general way with *P. osagensis*, the only important difference being that the plications are more numerous, smaller, and more angular. Of these there are usually five fairly strong ones on each side, but there may be four or six. Three is the usual number for the fold but four and even five occur in a very few specimens. Individuals with three mesial plications and four laterals, especially those in which one or two of the laterals are immature or imperfectly developed, might equally well be placed under *P. osagensis* itself. Apparently this variety has been referred by authors unqualifiedly to *osagensis*, but I believe it can be distinguished to advantage.

This form resembles *P. osagensis* var. *occidentalis,* which is, however, a much larger species, with, on the whole, more numerous mesial plications, and which occurs in a very different faunal association.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (stations 2001, 2004?, and 7193?).

PUGNAX ROCKYMONTANA Marcou.

Plate X, figures 13–14b.

1858. *Terebratula rocky-montana.* Marcou, Geology of North America, p. 50, pl. 6, figs. 13–13c.
Mountain limestone: Pecos village, N. Mex.

1860. *Rhynchonella eatoniæformis.* McChesney, Desc. New Spec. Foss., p. 49. (Date of imprint, 1859.)
Coal Measures: Graysville, Ill.; Big Creek limestone, Indiana.

1877. *Rhynchonella Rockymontana.* White, U. S. Geog. Surveys W. 100 Mer. Rept., vol. 4, p. 131, pl. 9, figs. 1a–d.
Carboniferous: Near Beckwith Spring, Cedar Range, Utah.

1893. *Pugnax Eatoniiformis.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 204. (Advance distribution in fascicles.)

1895. *Pugnax Eatoniiformis.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 204, pl. 60, figs. 11, 12. (Date of imprint, 1895.)
Coal Measures: Graysville, Ill.

1900. *Pugnax rockymontana.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 92, pl. 12, figs. 8, 8b.
Lower Coal Measures: Coffeyville, Montgomery County, and Kansas City, Kans.

This usually rare species is rather common in the Wewoka formation. The shell is large. The shape is, as a rule, more or less strongly triangular, or in some specimens pentagonal, though many young specimens are somewhat oval. The convexity is generally high. The dorsal valve is gently convex longitudinally and strongly convex transversely. The ventral valve is rather strongly convex longitudinally with a deep sinus and very prominent lateral angles. Its beak is small. The fold is marked by three and the sinus by two large, strong, angular plications. A very few specimens have a fourth supernumerary plication, smaller than the others and not coordinate with them. The plications are strong only toward the margin and they do not reach to the beak, dying out earlier in some specimens than in others. The sides are unplicated.

There is a small low septum in the dorsal valve, which divides close to the posterior extremity to form a diminutive spondylium. For some time I thought that the ventral valve was without the usual dental plates and in some specimens I have not been able to discover them. They seem to be small, far apart, and close to the rostral wall on either side, so that they are not easily detected.

Pugnax rockymontana has more the expression of typical Pugnax than any of the other species of the Pennsylvanian fauna. It has, however, a low septum and small spondylium, structures which seem to be lacking in *P. acuminata.* For the size of the shell, however, these structures are less well developed than in *P. osagensis.* In fact, according to my observations, most of the Carboniferous Pugnaces have these structures more or less well developed and differ only in degree (and some of them in no high degree) from Camarotœchia in this particular- It is my belief that if these shells are to be subdivided, as for conven. ience it is desirable that they should be, a more satisfactory basis of division would be external expression. In this regard *P. osagensis* would perhaps be placed more properly with Camarotœchia than with such forms as *Pugnax missouriensis* or *P. rockymontana,* standing in many respects midway between the two groups.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Genus RHYNCHOPORA Hall and Clarke.

RHYNCHOPORA ILLINOISENSIS Worthen.

Plate X, figures 12–12c.

1884. *Rhynchonella illinoiensis.* Worthen, Illinois State Mus. Nat. Hist. Bull. No. 2, p. 24.
Coal Measures: Peoria County, Ill.
1890. *Rhynchonella illinoiensis.* Worthen, Illinois Geol. Survey, vol. 8, p. 104, pl. 11, figs. 3–3c.
Coal Measures: Peoria County, Ill.
1904. *Rhynchopora illinoisensis.* Greger, Am. Geologist, vol. 33, p. 299, figs. 1–3.

This species is represented by a single specimen, unfortunately very fragmentary, which agrees very closely with Worthen's description and figures. It is highly convex and globular, the ventral valve strongly arched from front to back and the dorsal valve correspondingly strongly arched from side to side. The width exceeds the length. The plications are moderately strong and rather rounded and are distributed so that eight occur on the fold and about seven on each side; several more lateral costæ are indicated by denticulations on the edges of the shell rather than by striæ on the surface. The plications of the fold and sinus make strongly interlocking denticles on the flattened anterior portion. The specimen, which is an internal mold, clearly shows the punctate character of the shell.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Family SPIRIFERIDÆ.

Genus SPIRIFERINA King.

SPIRIFERINA KENTUCKYENSIS.

Plate XI, figures 8, 8a.

1852. *Spirifer octoplicata?* Hall, Stansbury's Expl. and Survey Great Salt Lake of Utah,[1] p. 409, pl. 4, figs. 4a, 4b. (Not *S. octoplicata* Sow.)
Carboniferous: Missouri River, near Weston.
1855. *Spirifer Kentuckensis.* Shumard, Missouri Geol. Survey Second Ann. Rept., p. 203.
Coal Measures: Missouri River, near Weston, and Grayson County, Ky.
1856. *Spirifer kentuckensis.* Hall, Pacific Railroad Rept., vol. 3, pt. 4, p. 102, pl. 2, figs. 10, 11.
Carboniferous: Pecos village, N. Mex.
1859. *Spirifer Kentuckensis.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 27. (Date of imprint, 1860.)
Upper Coal Measures: Leavenworth, Kans.

[1] This edition was printed in Philadelphia as a Senate executive document. Another edition, also a Senate executive document, was printed in Washington in 1853, and a third appeared unofficially in Philadelphia in 1855. The pagination is the same in all.

1866. *Spirifer laminosus.* Geinitz, Carb. und Dyas in Nebraska, p. 45, tab. 3, figs. 19a–d. (Not *S. laminosus* McCoy.)
Upper Coal Measures: Plattsmouth and Nebraska City, Nebr.

1872. *Spiriferina Kentuckensis.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 185, pl. 6, figs. 3a–d; pl. 8, figs. 11a, 11b.
Upper Coal Measures: Nebraska City, Nebr.; Kentucky; Illinois; Missouri; Iowa; Nebraska; Kansas; Texas; New Mexico.
Lower Coal Measures: Illinois and Iowa.

1876. *Spiriferina Kentuckensis.* White, U. S. Geol. and Geog. Survey Terr., 2d div., Powell's Rept. Geology Uinta Mountains, p. 90.
Lower and Upper Aubrey group: Confluence of Grand and Green rivers, Utah.

1877. *Spiriferina Kentuckensis.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 138, pl. 10, figs. 4a–c.
Carboniferous: Santa Fe, N. Mex.; Meadow Creek south of Fillmore, Utah. Camp Apache, Ariz.

?1883. *Spirifera (Spiriferina) Kentuckiensis.* Hall, New York State Geologist Rept., for 1882, pl. (36) 61, figs. 14–16.
Coal Measures.

1884. *Spiriferina Kentuckensis.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 135, pl. 35, figs. 13, 14.
Upper and Middle Coal Measures: Vermilion, Vigo, Knox, Gibson, Posey; Vanderburg, Dubois, and Spencer counties, Ind.

1888. *Spiriferina kentuckensis.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 231 (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

?1893. *Spiriferina Kentuckiensis.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 54. (Advance distribution in fascicles.)

1895. *Spiriferina kentuckensis.* Keyes, Missouri Geol. Survey, vol. 5, p. 86. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City and Lexington, Mo.

?1895. *Spiriferina Kentuckiensis.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 54, pl. 29, fig. 17; pl. 36, figs. 14–16. (Date of imprint, 1894.)
Coal Measures: Vinton County, Ohio; Illinois.

1896. *Spiriferina cristata.* Smith (pars), Am. Philos. Soc. Proc., vol. 35, p. 242.
Lower Coal Measures: Conway County, Ark.
Upper Coal Measures: Sebastian County, Ark., and Poteau Mountain, Okla.

1897. *Spiriferina cristata.* Smith (pars), Leland Stanford Junior Univ. Pub., Contrib. Biol. Hopkins Seaside Lab. No. 9, p. 32. (Date of imprint, 1896.)
Lower Coal Measures: Conway County, Ark.
Upper Coal Measures: Sebastian County, Ark., and Poteau Mountain, Okla.

1900. *Spiriferina cristata.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 96.
Upper and Lower Coal Measures: Fort Scott, Bronson, Bourbon County, Thayer, Kansas City, Lawrence, Lecompton, Topeka, Kans.

1903. *Spiriferina kentuckyensis.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 400, pl. 6, figs. 11–11c.
Hermosa formation: San Juan region, Colo.
Maroon formation: Crested Butte district, Colo.
Carboniferous: Uinta Mountain region and Glenwood Springs, Colo.

1904. *Spiriferina kentuckyensis.* Girty, U. S. Geol. Survey Prof. Paper 21, p. 53, pl. 11, figs. 17, 18.
Pennsylvanian (Naco limestone): Bisbee quadrangle, Ariz.

1906. *Spiriferina cristata.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 280, pl. 12, fig. 2.
Carboniferous: Weeping Water, Louisville, Cedar Creek, Nehawka, and Rock Bluff, Nebr.

Only one specimen belonging to this species has come to hand from the Wewoka formation, but it seems to be a characteristic representative. The shape is subtrigonal with acute extended cardinal angles. The lateral plications are high and sharply rounded, five to seven in number. The fold and sinus are simple, larger, and more prominent than the lateral ribs. Usually traces of a mesial plication more or less faint can be seen on them. The surface is crossed by closely and regularly arranged lamellæ with granulose edges.

Some authors regard *Spiriferina kentuckyensis* and *S. spinosa* as the same, but in so doing they confuse two entirely different species which can usually be distinguished without much difficulty even when exfoliated. Some authors also regard *S. kentuckyensis* as a synonym of *S. cristata* Schlotheim, but after examining specimens of the European species which I have reason to believe to be typical, I am satisfied that they are distinct.

The form which Hall and Clarke figured (in 1883 and 1895) as *S. kentuckyensis* seems to be a different species. It is larger, less transverse, with a short instead of an extended hinge line, and with low and broad instead of narrow high plications. It is very suggestive of *S. subelliptica,* but if really a Pennsylvanian species I should hardly know where to place it.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus SPIRIFER Sowerby.

SPIRIFER CAMERATUS Morton.

Plate XI, figures 4–4b.

1836. *Spirifer cameratus.* Morton, Am. Jour. Sci., 1st ser., vol. 29, pp. 32, 150, pl. 2, fig. 3.
Coal Measures: Putnam Hill, Zanesville, Ohio.

1849. *Spirifer Meusebachianus.* Roemer, Texas, p. 420.
Carboniferous limestone: About 20 miles below the Spanish forts, San Saba River, Tex.

1852. *Spirifer triplicata.* Hall, Stansbury's Exploration and Survey Great Salt Lake of Utah, p. 410, pl. 4, figs. 5a–e. (Printed in Philadelphia as a Senate executive document (No. 3). Reprinted in Washington in 1853, with same pagination. Reprinted in Philadelphia in 1855 but not as a Senate executive document.)
Carboniferous: Missouri River above Weston.

1852. *Spirifer fasciger?* Owen, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, pl. 5, fig. 4. (Not *Spirifer fasciger* Keyserling.)
Carboniferous: Missouri River, near mouth of Keg Creek, and Plattsburg, Mo.

1852. *Spirifer inequicostatus?* Owen, Rept. Geol. Survey Wisconsin, Iowa, and Minnesota, p. 586, pl. 5, fig. 6. (See specimens in U. S. Nat. Mus. Cat. Invert. Foss., 17954.)
Carboniferous limestone of Iowa: Skunk River?, Iowa.

1852. *Spirifer Meusebachanus.* Roemer, Kreid. von Texas, p. 88, tab. 11, figs. 7a–c.
Carboniferous: About 20 miles below the old Spanish forts, San Saba River, Tex.

1856. *Spirifer cameratus.* Hall, Pacific Railroad Rept., vol. 3, pt. 4, p. 102, pl. 2, figs. 9, 12, 13.
Carboniferous: Pecos village, N. Mex.

1858. *Spirifer striatus* var. *triplicatus.* Marcou, Geology of North America, p. 49, pl. 7, fig. 3.
[Mountain limestone:] Abundant in the Rocky Mountains, especially at Pecos village, at Tigeras, on the summit of the Sierra de Sandia, in Great Salt Lake, and on Vancouver Island.

?1858. *Spirifer Rockymontani* (pars). Marcou, idem, p. 50, pl. 7, figs. 4–4b.
Mountain limestone: Tigeras, N. Mex.

1858. *Spirifer cameratus.* Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 709, pl. 28, figs. 2a, 2b.
Coal Measures: Ohio; Illinois; Iowa; Missouri; Nebraska; Santa Fe and Pimas village, N. Mex.

1858. *Spirifer.* Rogers, Geology of Pennsylvania, vol. 2, pt. 2, p. 833, fig. 694.
Western Coal Measures: Pennsylvania.

1859. *Spirifer cameratus.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 27. (Date of imprint, 1860.)
Upper Coal Measures: Kansas.

?1859. *Spirifer cameratus.* Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 391. (Date of imprint, 1860.)
Permian sandstone and White limestone: Guadalupe Mountains, Tex.

1861. *Spirifer cameratus.* Newberry, Ives's Rept. Colorado River of the West, pt. 3, p. 127.
Upper Carboniferous limestone: Santa Fe and Pecos Village, N. Mex.

1866. *Spirifer cameratus.* Geinitz, Carb. und Dyas in Nebraska, p. 44.
Carboniferous limestone: Bellevue and Plattsmouth, Nebr.; stage B, b^1, Nebraska City, and stage B, b, Bennetts Mill, northwest of Nebraska City, Nebr.

1872. *Spirifer cameratus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 183, pl. 6, fig. 12; pl. 8, fig. 15.
Upper Coal Measures: Nebraska City, Nebr.
Coal Measures: Eastern Ohio, West Virginia, Pennsylvania, Iowa, Kansas, Texas, New Mexico.

1873. *Spirifer cameratus.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 573, pl. 25, fig. 7.
Coal Measures: Illinois.

1873. *Spirifer*, young of *S. cameratus?* Meek and Worthen, idem, pl. 25, figs. 6a–c.
Coal Measures: Illinois.

1874. *Spirifera camerata.* Derby, Cornell Univ. (Science) Bull., vol. 1, No. 2, p. 12, pl. 1, figs. 1, 3, 6, 9, 14; pl. 2, figs. 2, 15; pl. 4, fig. 5; pl. 5, fig. 11.
Coal Measures: Bomjardim and Itaituba, Brazil.

1875. *Spirifer cameratus.* Toula, Neues Jahrb., p. 240, pl. 7, fig. 3.
Permo-Carboniferous: West coast of Spitzbergen.

?1875. *Spirifer cameratus.* Toula, K. Akad. Wiss. Wien, Math. Naturw. Classe, Sitzungsber., vol. 71, Abth. 1, p. 543, pl. 2, figs. 2a, 2b.
Carboniferous limestone: Nova Zembla.

1876. *Spirifer cameratus.* White, U. S. Geol. and Geog. Survey Terr., 2d div., Powell's Rept. Geology Uinta Mountains, p. 90.
Lower Aubrey group: Confluence of Grand and Green rivers, Utah.

1876. *Spirifer cameratus.* Newberry, Macomb's Rept. Expl. Exped. from Santa Fe to Grand and Green rivers, p. 138.
Upper Carboniferous: New Mexico and Utah.

?1876. *Spirifer camerata.* Meek, Engineer Dept. U. S. Army, Simpson's Rept. Expl. Great Basin, Utah, p. 353, pl. 2, figs. 3a, 3b.
Yellow limestone (Upper Carboniferous?): Summit Spring Pass, east of Zuni Valley, etc.

1877. *Spirifer cameratus.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 132, pl. 10, figs. 1a–d.
Carboniferous: Fossil Hill, White Pine County; Ely Range; Old Potosi mine, Lincoln County, and Egan Range, 35 miles south of Egan Pass, Nevada; Camp Apache, Maricopa County; Salt River; confluence of White Mountain and Black rivers; and Canyon Butte, Ariz.; Oquirrh Range, near Camp Floyd; Lake Range on Fairfield road; west face of Oquirrh Range; North Fork of Lewiston Canyon, Oquirrh Range; cliff east of Bellevue; Meadow Creek, south of Fillmore; North Star district; Picacho Range; near Beckwith Spring, Cedar Range; Rock Canyon, Wasatch Range, near Provo; and Virgin Range, southwest of St. George, Utah; Santa Fe, N. Mex., and northern Missouri (figured specimens).

?1877. *Spirifer (Trigonotreta) cameratus.* Meek, U. S. Geol. Expl. 40th Par. Rept., vol. 4, p. 91, pl. 9, figs. 2, 2a.
Carboniferous limestone: Fossil Hill, White Pine district, Ruby group, Nev. Also, latitude 39° 33′ north, longitude 115° 12′ west.

1880. *Spirifer cameratus.* White, Indiana Dept. Statistics and Geology Second Ann. Rept., p. 517, pl. 8, fig. 3.
Coal Measures: Waterman, Parke County, Ind.

1881. *Spirifera cameratus.* White, Indiana Geol. Rept., 1879–80, p. 149, pl. 8, fig. 3.
Coal Measures: Waterman, Parke County, Ind.

1883. *Spirifera camerata.* Hall, New York State Geologist Rept. for 1882, pl. (32) 57, figs. 9–15.
Coal Measures: Ohio, Illinois, Iowa, and Missouri.

1884. *Spirifer cameratus.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Rept., pt. 2, p. 132, pl. 35, figs. 3–5.
Coal Measures: Indiana.

1887. *Spirifera camerata.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 45, pl. 2, fig. 22.
Coal Measures: Flint Ridge, Ohio.

1888. *Spirifera camerata.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 230.
Lower Coal Measures: Des Moines, Iowa.

1893. *Spirifer cameratus.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, pp. 26, 38. (Advance distribution in fascicles.)
Coal Measures: Ohio, Illinois, Missouri, and Iowa.

1894. *Spirifer cameratus.* Hall and Clarke, Introd. Study Brach., pt. 2, pl. 26, figs. 7, 8.
Coal Measures: Missouri, Illinois.

1894. *Spirifer cameratus.* Hall, New York State Geologist Thirteenth Ann. Rept., for 1893, pl. 26, figs. 7, 8.
Coal Measures: Missouri, Illinois.

1895. *Spirifera camerata.* Keyes, Missouri Geol. Survey, vol. 5, p. 83, pl. 40, figs. 5a–c. (Date of imprint, 1894.)
Coal Measures: Clinton, Kansas City, and Lexington, Mo.

1895. *Spirifer cameratus.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, pp. 26, 38, pl. 32, figs. 9–15.
Coal Measures: Ohio, Illinois, Missouri, Iowa.

1896. *Spirifer cameratus.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 241.
Upper Coal Measures: Sebastian County, Ark; Poteau Mountain, Okla.
Lower Coal Measures: Conway County, Ark.

1897. *Spirifer cameratus.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 31. (Date of imprint, 1896.)
Upper Coal Measures: Sebastian County, Ark.; Poteau Mountain, Okla.
Lower Coal Measures: Conway County, Ark.

1898. *Spirifer cameratus.* Beede, Kansas Univ. Quart., vol. 7, No. 2, p. 103, figs. 1–3, pl. 6.

1900. *Spirifer cameratus.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 99, pl. 12, figs. 5–5e.
Upper Coal Measures: Kansas City, Lawrence, Lecompton, Topeka, Grand Summit, Kans.

1903. *Spirifer cameratus.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 385.
Hermosa formation: San Juan region, Ouray, and Sinbads Valley, Colo.
Maroon formation: Crested Butte district, Colo.
Carboniferous: Glenwood Springs, Colo.

1904. *Spirifer cameratus.* Girty, U. S. Geol. Survey Prof. Paper 21, p. 53, pl. 11, figs. 13, 14.
Pennsylvanian (Naco limestone): Bisbee quadrangle, Ariz.

1906. *Spirifer cameratus.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 279, pl. 12, fig. 1.
Carboniferous: Louisville, Cedar Creek, Weeping Water, Nehawka, and Rock Bluff, Nebr.

This species is too well known and has been too often described for me to do more at this place than merely to call attention to certain points. One feature which few, if any, authors have remarked upon is the fine, microscopic ornamentation which was doubtless found on all specimens but which can now be observed only on the best preserved of them. In what are possibly typical examples this consists of extremely minute, radiating and concentric lines of nearly equal strength, with the transverse markings a little more prominent and persistent than the others. The two systems are on about the same scale.

That such a sculpture was to be expected is evident for I have observed it on many species of the *striatus* group and believe it to be a group character. Different species, however, show different modifications, one system of lines dominating in one and the other in another, the scale also varying both as a combination and differentially.

Though *S. cameratus* is usually an abundant species in Pennsylvanian faunas, it seems to be rare in the Wewoka formation, and to vary slightly from the type. Most of the specimens examined are more or less imperfect, the breakage being greatest where the shell is thinnest—at the hinge extremities. Thus at first glance, since the specimens are with a single exception uniform in this regard, one receives the impression that the outline contracts at the hinge and that the greatest width is a little in front and does not have the usual excess over the greatest length. A study of the lines of growth, however, leaves little doubt that the original shape, while not extremely transverse, offered no departure from the normal. A real difference, as distinguished from that of appearance only, is found in the costation; the costæ have the characteristic fasciculation near the apex of either valve, but the large folds thus formed abruptly die out, so that the surface below is as even as that of the nonfasciculate group of Spirifers. I believe, but am not certain, that this same variation occurs in specimens from the Mississippi Valley, and for the present do not regard it of sufficient value for varietal distinction.

The preservation of these shells is not favorable to the retention of the minutiæ of sculpture, but they show fine, crowded, sublamellose, transverse liræ, and I believe I have detected traces of fine radial markings.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

SPIRIFER aff. S. BOONENSIS Swallow.[1]

Plate XI, figure 5.

Among the Spirifers of the Wewoka formation a single specimen presents characters which seem to distinguish it from the more common *Spirifer cameratus* and to indicate that it belongs to an altogether different group. It has the general appearance of *S. cameratus*, being large and long-winged, but its plications are much larger, nonbifurcate, and therefore nonfasciculate. Toward the front especially they are broad, flat, and rather poorly defined by narrow, shallow striæ, those in the sinus being particularly indistinct. Exception must be made to the statement that the costæ do not divide, for those in the sinus divide freely, and one or two of the lateral ones nearest to the sinus show indications of dividing, but in the main the lateral costæ are undivided even toward the front and are unfasciculate even at the beak.

The fine surface markings are not shown.

This shell apparently does not belong to the same species as those identified as *S. cameratus*, unless it be regarded as a very aberrant example. It seems better, however, to regard it as more nearly related to *S. rockymontanus* and *S. boonensis*, though hardly referable to either species on strict construction.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

[1] Swallow, St. Louis Acad. Sci. Trans., vol. 1, p. 646, 1860; also Girty, U. S. Geol. Survey Prof. Paper 16, p. 381, Pl. VI, figs. 1-3, 1903.

Genus SQUAMULARIA Gemmellaro.

SQUAMULARIA PERPLEXA McChesney.

Plate XI, figures 1–3a.

1855. *Spirifer lineatus.* Shumard (not *S. lineatus* Martin), Missouri Geol. Survey Second Ann. Rept., p. 216.
Coal Measures: [Missouri].

1856. *Spirifer lineatus.* Hall (not *S. lineatus* Martin), Pacific Railroad Rept., vol. 3, pt. 4, p. 101, pl. 2, figs. 6–8.
Carboniferous: Pecos village, N. Mex.

1858. *Spirifer lineatus.* Marcou (not *S. lineatus* Martin), Geology of North America, p. 50, pl. 7, figs. 5–5c.
Mountain limestone: Pecos village and Tigeras, N. Mex.

1859. *Spirifer lineatus.* Meek and Hayden (not *S. lineatus* Martin), Acad. Nat. Sci. Philadelphia Proc., p. 28. (Date of imprint, 1860.)
Upper Coal Measures: Leavenworth, Kans.

1860. *Spirifer perplexa.* McChesney, Desc. New Spec. Foss., p. 43. (Date of imprint, 1859.)
Upper Coal Measures: Almost every part of the country where rocks of that age occur.

1861. *Spirifer lineatus.* Newberry (not *S. lineatus* Martin), Ives's Rept. Colorado River of the West, pt. 3, p. 127.
Upper Carboniferous: Cherty limestone west of Little Colorado River; vicinity of Santa Fe, N. Mex.; Kansas; Missouri.

?1864. *Spirifer lineatus.* Meek (not *S. lineatus* Martin), California Geol. Survey, Paleontology, vol. 1, p. 13, pl. 2, figs. 6–6d.
Carboniferous: Bass's ranch, Shasta County, Cal.

1866. *Spirifer lineatus.* Swallow (not *S. lineatus,* Martin), Acad. Sci. St. Louis Trans., vol. 2, p. 408. (Date of imprint, 1868.)
Coal Measures: Mississippi Valley.

1866. *Spirifer lineatus* var. *perplexa.* Swallow, idem, p. 408.
Coal Measures: Mississippi Valley.

1866. *Spirifer lineatus* var. *striato-lineatus.* Swallow, idem, p. 408.
Upper and Middle Coal Measures: Missouri.

1872. *Spirifer lineatus?* Meek, U. S. Geol. Survey Nebraska Final Rept., pl. 2, figs. 3a, 3b.
Upper Coal Measures: Platte River, Nebr.

1874. *Spirifera* (*Martinia*) *perplexa.* Derby, Cornell Univ. (Science) Bull., vol. 1, No. 2, p. 16, pl. 3, figs. 27, 39, 40, 45, 50; pl. 8, fig. 13.
Coal Measures: Bomjardim and Itaituba, Brazil, and River Pichis, Peru.

1881. *Spirifer* (*Martinia*) *lineatus?* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 3, Suppl., Appendix, p. xii.
Coal Measures: Coyote Creek, N. Mex.

1882. *Spirifer* (*Martinia*) *lineatus.* White, Indiana Dept. Geology and Nat. Hist. Eleventh Rept., p. 372, pl. 42, figs. 4–6.
Coal Measures: Eugene, Ind.

1884. *Spirifer* (*Martinia*) *lineatus.* White, idem, Thirteenth Rept., pt. 2, p. 133, pl. 27, figs. 4–6.
Coal Measures: Fountain, Park, Vermilion, Vigo, Sullivan, Gibson, Pike, Knox, Posey, Vanderburg, and Warrick counties, Ind.

1886. *Spirifer lineatus?* Heilprin, Pennsylvania Second Geol. Survey Ann. Rept. for 1885, p. 453.
Upper Coal Measures, Mill Creek limestone: Wilkes-Barre, Pa.

1886. *Spirifer lineatus?* Heilprin, Wyoming Hist. and Geol. Soc. Proc. and Coll., vol. 2, pt. 2, p. 269.
Upper Coal Measures, Mill Creek limestone: Wilkes-Barre, Pa.

1887. *Spirifera (Martinia) lineata?* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 46, pl. 1, figs. 13a–c.
Coal Measures: Flint Ridge, Ohio.

1888. *Spirifera lineata.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 230. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1893. *Spirifer lineatus.* Hall and Clarke (not *S. lineatus* Martin), New York Geol. Survey, Paleontology, vol. 8, pt. 2, pp. 10, 11, 17, 21, 30, 39. (Advance distribution in fascicles.)
Coal Measures: Iowa.

1895. *Spirifera perplexa.* Keyes, Missouri Geol. Survey, vol. 5, p. 84. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1895. *Spirifer lineatus.* Hall and Clarke (not *S. lineatus* Martin), New York Geol. Survey, Paleontology, vol. 8, pt. 2; pp. 10, 11, 17, 21, 30, 39, pl. 38, figs. 2, 4, 7, 8.
Coal Measures: Iowa.

1899. *Reticularia perplexa.* Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 577, pl. 72, fig. 1a.
Upper Coal Measures: McAlester quadrangle.

1900. *Reticularia perplexa.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 102, pl. 12, figs. 4–4c.
Upper and lower Coal Measures to base of Permian: Fort Scott, Iola, Lawrence, Topeka, Kans.

1900. *Martinia lineata.* Herrick and Bendrat, Am. Geologist, vol. 25, No. 4, p. 240.
Coal Measures: Sandia Mountains, N. Mex.

1903. *Squamularia perplexa.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 392, pl. 6, figs. 8, 8a, 9–9b, 10, 10a.
Hermosa formation: San Juan region and Ouray, Colo.
Weber formation: Crested Butte and Leadville districts, Colo.
Maroon formation: Crested Butte district, Colo.
Robinson limestone: Leadville district, Colo.

1906. *Reticularia perplexa.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 279, pl. 11, fig. 5.
Carboniferous: Weeping Water, Cedar Creek, Louisville, and Nehawka, Nebr.

1909. *Squamularia perplexa.* Girty, U. S. Geol. Survey Bull. 389, p. 66.
Yeso formation: Mesa del Yeso, N. Mex.
San Andreas formation: San Andreas, N. Mex.

1910. *Squamularia perplexa.* Raymond, Carnegie Mus. Annals, vol. 7, No. 1, p. 156, pl. 24, fig. 3.
Vanport limestone: New Castle, Pa.

This species is moderately abundant in the Wewoka formation and shows considerable variation. The size attained is rather uncommon, the largest specimen having a width of no less than 25 millimeters. The shape is subcircular to subquadrate; the length and breadth being about equal. In some specimens the length is distinctly greater; in others, including most young specimens, the width is greater. The form is usually highly gibbous, the ventral valve being much more strongly convex than the dorsal. Correspondingly, the umbonal region of both valves is prominent and the beaks are distinct and strongly incurved. A faint, narrow sinus is usually present in the ventral valve. The outline is strongly and rather abruptly contracted at the hinge, which is considerably shorter than the width in front. The area is well defined, strongly arcuate, cut by an equilateral delthyrium whose base occupies about one-third of the cardinal line. The deltidial plates are usually more or less completely preserved.

The sculpture consists of slightly elevated concentric ridges bearing fimbriose lamellæ. The spines are small and in some specimens can be seen to be double-barreled. Great diversity is shown in the distance between the lamellæ; the maximum interval observed is 3 millimeters, but the average is much less, and in most mature shells the lamellæ are more crowded near the front.

There are no internal plates.

I have removed from the synonymy Whitfield's citations in 1891 and 1895 of specimens from Hocking County, Ohio, because I feel fairly confident that he had in hand an Athyroid, probably *Cliothyridina orbicularis*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Genus AMBOCŒLIA Hall.

AMBOCŒLIA PLANICONVEXA Shumard.

Plate XI, figures 6–7b.

1855. *Spirifer plano-convexa.* Shumard, Missouri Geol. Survey Second Ann. Rept., p. 202.
Upper Coal Measures: On Missouri River, near mouth of Platte River.

1859. *Spirifer planoconvexa.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 28. (Date of imprint, 1860.)
Upper Coal Measures: Manhattan, Juniata, and Leavenworth, Kans.

1860. *Ambocelia gemmula.* McChesney, Desc. New Spec. Foss., p. 41.
Coal Measures: Peoria and Bureau counties, Ill.

1864. *Spirifer (Martinia) plano-convexus.* Meek and Hayden, Smithsonian Contrib. Knowledge, No. 172, p. 20, figs. a–e.
Coal Measures: Manhattan and Upper Mill Creek, Kans.

1865. *Spirifer (Martinia) plano-convexus.* Meek and Hayden, Smithsonian Contrib. Knowledge, vol. 14, art. 5, p. 20, figs. a–e.
Coal Measures: Manhattan and Upper Mill Creek, Kans.

1866. *Spirifer plano-convexus.* Geinitz, Carb. und Dyas in Nebraska, p. 42, tab. 3, figs. 10–18.
Upper Coal Measures: Plattsmouth, Nebraska City, Nebr.

1868. *Martinia plano-convexa.* McChesney, Chicago Acad. Sci. Trans., vol. 1, p. 34, pl. 1, 3a–c. (Date of imprint, 1867.)
Coal Measures: Peoria and Bureau counties, Ill.

1872. *Spirifer (Martinia) planoconvexus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 184, pl. 4, figs. 4a, 4b; pl. 8, figs. 2a, 2b.
Upper Coal Measures: Nebraska City, Bennetts Mill, Wyoming, Cedar Bluff, Rock Bluff, Plattsmouth, Brownville, Otoe City, Rulo, Bellevue, and Omaha, Nebr.
Coal Measures: Iowa; Missouri; Kansas; Pittsburgh, Pa.; West Virginia.

1874. *Spirifera (Martinia) planoconvexa.* Derby, Cornell Univ. (Science) Bull., vol. 1, No. 2, p. 19, pl. 8, figs. 12, 16, 18; pl. 9, fig. 7.
Coal Measures: Bomjardim and Itaituba, Brazil, and Pichis River, Peru.

1877. *Spirifer (Martinia) planoconvexus.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 135, pl. 10, figs. 3a–c.
Carboniferous: Near Santa Fe, N. Mex.; Elko Mountain, Nev.

1884. *Spirifer (Martinia) planoconvexa.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 134, pl. 32, figs. 23–24.
Coal Measures: Indiana. Occurs from Virginia to Utah and New Mexico.

1887. *Spirifera (Martinia) planoconvexa.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 46, pl. 1, fig. 12.
Coal Measures: Flint Ridge, Ohio.

1893. *Ambocœlia planoconvexa.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 58. (Advance distribution in fascicles.)

1894. *Ambocœlia planoconvexa.* Hall and Clarke, Introd. Study Brach., pt. 2, pl. 31, figs. 14–17.
Coal Measures: Illinois, Kansas.

1894. *Ambocœlia planoconvexa.* Hall and Clarke, New York State Geologist Thirteenth Ann. Rept., for 1893, vol. 2, pl. 31, figs. 14–17.
Coal Measures: Illinois, Kansas.

1895. *Spirifera planoconvexus.* Keyes, Missouri Geol. Survey, vol. 5, p. 85. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1895. *Ambocœlia planoconvexa.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 56, pl. 39, figs. 10–15.
Coal Measures: Springfield, Ill.; Manhattan, Kans.

1900. *Ambocœlia planoconvexa.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 101.
Upper and Lower Coal Measures: Fort Scott, Fredonia, Eudora, Lawrence, Lecompton, Topeka, Emporia, Kans.

1903. *Ambocœlia planiconvexa.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 394.
Hermosa formation: San Juan region, Colo.

1904. *Ambrocœlia planoconvexa.* Reagan, Indiana Acad. Sci. Proc. for 1903, p. 241, plate figs. 9a–9c.
Upper Red Wall: White River canyon, 12 miles southwest of Fort Apache, Ariz.

1906. *Ambocœlia planoconvexa.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 279, pl. 10, fig. 5.
Carboniferous: Weeping Water, Cedar Creek, and Rock Bluff, Nebr.

This species is fairly abundant in the Wewoka material examined. Few specimens attain a width of 10 millimeters. The valves are very unequal, the dorsal being nearly flat with a minute depressed beak, and the ventral strongly convex with a very prominent projecting incurved beak. The hinge line is a trifle shorter than the greatest width, which occurs just in front, and the cardinal angles are rounded. A shallow sulcus passes down the middle of the ventral valve and less often another more indistinct sulcus passes down the middle of the dorsal valve.

The surface appears smooth except for incremental lines, chiefly noticeable toward the margins and near the hinge, and, at most, appears finely punctate. In one specimen, however, the surface is covered with a great number of very small spines which are not appreciably arranged in concentric rows except where the lamellose growth lines are apparent.

Considerable variation is shown in the proportions of length and width. All the dorsal valves are conspicuously transverse, and some of them narrow toward the front, where they have a shield-shaped outline. Owing to the projection of the beak beyond the hinge the ventrals are much less transverse and in some the length exceeds the width.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Family ATHYRIDÆ.

Genus COMPOSITA Brown.

COMPOSITA SUBTILITA.

Plate XII, figures 4–4c; Plate V, figure 7; Plate VI, figure 13.

1842. *Terebratula Roissyi.* D'Orbigny (not L'Éveillé), Voyage dans l'Amérique méridionale, Paleontology, vol. 3, pt. 4, p. 46.
Carboniferous: Yarbichambi, Bolivia.

1847. *Terebratula peruviana.* Idem, vol. 8, Geology, pl. 3, figs. 17–19.

1852. *Terebratula plano-sulcata.* Owen, Rept. Geol: Survey Wisconsin, Iowa, and Minnesota, pl. 5, fig. 9.
Carboniferous limestone: Near Council Bluffs, Iowa.

1852. *Terebratula subtilita.* Hall, Stansbury's Expl. and Survey Great Salt Lake of Utah,[1] p. 409, pl. 4, figs. 1a, 1b, 2a–c.
Carboniferous: Missouri River, near Weston,

?1853. *Terebratula subtilita.* Shumard, Marcy's Expl. Red River of Louisiana, 32d Cong., 2d sess., S. Doc. No. 54, p. 202, pl. 4 (Pal.), fig. 8.
Carboniferous: Washington County, Ark.

?1854. *Terebratula subtilita.* Shumard, idem, 33d Cong., 1st sess., H. Ex. Doc., p. 176, pl. 4 (Pal.), fig. 8.
Carboniferous: Washington County, Ark.

1855. *Terebratula subtilita.* Schiel, Pacific Railroad Rept., vol. 2 [Second Rept.], On line of 41st Par., p. 108, pl. 1, figs. 2a, 2b.
Carboniferous limestone: 8 miles west of Westport.

1856. *Terebratula subtilita.* Hall, Pacific Railroad Rept., vol. 3, pt. 4, p. 101, pl. 2, figs. 3–5.
Carboniferous: Pecos village, N. Mex.

[1] Printed in Philadelphia; reprinted in Washington in 1853 also as a Senate executive document; a third edition (unofficial) was published in Philadelphia in 1855. All bear the same pagination.

1857. *Terebratula* (?) *subtilita.* Davidson, Pal. Soc., Mon. British Carb. Brach., p. 18, pl. 1, figs. 21, 22?. (Imprint of whole volume, 1863.)
Carboniferous: Mayen Wais, England.

1858. *Terebratula plano-sulcata.* Marcou, Geology of North America, p. 52, pl. 6, figs. 8–8b.
Mountain limestone: Tigeras, N. Mex.; Ohio; Indiana; Illinois; Kentucky; Arkansas.

1858. *Terebratula Roysii.* Marcou (not L'Éveillé), idem, p. 51, pl. 6, figs. 10, 10b.
Mountain limestone: Salt Lake City, Utah; El Paso, Chihuahua; headwaters of the Rio Colorado Chiquito.

?1858. *Terebratula subtilita.* Marcou, idem, p. 52, pl. 6, figs. 9–9f.
Mountain limestone: Sierra Madre; Sierra de Magoyon; Great Salt Lake; Tigeras and Pecos village, N. Mex.; summit of Sierra de Sandia and Sierra de Magoyan; El Paso, Chihuahua; junction of rivers San Pedro and Gila, Ariz.; sources of Rio Colorado Chiquito; Shasta County, Cal.; Vancouver Island, British Columbia.

1858. *Terebratula subtilita.* Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 714.
Coal Measures: Ohio; Indiana; Illinois; Iowa; Missouri; Kansas; Nebraska; and Pecos village, N. Mex.

1859. *Spirigera subtilita.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 28. (Date of imprint, 1860.)
Upper Coal Measures: Kansas.

1860. *Athyris subtilita.* Davidson, Pal. Soc. Mon. British Carb. Brach., p. 86, pl. 1, figs. 21, 22; pl. 17, figs. 8–10. (Imprint of entire volume, 1863.)
Carboniferous: Mayen Wais, Bolland, Kendal, England; Tournay, Belgium.

1861. *Athyris subtilita.* Salter, Geol. Soc. London Quart. Jour., vol. 17, p. 64, pl. 4, fig. 4.
Carboniferous: Isthmus of Copacabana, Lake Titicaca.

1861. *Athyris subtilita.* Newberry, Ives's Rept. Colorado River of the West, pt. 3, p. 126.
Upper Carboniferous: Cherty limestone on banks of Colorado between Little Colorado and Diamond rivers; Pecos village, east of Santa Fe.

1862. *Athyris subtilita.* Davidson, Pal. Soc. Mon. British Carb. Brach., p. 217, pl. 1, figs. 21, 22, pl. 17, figs. 8–10.

1866. *Athyris subtilita.* Geinitz, Carb. und Dyas in Nebraska, p. 40, pl. 3, figs. 7–9.
Upper Coal Measures: Omaha City, Plattsmouth, Bennetts Mill, and Nebraska City, Nebr.

1869. *Spirigera* (*Athyris*) *subtilita.* Toula, K. Akad. Wiss. Wien, Math. naturw. Classe, Sitzungsber., vol. 59, Abth. 1, p. 438, pl. 1, fig. 5.
Carboniferous limestone: 10 miles from Cochebamba, Bolivia.

1872. *Athyris subtilita.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 180, pl. 1, fig. 12; pl. 5, fig. 8; pl. 8, fig. 4.
Upper Coal Measures: Nebraska City, Bennetts Mill, Wyoming, Cedar Bluff, Rock Bluff, Plattsmouth, Bellevue, and Omaha, Nebr.
Coal Measures: Illinois; Missouri; Iowa; West Virginia; Ohio; Kansas; Pecos village, N. Mex.

1873. *Athyris subtilita.* Meek and Worthen, Illinois Geol. Survey, vol. 3, p. 570, pl. 25, fig. 14.
Coal Measures: Illinois.

1874. *Athyris subtilita.* Derby (pars), Cornell Univ. (Science) Bull., vol. 1, No. 2; p. 7, pl. 1, figs. 5, 8 (not fig. 7 = *Spirigerella derbyi*); pl. 3, figs. 8, 16, 19, pl. 6, fig. 2; pl. 9, fig. 4.
Coal Measures: Bomjardim, Itaituba, and Paredao, Brazil.

1876. *Spirigera subtilita.* White, U. S. Geol. Geog. Survey Terr., 2d div., Powell's Rept. Geology Uinta Mountains, p. 90.
Lower Aubrey group: Confluence of Grand and Green rivers, and near Echo Park, Utah.
Upper Aubrey group: Beehive Point, near Horseshoe Canyon, Utah.

1876. *Athyris subtilita.* Meek, Simpson's Rept. Expl. Great Basin Utah, p. 350, pl. 2, figs. 4a, 4b.
Coal Measures: Yellow limestone, Humboldt Mountains.

1876. *Athyris subtilita.* Newberry, Macomb's Rept. Expl. Exped. Santa Fe to Grand and Green rivers, p. 138.
Upper Carboniferous: On the Colorado; west of the San Francisco Mountains; junction of Grand and Green rivers; in the Sierra la Plata; at Santa Fe; Pecos.

1876. *Athyris subtilita.* Derby, Mus. Comp. Zool. Bull., vol. 3, p. 279.
Coal Measures: Yampopata, Brazil.

1876. *Athyris subtilita.* Meek, U. S. Geol. and Geog. Survey Terr. Bull., vol. 2, p. 355, pl. 1, figs. 2, 2a.
Carboniferous: Katlahwoke Creek, Rocky Mountains.

1877. *Spirigera subtilita.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 141, pl. 10, figs. 6a–c.
Carboniferous: Carizo Creek, Maricopa County; Camp Apache; Tenney's ranch; Kaibab Plateau; confluence of White Mountain and Black rivers; Grass Mountain, 35 miles north of Pioche, and foothills of Dragoon Mountains, Ariz.; Fossil Hill, White Pine County, and Camp Cottonwood, Nev.; 15 miles south of St. George; near Ophir City; Rock Canyon, Wasatch range, near Provo; and near Minersville, Utah.

1877. *Athyris subtilita.* Meek, U. S. Geol. Expl. 40th Par. Rept., vol. 4, p. 83, pl. 8, figs. 6, 6a.
Carboniferous limestone: Ruby group, Moleen Peak, near Humboldt River, Nev.

1884. *Athyris subtilita.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 136, pl. 35, figs. 6–9.
Lower, Middle, and Upper Coal Measures: Indiana.

1887. *Athyris subtilita.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 44, pl. 1, figs. 18 (16a–c).
Coal Measures: Flint Ridge, Ohio.

1887. *Athyris subtilita.* De Koninck, Mus. roy. hist. nat. Belgique Annales, vol. 14, p. 73, pl. 18, figs. 1–4, 7–10, 12–28; pl. 19, figs. 47–56.
Carboniferous limestone: Lives and Namèche, Belgium.

1888. *Athyris subtilita.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 231. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1891. *Athyris subtilita.* Whitfield, New York Acad. Sci. Annals, vol. 5, p. 604, pl. 16, figs. 7–9.
Coal Measures: Falls Township and Webb Summit, Hocking County, Ohio.

1893. *Seminula subtilita.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 95, figs. 66, 67 on p. 95, and figs. 58, 59 on p. 86. (Advance distribution in fascicles.)
St. Louis group: Pella, Iowa.
Coal Measures: Kansas City, Mo.; Winterset, Iowa.

1894. *Seminula subtilita.* Hall and Clarke, New York State Geologist Thirteenth Ann. Rept., for 1893, vol. 2, pl. 35, figs. 16–19.
Coal Measures: Chariton County, Mo.; Winterset, Iowa; Kansas City, Mo.

1894. *Seminula subtilita.* Hall and Clarke, Introd. Study Brach., pt. 2, pl. 35, figs. 16–19.
Coal Measures: Chariton County, Mo.; Winterset, Iowa; Kansas City, Mo.

1895. *Athyris argentea.* Keyes, Missouri Geol. Survey, vol. 5, p. 92, pl. 39, figs. 11a–d. (Date of imprint, 1894.)
Coal Measures: Kansas City, Lexington, and Clinton, Mo.

1895. *Seminula subtilita.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 95, figs. 66, 67 on p. 95, and figs. 58, 59 on p. 86; pl. 47, figs. 17–31. (Date of imprint, 1894.)
St. Louis group: Pella, Iowa.
(?) Chester limestone: Caldwell County, Ky.; Chester, Ill.
Coal Measures: Manhattan, Kans.; Coppers Creek, Iowa; Chariton County, Mo.; Winterset, Iowa; Miami County, Kans.; Kansas City, Mo.; Ohio.

1895. *Athyris subtilita.* Whitfield, Ohio Geol. Survey Rept., vol. 7, p. 488, pl. 12, figs. 7–9. (Date of imprint, 1893.)
Coal Measures: Falls Township and Webb Summit, Hocking County, Ohio.

1896. *Athyris subtilita.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 241.
Upper Coal Measures: Sebastian County, sec. 12, T. 8 N., R. 32 W., Arkansas; Poteau Mountain, Okla.
(?) Burlington or Lower Keokuk, Boone chert: Stone County, NW. ¼ sec. 9, T. 14 N., R. 10 W., Arkansas.

1897. *Athyris subtilita.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 31. (Date of imprint, 1896.)
Upper Coal Measures: Sebastian County, Ark., sec. 12, T. 8 N., R. 32 W.; Poteau Mountain, Okla.
(?) Burlington or Lower Keokuk, Boone chert: Stone County, Ark., NW. ¼ sec. 9, T. 14 N., R. 10 W.

1900. *Seminula argentea.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 105, fig. 3c on p. 53.
Upper and Lower Coal Measures: Marmaton station, Bourbon County, Iola, Kansas City, Eudora, Lawrence, Lecompton, Topeka, Manhattan, Grand Summit, Kans.

1900. *Seminula argentia.* Knight, Univ. Wyoming, Wyoming Exp. Sta. Bull. 45, pl. 3, fig. 6.

1902. *Seminula argentia.* Beede, Kansas Univ. Sci. Bull., vol. 1, pp. 155–157, pl. 6.

1903. *Seminula subtilita.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 403, pl. 7, figs. 1–1b, 2, 2a, 3, 3a, 4–7, 7a, 8–10.
Molas formation: San Juan region, Colo.
Hermosa formation: San Juan region and Ouray, Colo.
Rico formation: San Juan region, Colo.
Weber formation: Crested Butte and Leadville districts, Colo.
Maroon formation: Crested Butte district, Colo.
Robinson limestone: Leadville district, Colo.
Carboniferous: Glenwood Springs, Colo.

1904. *Seminula subtilita.* Girty, U. S. Geol. Survey Prof. Paper 21, p. 53, pl. 11, figs. 15, 16.
Pennsylvanian (Naco limestone): Bisbee quadrangle, Ariz.

?1904. *Seminula argentia.* Reagan, Indiana Acad. Sci. Proc. for 1903, p. 242, pl., figs. 12a–c, 12e–g, 12m.
Upper Red Wall group and Lower Aubrey: Carrizo Creek, White River, Maricopa County, Fort Apache, Jemez, N. Mex., White River, Ariz., etc.

1906. *Seminula argentea.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 274, pl. 12, figs. 4–7.
Carboniferous: Louisville, Weeping Water, Cedar Creek, Nehawka, Nebr.

1909. *Composita subtilita?* Girty, U. S. Geol. Survey Bull. 389, p. 68.
Yeso formation: Mesa del Yeso, N. Mex.
Abo formation: Abo Canyon, N. Mex.
San Andreas formation: Fra Cristobal, N. Mex.

This ubiquitous species is one of the rarer brachiopods of the Wewoka formation. It is represented in a number of collections, but in most of them by only one or two specimens.

I shall not attempt to describe this well-known form, for the Wewoka fossils show no novel features but present the characters shown by the average specimens from the typical area. Possibly on account of its smooth surface, shells of this species were favorite hosts for the sessile *Crania modesta*, one specimen having no less than five Cranias attached to it.

The abnormal spiralia in *Composita subtilita*, which Dr. Beede describes (1902), are probably found in specimens in which, after decomposition of the soft parts, the spiral cones have become displaced and lie at random in the internal cavity of the shell. Dr. Beede has apparently not determined the connection or disconnection of the cones with the loop in the posterior end of the dorsal valve, and I have no doubt that the explanation suggested is true of his specimens, as it is of specimens of other spire-bearing species which I have seen and which exhibit a similar fortuitous disarrangement.

It is a matter of some doubt what name should be employed for this species. Some writers use *Terebratula argentea* Shepard. Shepard's description and figures are so poor, however, that one might well take the position that his species can not be recognized. Probably the best that can be said is that *Terebratula argentea* may be, not that it is, the species which was subsequently called by Hall *Terebratula subtilita*, and which for many years was known only by that name. It is impossible to tell, however, that *T. argentea* was not introduced for an altogether different type of shell, such as *Squamularia perplexa*.

Another name which may possibly claim priority over *Composita subtilita*, and which was introduced for a closely related type of shell, is *C. peruviana* D'Orbigny. Salter cites D'Orbigny's species as a synonym of *C. subtilita*. The status of *C. peruviana* is peculiar. It would appear that D'Orbigny intended to introduce this as a new species and subsequently decided that it was the same as *Spirifer roissyi* L'Éveillé. At least, we find the species cited as *Spirifer roissyi* in the text and *Terebratula peruviana* in the plates. As against this hypothesis it would appear that the plates were not published until five years after the text, the one bearing the imprint of 1842 and the other 1847. On the other hand, there are some indications that the plates, in part at least, were distributed before the text, since in the synonymy of *Productus villiersi* D'Orbigny gives "*Productus villiersi* D'Orbigny, 1839, Planches publiées." Again, some of the plates, which appear to be lithographs, may have been engraved a long time before the whole set was completed and published—in fact, before the text itself was finished. The legends are printed, and though it would have been possible to change them, to do so would have been rather difficult. If some of the plates had already been published, there would have existed this additional reason for not making the change.

Furthermore, D'Orbigny says, under the title *Spirifer roissyi*, "Plate III, fig. 17–19 (sous le faux nom de *Terebratula antisiensis*)," but figures 17 to 19 appear on the plate as *T. peruviana*, and it is evident that D'Orbigny's description of *S. roissyi* applies to *T. peruviana* of the plate and not to *T. antisiensis*, which is an altogether different form. "*Antisiensis*" is therefore a lapsus calami. Furthermore, D'Orbigny had already on a previous page of the same volume (p. 36) described a Devonian species as *Terebratula peruviana*. The Devonian form is entirely different from the Carboniferous species appearing on the plate as *T. peruviana*. Neither of them is a Terebratula, and neither belongs to the same genus as the other. Consequently, had the Carboniferous form been properly described and figured, I would have been inclined to recognize it as *Composita peruviana*, in which case the name would supersede *C. subtilita* if the two species are identical. However, since there may be some question as to the identity of the two species and also some question as to the validity of *C. peruviana*, it seems best for the present not to use D'Orbigny's name.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2004 and 7193).

Genus **CLEIOTHYRIDINA** Buckman.

CLEIOTHYRIDINA ORBICULARIS McChesney.

Plate XII, figures 1–3c.

1860. *Athyrus orbicularis*. McChesney, Desc. New Spec. Foss. p. 47. (Date of imprint, 1859.)
Coal Measures: Western States.

?1860. *Spirigera missouriensis*. Swallow, Acad. Sci. St. Louis Trans., vol. 1, p. 650.
Coal Measures: Montgomery and Chariton counties, Mo.

1866. *Athyris planosulcata*. Geinitz, Carb. und Dyas in Nebraska, p. 42.
Coal Measures: Omaha City and Plattsmouth, Nebr.

1874. *Athyris sublamellosa*. Derby, Cornell Univ. (Science) Bull., vol. 1, No. 2, p. 10, pl. 2, figs. 9–12; pl. 3, figs. 15, 21, 29; pl. 6, fig. 16; pl. 9, figs. 5, 6.
Coal Measures: Bomjardim and Itaituba, Brazil.

1877. *Spirigera planosulcata*. White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 143, pl. 10, figs. 5a–d.
Carboniferous: Santa Fe, N. Mex.; Rush Creek, Lake County, Colo.

1891. *Spirifera* (*Martinia*) *lineata*. Whitfield, New York Acad. Sci. Annals, vol. 5, p. 603, pl. 16, figs. 3–5.

1895. *Spirifera* (*Martinia*) *lineata*. Whitfield, Ohio Geol. Survey Rept., vol. 7, p. 488, pl. 12, figs. 3–5. (Date of imprint, 1893.)
Coal Measures: Hocking County, Ohio.

1897. *Cleiothyris orbicularis*. Schuchert, U. S. Geol. Survey Bull. 87, p. 182.

?1897. *Cleiothyris missouriensis*. Schuchert, idem, p. 182.
1900. *Cleiothyris roissyi*. Beede, Kansas Univ. Geol. Survey, vol. 6, p. 104, pl. 11, figs. 5, 5b, 5c; pl. 12, fig. 2.
Lower Coal Measures: Fort Scott, Marmaton station, Bourbon County, Prescott, Lynn County, Kans.
1903. *Cliothyris orbicularis*. Girty, U. S. Geol. Survey Prof. Paper 16, p. 407.
Pennsylvanian: Glenwood Springs, Colo.

Although this species is rather rare in our Pennsylvanian faunas, it is remarkable that it appears so seldom in the literature, and it is also remarkable, in view of its rarity elsewhere, that it should be one of the most common brachiopods of the Wewoka formation. Besides being very abundant it is also of large size.

The general shape of these shells is subcircular, the regularly rounded outline being but slightly interrupted by the strongly incurved beak of the ventral valve. In almost all specimens the width is greater than the length, and in many the shape is strongly transverse. Many specimens are highly gibbous, but others are more discoidal. The convexity of the dorsal valve is in most specimens greater than that of the ventral. The usual sinus is present in the ventral valve, and a narrow indistinct sinus is also developed in the dorsal valve, but one or both may be absent. In many specimens they are obscured by the mat of spines that thickly covers the surface. These spines spring from short lamellæ and in many shells are well preserved and conspicuous, giving the shells the appearance of being somewhat coarsely striated longitudinally. When they are broken off the lines of the transverse lamellæ are revealed, which may or may not retain traces of the spines in serrated edges. Much variation is exhibited in the arrangement of the lamellæ, some specimens having them more widely spaced than others.

In another paper[1] I have discussed the relationship between *C. orbicularis*, *C. missouriensis*, and *C. sublamellosa*. I am still strongly of the opinion that the two former are the same species and am almost equally confident that the Mississippian species is distinct from the Pennsylvanian, on account of the more transverse shape of *C. orbicularis*. The difference, however, is not entirely constant.

I am including in the synonymy Whitfield's citations of *Spirifer lineatus* (*Squamularia perplexa*), made in 1891 and 1895. As shown by the figures his specimens have not the configuration of *Squamularia perplexa*, being insufficiently transverse and having too well developed a sinus. In the internal molds the compressed shape of the ventral valve near its apex suggests the presence of dental plates, and the umbo of the dorsal valve shows muscular imprints and perhaps a low septum. Indeed, there is little in Whitfield's figures to distinguish them from the accompanying figures of *Composita subtilita* except, of course, the spinose character of the sculpture. I

[1] The Carboniferous formations and faunas of Colorado: U. S. Geol. Survey Prof. Paper 16, p. 407.

am fairly satisfied therefore that Whitfield was really dealing not with a Spirifer but with an Athyris, and if so, there can be little doubt, with *Cliothyridina orbicularis*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Genus HUSTEDIA Hall and Clarke, 1893.

HUSTEDIA MORMONI Marcou.

Plate XII, figures 5–6a.

1858 (February). *Terebratula Mormonii.* Marcou, Geology of North America, p. 51, pl. 6, figs. 11–11c.
Mountain limestone: Salt Lake City, Utah.

1858 (June). *Retzia punctilifera.* Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 220. (Date of imprint, 1860.)
Upper Coal Measures: Audrain and Howard counties, Mo., below mouth of Platte River, Nebr.; near Manhattan, at Willowsprings, on Santa Fe road; and headwaters of Verdigris River, Kans.

1859. *Retzia Mormonii.* Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., p. 27. (Date of imprint, 1860.)
Upper Coal Measures: Manhattan and Leavenworth, Kans.

1860. *Retzia subglobosa.* McChesney, Desc. New Spec. Foss., p. 45. (Date of imprint, 1859.)
Upper Coal Measures: Menard, Mason, Fulton, Peoria, Tazewell, Knox, and Marshall counties, Ill.

?1864. *Retzia compressa.* Meek, California Geol. Survey, Paleontology; vol. 1, p. 14, pl. 2, figs. 7–7c.
Carboniferous: Bass's ranch, Shasta County, Cal.

1865. *Retzia subglobosa.* McChesney, Illus. New Spec. Foss., pl. 1, fig. 1.

1866. *Retzia Mormonii.* Geinitz, Carb. und Dyas in Nebraska, p. 39, tab. 3, fig. 6.
Upper Coal Measures: Plattsmouth, Nebr.

1868. *Retzia punctulifera.* McChesney, Chicago Acad. Sci. Trans., vol. 1, p. 32, pl. 1, figs. 1a–c. (Date of imprint, 1867.)
Upper Coal Measures limestone: Menard, Mason, Fulton, Peoria, Tazewell, Knox, and Marshall counties, Ill.

1872. *Retzia punctulifera.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 181, pl. 1, fig. 13; pl. 5, fig. 7.
Upper Coal Measures: Rock Bluff, Plattsmouth, and Nebraska City, Nebr.
Coal Measures: Nebraska, Kansas, Illinois.

1874. *Eumetria punctulifera.* Derby, Cornell Univ. (Science) Bull., vol. 1, No. 2, p. 4, pl. 8, figs. 4, 5, 7, 8, 10; pl. 9, fig. 3.
Coal Measures: Bomjardim and Itaituba, Brazil, and Pichis River, Peru.

1875. *Terebratula Mormonii.* Marcou, Acad. Sci. St. Louis Trans., vol. 3, p. 252.

1877. *Retzia Mormonii.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 141, pl. 10, figs. 7a–c.
Carboniferous: Near Santa Fe, N. Mex., top of Grass Mountain, Ely Range, 30 miles north of Pioche, Nev.

?1883. *Retzia compressa.* Kayser, Richthofen's China, vol. 4, p. 176, pl. 22, figs. 1–4.
Upper Carboniferous: Lo-Ping, China.

1884. *Retzia radialis* (pars). Walcott (non Phillips), U. S. Geol. Survey Mon. 8, p. 220, pl. 7, figs. 5f–h (not figs. 5–5e).
Upper Carboniferous: Eureka district, Nev.

1884. *Retzia Mormonii.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 136, pl. 35, figs. 10–12.
Coal Measures: Indiana.
1888. *Retzia mormoni.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 231. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.
1893. *Hustedia Mormoni.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 120, fig. 106.
1894. *Hustedia Mormoni.* Hall and Clarke, Introd. Study Brach., pt. 2, pl. 37, figs. 13–20.
Coal Measures: Near Kansas City, Mo.
1894. *Hustedia Mormoni.* Hall and Clarke, New York State Geologist Thirteenth Ann. Rept., for 1893, pl. 37, figs. 13–20.
Coal Measures: Near Kansas City, Mo.
1895. *Hustedia mormoni.* Hall and Clarke, New York Geol. Survey, Paleontology, vol. 8, pt. 2, p. 120, fig. 106; pl. 51, figs. 1–9. (Date of imprint, 1894.)
Coal Measures: Near Kansas City, Mo.
1895. *Retzia mormoni.* Keyes, Missouri Geol. Survey, vol. 5, p. 95, pl. 41, figs. 2a–c. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City and Lexington, Mo.
1896. *Retzia radialis.* Smith (non Phillips), Am. Philos. Soc. Proc., vol. 35, p. 241.
Upper Coal Measures: Sebastian County, Ark., and Poteau Mountain, Okla.
1897. *Retzia radialis.* Smith (non Phillips), Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 31.
Upper Coal Measures: Sebastian County, Ark., and Poteau Mountain, Okla.
1900. *Hustedia mormoni.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 103, pl. 9, figs. 10, 10b–d, pl. 12, fig. 3.
Upper Coal Measures: Fort Scott, Iola, Kansas City, Lawrence, Lecompton, Topeka, Beaumont, Kans.
1903. *Hustedia mormoni.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 411, pl. 7, figs. 12, 12a, 13.
Maroon formation: Crested Butte district, Colo.
1904. *Hustedia mormoni.* Girty, U. S. Geol. Survey Prof. Paper 21, p. 53, pl. 11, figs. 19–21.
Pennsylvanian (Naco limestone): Bisbee quadrangle, Ariz.
1906. *Hustedea mormoni.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 276.
Carboniferous: Weeping Water, Cedar Creek, Nehawka, and Red Bluff, Nebr.

This well-known species is found in many of the collections of the Wewoka formation, but it is rather rare, a specimen or two being the usual representation in each.

Meek states that each valve bears 14 to 15 (rarely 16 to 17) small costæ and that the ventral valve shows traces of a sinus. The specimens seen exhibit greater variation in the number of plications, many having only 11 or 12 or even 10, and ranging from that number up to 16. In some the sinus in the ventral valve is conspicuous; in others no sinus can be detected. Most of the specimens, however, have been more or less completely compressed, obliterating the sinus, if present, and making it difficult to count the plications.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (station 2004).

MOLLUSCA.

PELECYPODA.

Family GRAMMYSIIDÆ.

Genus EDMONDIA De Koninck.

It is a little uncertain whether the American shells of which the two species described below are very characteristic really belong to De Koninck's genus. As Edmondia was originally defined it is certain that they do not. One important difference has to do with the lunule and another with the internal plate.

In his Latin description of Edmondia De Koninck described the shell as possessing a gaping lunule, and in his French description following he described the lunule as excavated. In Zittel's American textbook of paleontology the shell is said to be gaping in front, which is probably the idea that De Koninck wished to convey, rather than that it was actually lunulate. Hind takes the expression more literally, justly remarking "The figures show conclusively that there is no lunule, and no mention is made of this character in the amended diagnosis of 1885." [1] The same author adds that De Koninck professes to take *Isocardia unioniformis* Phillips as his type species of Edmondia but that he figured very different shells belonging to that species. "But fortunately Phillips's shell undoubtedly belongs to the genus Edmondia and therefore may still be considered as the type of the genus."

With this conclusion of Hind's as to the type I can in nowise agree, for it is clear to me that the genotype is the species, whatever it may prove to be, to which the shells that De Koninck figured as *Edmondia unioniformis* actually belong. I may note in passing, however, that despite his remark above quoted and his repetition of it in substance in his discussion of *E. unioniformis,* Hind retains De Koninck's citation in the synonymy of that species. It would also appear from the passages above quoted that the character of the gaping anterior end was a wrong observation, whether the genus be founded upon *E. unioniformis* or on De Koninck's misidentified shell.

The other structure, however, which is apparently lacking in the American shells, is recognized as present by Hind also. He describes it thus: [2] "Casts show that there existed, posterior to the hinge plate, an internal ossicle, elongate, flattened, which was directed outwards and downwards into the cavity of the umbo." This structure I have never seen on any of our American Edmondias, but it is one which would be naturally difficult of observation and I may have overlooked it. Hind also describes the hinge as "edentulous, simple,

[1] Hind, Wheelton, British Carboniferous Lamellibranchiata, vol. 1, p. 288, Paleontographical Soc., 1896–1900.

Idem, p. 287.

and erect, possessing a transverse, deeply situated, thickened ridge, separated from the edge of the valve by a smooth groove." Again, in describing the hinge plate of *E. unioniformis*, he remarks:[1] "The hinge is edentulous, with a deep, thick, vertical ridge of shell, and the flat expanded ossicle seen as a groove in casts." I confess that this is not at all clear to me and is not made more intelligible by his figures (Pl. XXVII, figs. 16a, 16b). Furthermore, there is nothing in some very perfectly preserved American shells to which this description at all applies. The only structure of the kind which they show is a ligamental furrow formed by the thin projecting lower edge of the shell along the cardinal line, with a steplike rise a little farther back producing a narrow but well-marked shelf or groove for an external ligament. This structure is also mentioned by Hind and appears to be distinct from the one discussed above, which I can not recognize in American shells.

The American forms, of course, possess neither lunule nor escutcheon and, clearly, neither gape in front nor have an opening specially excavated at the end of the shell.

EDMONDIA OVATA Meek and Worthen.

Plate XIV, figure 13.

1873. *Edmondia ovata.* Meek and Worthen, Illinois Geol. Survey, vol. 5, pl. 26, fig. 13. [Coal Measures: Illinois.]

1874. *Edmondia ovata.* Meek, Am. Jour. Sci., 3d ser., vol. 7, p. 580.

Shell of medium size, transversely ovate; width nearly twice, although distinctly less than twice, the height. Anterior outline regularly rounded. Ventral margin also regularly rounded, more gently in the middle than at the sides. Posterior margin about like the anterior but somewhat straightened above, so as to give this end of the shell a subtruncate appearance, meeting the cardinal border in an obscure, obtuse angle. Cardinal margin behind the beaks nearly straight. Convexity moderate, highest in the umbonal region. Shells somewhat compressed toward the posterior margin. Beaks rather prominent, situated about two-fifths of the width back from the front end.

Sculpture not well shown but seeming to consist of rather prominent lamellæ arranged at regular and distant intervals with lamellose growth lines between. In one rather well preserved specimen the lamellæ are more prominent near the anterior end than farther back.

This form resembles both *E. ovata* and *E. subtruncata* (which Meek suggests may be one and the same species), differing from the latter in just the characters by which Meek says that the two forms are to be distinguished, if at all. It is more transverse than *E. subtruncata*, with the beak slightly more central and the anterior extremity fuller

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[1] Op. cit., p. 293.

above under the beak. It is perhaps a little more truncate behind than the type specimen of *E. ovata.*

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (station 2004).

EDMONDIA GIBBOSA McCoy?

Plate XIV, figure 12.

1844. *Astarte gibbosa.* McCoy, Syn. Carb. Foss. Ireland, p. 55, pl. 8, fig. 11.
Carboniferous: Ireland.

1866. *Astarte gibbosa.* Geinitz, Carb. und Dyas in Nebraska, p. 16, pl. 1, figs. 23, 24.
Carboniferous: Plattsmouth, Nebr.

1903. *Edmondia gibbosa.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 447, pl. 9, figs. 7-9.
Rico formation: San Juan region, Colo.
Cisco group: Graham, Young County, Tex.

1909. *Edmondia gibbosa.* Girty, U. S. Geol. Survey Bull. 389, p. 73.
Abo sandstone: Sandia Mountains, Abo Canyon, and Mesa del Yeso, N. Mex.
Yeso formation: Blackinton's ranch, N. Mex.

Shell rather small, subcircular. Shape transverse, about one and one-fourth times as wide as high; greatest height posterior to the middle. Anterior extremity rounded, most prominent above the middle. Basal outline regularly rounded, slightly diverging posteriorly with the cardinal line. The latter is nearly straight. The posterior outline is broadly curved, subrectilinear above, giving this portion a truncate effect. Posterior superior angle fairly distinct. Convexity moderate. Beaks prominent.

Surface marked by rather closely and regularly arranged concentric lamellæ.

This is clearly the same species as the shell from the Cisco formation of Texas which I figured as *Edmondia gibbosa* in 1903. Representatives of the same species occur in the present collection from the same formation and the same general locality.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (station 2004).

Family NUCULIDÆ.

The Nuculidæ and Ledidæ have sometimes been included by authors in a single family and it seems difficult to frame definitions of the two groups which will be mutually exclusive. Verrill and Bush say:[1]

> The family Nuculidæ differs from Ledidæ mainly in having no siphon tubes, the mantle edges being completely disunited. The Ledidæ are remarkable for the great variations in the structure of the hinge teeth, ligament, cartilage, and mantle, as well as in the form of the shell.

[1] Am. Jour. Sci., 4th ser., vol. 3, p. 52, 1897.

On page 59, they define the two families as follows:

(Nuculidæ D'Orb.) Shell not gaping, short-ovate, subtrigonal, or rounded; posterior end without a rostrum; beaks usually curved backward; no siphon tubes nor pallial sinus.

(Ledidæ.) Shell ovate, oblong or lanceolate; posterior end generally the longer and usually more or less rostrated; siphon tubes and pallial sinus generally present.

In the American edition of Zittel's textbook of paleontology (p. 363) the families are defined as follows:

Shell compact, closed, with the teeth in two series meeting below the umbones, separated by a chondrophore; area represented by an obscure lunule and escutcheon; no ligament, but a wholly internal, amphidetic, alivincular resilium; internal layer of shell nacreous; mantle lobes free, without siphons; pallial line simple. (Nuculidæ.)

Shell as in the Nuculidæ, but elongated with the ligament variable, the resilium sometimes external or absent, the internal shell layer subnacreous or porcellanous, the ends of the shell partly gaping; the mantle lobes more or less united; with complete, sometimes elongate siphons; pallial line usually sinuated. (Ledidæ.)

To the Ledidæ I have referred shells from the fauna under consideration which represent the genera Leda and Yoldia. Those referred to Leda would be excluded from the Ledidæ by a strict application of the Zittel definition, because they are distinctly closed all around instead of gaping. The Yoldias, however, gap at both ends and both types are characterized by being transversely elongated and by having the beaks directed toward the long end which is posterior. This assignment does not contradict Verrill and Bush's definition either of the Ledidæ or of the genus Leda.

To the Nuculidæ I am referring shells which belong to Nucula and to the two new groups Nuculopsis and Anthraconeilo. In all three groups the beaks point toward the short side, differing in this respect from the Ledidæ (of the same fauna), but in Nuculopsis they are directed forward toward the short side, whereas in the two other groups they are directed backward toward the short side.

Nuculopsis has an external ligament, a character which, under Zittel's definition, would debar it from the Nuculidæ but would bring it within the special subfamily (the Glominæ) made by Verrill and Bush for shells having an elongated ligament, which is partly external. Moreover, in Glomus, the only representative of the Glominæ, the beaks are directed forward. In its general characters Nuculopsis more strongly resembles Nucula, to which genus the typical species has uniformly been referred, than it does Leda and Yoldia, and, as just pointed out, it can without much incongruity be included in a division of the Nuculidæ. On the other hand, it appears to be more closely allied to Malletia and Tindaria, especially the latter, than to Glomus, and those two genera are members of the Ledidæ. It may well be, therefore, that Nuculopsis really belongs in the Tindarinæ of the Ledidæ, the determining factor, perhaps, residing in the soft parts (the presence or absence of siphon tubes) the character of which will never be known.

In the entirely external position of the ligament and in the transverse and arcuate instead of oblique and straight teeth Nuculopsis differs from Glomus.

Anthraconeilo differs from Nucula chiefly by being very transverse and extended instead of compact, possessing in fact more the shape of the Ledidæ with the essential characters of Nucula. To some extent also the dentition of Anthraconeilo is peculiar. Its shape would exclude it from the Nuculidæ as defined, but its relations seem to be clearly with that group. It may in fact be only a subgenus of Nucula.

Genus NUCULA Lamarck.

Conchologists generally have failed to find adequate differences between the Paleozoic shells representing Nucula and Leda and the typical living representatives of those genera. Recently Williams and Breger have sought to distinguish a group under the title Nuculoidea which would include most of the Paleozoic Nuculas. The only differentiating character of this new genus seems to be the absence of denticulations along the margins of the shell, a character which is present in many of the modern species. I am informed, however, that this character is absent in many living species also; that in some species it is present or absent at different stages of growth, and that it is regarded by conchologists as a practical group character but no more. Accordingly it does not seem advisable to use Nuculoidea, although all the representatives both of the Nuculidæ and Ledidæ discussed in this paper are without denticulate margins.

The evidence for separating the Paleozoic Ledas seems rather more cogent than that for separating the Nuculas. It is doubtful whether the character of the pallial line is a practicable one for this purpose, for it is so seldom distinctly preserved in fossil shells. Of course, the typical Leda has a pallial sinus, and shells in which the pallial line is entire could not with propriety be referred to the same genus. Nevertheless some authors have described fossil lediform shells as having a simple pallial line. The most persistent character available for differentiating the Paleozoic forms is an internal prominence or ridge passing diagonally from the beaks toward the longer end. This seems a trivial character and its significance is not understood, but it appears to be regularly present in the Paleozoic Ledas and absent from the living ones. Upon this prominence in the umbonal region is situated a rather well marked scar, which has no analogy in the living shells except in the less localized points of attachment of the mantle and with these this scar may provisionally be correlated. I may mention that in both the Ledas and Nuculas which enter into the present fauna the chondrophore seems not to interrupt the line of denticles but to be situated below it. My specimens are not entirely unambiguous in this regard and since a number of authors have described species (not, however, the same that are discussed here) as having these features arranged in a normal way it seems probable that my specimens are misleading.

NUCULA WEWOKANA Girty.

Plate XIII, figures 6–8.

1911. *Nucula wewokana.* Girty, New York Acad. Sci. Annals, vol. 21, p. 131. Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell small, triangular; width slightly though distinctly greater than the height. Beaks set well toward the posterior end, toward which they more or less distinctly point. The convexity is high. The cardinal and posterior ends are abruptly flattened or depressed into a usually well defined escutcheon and lunule. The ventral border is regularly rounded. The anterior and cardinal lines are straight or gently convex according as the lunule and escutcheon are flat or project somewhat from the abrupt infolding of the shell along the two edges. The anterior end is strongly rounded; the posterior is subangular.

The surface is finely, sharply, and regularly striated.

This is a rare species in the collection, only 12 specimens having come to hand. They show differences among themselves but in general correspond to the description above. In the very gibbous specimen represented by figure 8, Plate XIII, the lunule and escutcheon are sharply defined and the shape is more deltoid than that of shells in which the inflected portion, less strongly and abruptly bent, projects farther beyond the line of flexure.

Nucula wewokana is related to *N. parva* McChesney, with which, in fact, I at first identified it. It differs, to judge by the figures of McChesney and of Meek and Worthen, in being less transverse and in having the shell at the posterior or shorter end less strongly projecting. *N. wewokana* is also very similar in outline to *N. pulchella* Beede and Rogers, but *N. pulchella* is said not to have a distinct lunule and the posterior end seems to be abruptly truncated. In the present species the shell projects a little, so that the outline at this end is usually gently convex and is formed by the edge of the shell, whereas in *N. pulchella* it is straight and is formed by the angle of flexure, which either overarches the margin or is coincident with it when viewed from above.

These little shells vary more or less owing to what may be called individual peculiarities, and slight inaccuracies of enlargement give them rather strongly different appearances. It may be that all these species and possibly also the one which Meek and Worthen identify as *N. beyrichii* will eventually be united, but it does not seem advisable to unite them at present.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001 and 7193).

NUCULA ANODONTOIDES Meek ? [1]

Plate XIII, figures 1-5.

1871. *Nucula anodontoides.* Meek, West Virginia Univ. Regents Third Ann. Rept., Appendix B, p. 71.
Coal Measures: Monongalia County, W. Va.

1897. *Nucula ventricosa.* Hind, British Carb. Lamellibranchiata, vol. 1 (Paleontogr. Soc., vol. 51), p. 180, pl. 14, figs. 16, 16a.
Coal Measures: Oakwood, Vermilion County, Ill.

As this species is known only from Meek's first description, and as that description is given in a work that is rare and hard to come at, I quote it in full as follows:

Shell ovate, ventricose, the greatest convexity being in the umbonal region; posterior side short, faintly subtruncate vertically at the immediate extremity; basal margin semielliptical in outline; cardinal margin nearly straight externally, equaling about half the length of the valves, carinate at the extremities; anterior side rather long, very narrowly rounded in the middle of the extremity, to which point the basal margin rounds up rather gradually, and the anterior dorsal edge slopes obliquely from the edge of the hinge; beaks moderately prominent, convex, incurved without very distinct obliquity, and located about halfway between the middle and the posterior side; umbonal slopes, both before and behind, subangular, in consequence of the presence of a lunule and escutcheon-like impression, of which that on the anterior or longer side is larger, being usually continued nearly or quite to the extremity of that side. Surface smooth, or only showing under a magnifier very obscure lines of growth.

Length of the largest specimen, 0.57 inch; height, 0.40 inch; convexity, 0.30 inch. Some of the other specimens are proportionably more convex.

I have described the shorter side as the posterior of this shell, which, of course, would probably be incorrect if it is not a true Nucula. Although I only know from some of the imperfect specimens that it has a rather coarsely crenate hinge, there can be little doubt that it has an internal ligament, and thus differs from Tellinomya and other Paleozoic types that have been separated under other names, since the dorsal margin of the valves can be seen to fit closely all the way along, so as to show no traces of an external ligament. It has not the physiognomy of the typical modern Nuculas, but looks externally like a miniature Anodon. It seems to be *closely* allied to *N. Beyrichi* V. Schauer, from the Permian of Germany, but is larger, more robust, more nearly smooth, and differs in the lunule-like impressions before and behind the beaks.

Locality and position.—Just below the Mahoning sandstone, Monongalia County, W. Va. Coal Measures.

The fossils under discussion are rather rare, though most of the collections contain one or more specimens. The shape may be described as transversely subovate; less commonly subtriangular. The average specimen is under 14 millimeters in width. The ventral border is rather regularly convex, contracting with the gently curved

[1] Some American citations of *Nuculopsis ventricosa*, in whole or in part, probably belong in the synonymy of the form here provisionally referred to *N. anodontoides*. It is impossible from the literature to be sure whether some of the specimens described belong to one form or to the other or to both.

hinge line toward the longer or anterior end. The ends are regularly rounded, the anterior more narrowly than the posterior. The beaks are rather prominent, directed toward the shorter (posterior) side and situated about midway between the middle of the shell and the posterior extremity. The convexity is rather high. The lunule and escutcheon are fairly well defined in some specimens but are nearly obsolete in others.

The surface is marked by fine, regular, closely arranged, concentric striæ.

The dentition is not well shown by the Wewoka specimens, but the teeth appear to be about 17 in number, gradually diminishing in size from either end toward the beak. About 10 may be called anterior teeth and 7 posterior. A chondrophore is probably present, but it appears to lie below the range of denticles and does not interrupt them. There are the usual large anterior and posterior adductor scars, with two pairs of pedal scars, one pair between the beak and the anterior and the other between the beak and the posterior adductors.

Without specimens or figures and with only the description to go by, it is, of course, uncertain that this is Meek's *Nucula anodontoides*, but certainly these shells agree closely with his description.

This form resembles more or less closely Meek's figures of *N. beyrichi* and *N. ventricosa*, given in his Nebraska report, and also Geinitz's identification of *N. beyrichi*. It is possible that one or another of these will find place in the present synonymy.

In the collections under discussion *Nucula anodontoides?* occurs associated with *Nuculopsis ventricosa*, and although the two are believed to be very unlike both in specific and generic characters, some specimens can not be referred with certainty to one species or the other. This uncertainty generally exists as to young specimens and those whose characters have been more or less obscured or altered. As to characteristic examples no doubt can arise. *N. ventricosa* has a more concave outline beneath the beaks, making a more pointed or nasute extremity. It has a well-marked constriction and emargination on the short end, a less distinct lunule and escutcheon, a smooth or coarsely and irregularly instead of finely and regularly striated surface, and, of course, a ligamental furrow behind the beaks—a fact which changes the entire orientation of the shell. I have also found difficulty in separating what may be young specimens of this species from *N. wewokana*. The less transverse and nondeltoid shape of the latter, with its more distinct lunule and escutcheon, can generally be relied on to distinguish it.

In the description cited above it will be noticed that Meek states that *N. anodontoides* is closely allied to *N. beyrichi*. It is not surprising, therefore, that the shells which I am here identifying with the former species resemble more or less closely Meek's figures of the latter given in his Nebraska report,[1] and also Geinitz's identification of *N. beyrichi* based on American specimens. On page 119 I have pointed out that authors may have referred two distinct forms to *Nucula ventricosa* of Hall, and it is possible that some of the citations of the latter species as well as of *N. beyrichi* will find place in the synonymy of *N. anodontoides*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Genus **ANTHRACONEILO** Girty.

1911. Anthraconeilo. Girty, New York Acad. Sci. Annals, vol. 21, p. 131.

The shells included under this title are rather large, strongly transverse, very inequilateral, and considerably produced anteriorly. The beaks point toward the shorter side. The shell is closed all around. The dentition is taxodont, with a great many small teeth on the anterior side and a few large teeth on the posterior. A chondrophore is probably present, but was not observed. The anterior and posterior scars are large. Probably two other smaller scars are situated near the hinge, one in front and the other behind the beak, between it and the anterior and posterior scars. The pallial line is apparently entire or with only an obscure sinus. If a sinus is really present the orientation here employed should be reversed; the long side would then be posterior and the beaks would point forward, toward the short side. The sculpture consists of fine regular concentric striæ.

This type in general appearance is intermediate between Nucula and Leda. From Nucula it differs in its transverse shape and produced anterior extremity. From Leda it differs in having the beak directed toward the short side, which is probably posterior, as in Nucula. The muscle scars seem to be much as I have observed them in *L. bellistriata* (see p. 124), but there is no oblique internal ridge crossing the umbonal region, and the arrangement of the teeth, chiefly to one side of the beak, is conspicuously different.

Anthraconeilo also much resembles Paleoneilo, but differs from it in lacking an external ligament and in being without the sinus developed in the inferior contour and in the lines of sculpture. The latest species which can with safety be referred to Paleoneilo occur in the early Mississippian.

From Yoldia, Anthraconeilo differs in not gaping behind and in having the beak directed toward the shorter side.

[1] U. S. Geol. Survey Nebraska Final Rept., 1872, pl. 10, figs. 18, 19, the latter being copied from Geinitz.

In addition to the type species described beyond as *Anthraconeilo taffiana*, there can probably be transferred to this group three species that are now included under Yoldia—*Y. carbonaria*, *Y. knoxensis*, and *Y. oweni*. The last two differ from Yoldia and agree with Anthraconeilo in having the beaks turned toward the short side of the shell, and their inclusion in Anthraconeilo is therefore regarded as probably correct. The transfer of *Y. carbonaria* is more doubtful, since it seems presumptuous to suppose that so excellent a conchologist as Meek would assign to Yoldia a shell in which the beaks pointed toward the short side, and if they point toward the long side *Y. carbonaria* is clearly not a representative of Anthraconeilo. Even if the beaks point toward the long side, however, I should somewhat doubt the correctness of Meek's reference to Yoldia on account of the convexity of the shell and the prominence of the beaks.

Type species.—Anthraconeilo taffiana.

ANTHRACONEILO TAFFIANA Girty.

Plate XV, figures 9-13.

1911. *Anthraconeilo taffiana.* Girty, New York Sci. Annals, vol. 21, p. 132.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell rather large, transverse. Width nearly twice the height. Shape subelliptical. Posterior end strongly and symmetrically rounded. Dorsal border long, rectilinear. Ventral border convex, more strongly curved toward the posterior end, subrectilinear anteriorly. Anterior end produced, more or less symmetrical, somewhat truncated at the narrow extremity. Greatest height about one-third the shell length in front of the posterior margin. Convexity rather high, chiefly situated in the posterior third of the shell; compressed anteriorly, somewhat compressed near the posterior margin as well. Beak small, strongly incurved, pointing toward the short end of the shell.

Surface not well shown but in many specimens apparently smooth. A few shells are marked by regular, closely arranged concentric striæ, and many show more prominent irregularities of growth.

The dentition consists of about 6 large posterior teeth and about 30 small anterior teeth. An interval beneath the beak is probably occupied by a number of additional teeth of small size.

There is the usual complement of large muscle scars, one anterior and one posterior, situated near the dorsal border. Apparently a small elongate scar occurs between the anterior adductor and the beak, close to the cardinal line. Possibly a corresponding scar occurs also between the beak and the posterior adductor. This arrangement is, therefore, very much as I have observed it in *Leda bellistriata*, but of the curved oblique internal ridge in the umbonal region with its attachment (?) scar no equivalent structure has been observed in the present form. The shell is considerably thickened between the beak and the large posterior adductor, however, causing a deep excavation in internal molds, sharply defining the anterior boundary of the scar. The pallial line appears to be entire, or with a faint deflection in the anterior portion. It has not been clearly seen in that portion.

This species is related to *Yoldia oweni* McChesney, and I was for a time disposed to think that it might be the same. Its different shape, smooth surface, lack of a constriction, and smaller number of teeth, however, seem to show that it is distinct. Of the two other species of "Yoldia" provisionally included under *Anthraconeilo*, *A. taffiana* is probably most similar to *A. carbonaria*, whose assignment to this group is most in doubt. It differs from the latter in being not quite so transverse and in having the short side not quite so projecting. Of course if *A. carbonaria* is a true Yoldia, or at least if it has the beaks directed toward the long side, the generic relations are altogether different. *A. knoxensis* is a smaller form with larger and more prominent umbones and a differently shaped and less projecting posterior extremity. A direct comparison of specimens will be desirable to demonstrate conclusively the independence as a distinct species of *A. taffiana*, but I felt disposed to assume importance for the differences pointed out and a distinct specific entity for the present form because I was making it the type of a new generic (or subgeneric) group.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001 and 2004).

Genus **NUCULOPSIS** Girty.

1911. Nuculopsis. Girty, New York Acad. Sci. Annals, vol. 21, p. 133.

Much confusion exists in the writings of paleontologists as to the orientation of shells of the Nuculidæ and Ledidæ. The general practice seems to have been to describe these shells as if they were normal in their construction, with the beak turned toward the shorter anterior end, whereas, as a general rule, the beaks in these forms are reversed, pointing to the posterior instead of to the anterior side. Furthermore, the long as well as the short side may be anterior, according as the subject belongs to one genus or to another.

In fact to determine the orientation of these shells is a matter of no small difficulty without the soft parts, and of course the soft parts are not known in the fossil condition. If an external ligament is present, it is fairly safe to consider its position as posterior (opisthodetic), and if a sinus is developed in the pallial line, the end of the shell on which it is found may be called the posterior side. Even if this character could readily be determined in fossil shells the fact would still remain that many forms have no external ligament and no pallial sinus. In the case of such species the only course seems to be to depend on their zoologic affinities and their modern analogies.

There are, it is evident, only four possible conditions in regard to the position and direction of the beak: (*a*) Beaks turned toward the short side which is anterior; (*b*) beaks turned toward the short side which is posterior; (*c*) beaks turned toward the long side which is anterior, and (*d*) beaks turned toward the long side which is posterior. All these conditions save (*c*), in which the beaks are turned toward the long side which is anterior, seem to occur among the Nuculoid and Ledoid shells. To the first group, which represents the condition usually found in pelecypod shells, belong such forms as Malletia, Tindaria, and the genus here described as Nuculopsis. In this group the beaks are directed forward and the anterior side is the short side of the shell.

Nucula itself shows a reversal of two general rules—that the beaks point forward and that the short side is anterior—for the short side is posterior and the beak points toward it. The same condition is probably also found in Anthraconeilo.

In Leda and Yoldia, as in Nucula, the beaks point backward instead of forward, but in these groups the orientation is normal, the short rounded side being anterior and the contracted elongated side posterior.

The present genus is based on *Nucula ventricosa* of Hall and is distinguished from Nucula primarily because, though the beaks point toward the short side of the shell, that side is not posterior but anterior. This fact is determined by the occurrence of a ligamental groove or area along the hinge margin on the long side of the shell. Though varying in distinctness, traces of this structure appear in nearly all the numerous specimens examined. It is, therefore, a real and persistent character of the species and is hardly open to any other interpretation than that which I have put upon it. The existence of this structure then, which has no homologue in Nucula, and its almost definitive importance in determining that the long side instead of the short side of the shell is posterior, constitute the most important differences from that genus.

The shape is more elliptical than triangular and the long side is rather produced for Nucula itself. The beaks are conspicuously turned toward the shorter side. The typical species has a distinct though ill-defined and narrow constriction near the anterior extremity. The lunule and escutcheon are poorly defined. The surface is generally almost smooth. On the interior there are the usual large posterior and anterior adductors, in addition to which between those scars and the beaks a third and fourth pair of muscular imprints can be seen. The dentition consists of a continuous series of taxodont denticles, not apparently interrupted by a chondrophore. The anterior teeth are few and large, the posterior teeth numerous and diminishing in size toward the beak, where they seem to end abruptly against the large anterior teeth. A chondrophore is almost certainly present, but, unlike the structure of living shells, it seems to be situated within and below the row of cardinal teeth without extending to the beak and forming an interruption to them. This can not, however, be positively asserted.

Nuculopsis, in point of its most significant character, the external ligament, is suggestive of Glomus and of Malletia and Tindaria, particularly the latter. Indeed, it is difficult to point out important characters unmistakably ascertained, by which *Nucula ventricosa* should be excluded from Tindaria. Feeling that there is a certain improbability in the occurrence of an isolated species in the Carboniferous belonging to a genus which is otherwise known only in Tertiary and recent faunas, I have attached importance to the fact that (1) the beaks are strongly anterior instead of subcentral; (2) the test is massive and the umbones prominent; (3) the structure which simulates a chondrophore, but which is situated below the row of teeth instead of across it, has no analogue in Tindaria; (4) the pallial line is entire(?). Only certain of these characters mark differences between Nuculopsis and Tindaria; others mark those between the former genus and Malletia.

NUCULOPSIS VENTRICOSA Hall.

Plate XV, figures 1–8.

1858. *Nucula ventricosa.* Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 716, pl. 29, figs. 4, 5a, 5b.
Coal Measures: [Iowa].

1872. *Nucula ventricosa.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 204, pl. 10, figs. 17a–c.
Upper Coal Measures: Nebraska City and Rock Bluff, Nebr.
Lower Coal Measures: West Virginia.
Coal Measures: Illinois.

1882. *Nucula ventricosa.* White, Indiana Geol. Survey Eleventh Ann. Rept., p. 371, pl. 42, figs. 9, 10.
Coal Measures: Sullivan County, Ind.

1884. *Nucula ventricosa.* White, Indiana Geol. Survey Thirteenth Ann. Rept., p. 146, pl. 27, figs. 9, 10.
Coal Measures: Sullivan County, Ind.

1888. *Nucula ventricosa.* Keyes, Philadelphia Acad. Nat. Sci. Proc., p. 233.
Lower Coal Measures: Des Moines, Iowa.

1895. *Nucula ventricosa.* Keyes, Missouri Geol. Survey, vol. 5, p. 121, pl. 45, figs. 3a, 3b. (Date of imprint, 1894.)
Lower Coal Measures: Clinton, Mo.
Upper Coal Measures: Kansas City and Gentry, Mo.

1896. *Nucula ventricosa.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 245.
Lower Coal Measures: Conway County, Ark.

1897. *Nucula ventricosa.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 35.
Lower Coal Measures: Conway County, Ark.

1900. *Nucula ventricosa.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 150, pl. 22, figs. 9, 9b.
Upper Coal Measures: Kansas City, Rosedale, Turner, Topeka, Grand Summit, Kans.

1903. *Nucula ventricosa?* Girty, U. S. Geol. Survey Prof. Paper 16, p. 441.
Weber formation?: Leadville district, Colo.

Shell rather large, transversely elliptical, very ventricose. Beaks large, prominent, strongly incurved, and directed toward the short side of the shell. A narrow, ill-defined but usually distinct constriction can be seen near the ventral margin near the anterior end. This end is more or less nasute owing to the outline being strongly retracted above under the beak and somewhat emarginate below as a result of the constriction. Ventral margin more or less sigmoidal, strongly convex in its posterior portion with the small sinus or emargination toward the front as just described. Posterior end abruptly rounded, the extreme projection being above the median line. Dorsal border gently arcuate, somewhat elevated above the umbonal ridge which lies near the cardinal border. The anterior end below the beaks is slightly concave, but the lunule is at best ill defined and there is no distinguishable escutcheon. Just back of the beaks, however, the shell is excavated along the margin into linear grooves, one on either valve, for an external ligament.

The surface is generally smooth but is sometimes marked by a few faint concentric striæ. Many specimens have a few larger and deeper incremental striæ, especially toward the margin.

On the interior there are the usual large anterior and posterior adductors, the latter situated near the cardinal line and close to the posterior margin. Slightly above and anterior to the posterior scar is another somewhat smaller scar which in some specimens is clearly duplicate, one portion being more deeply impressed than the rest. In a few individuals a fourth scar, rather large, but not deeply impressed, can be seen between the beaks and the anterior adductor.

The dentition is fairly well shown by the specimens, though certain details remain still in doubt. Apparently the posterior teeth extend quite to the beak, gradually diminishing in size until the final ones are very diminutive. Under the beak the posterior teeth meet the anterior ones, which do not show a corresponding diminution in size and are therefore much larger than those which abut against them. I think there can be no reasonable doubt that a chondrophore is present, but, unlike the chondrophore of living nuculoids it does not extend to the beaks, thus interrupting the dentition, but is interior to the row of teeth which surrounds the margin, and at a somewhat lower level. I can not be absolutely certain that this difference, which has been observed also in *Leda bellistriata*, really exists, but such are the indications. There appear to be 6 or 7, or in some specimens possibly only 5, large anterior teeth. The posterior teeth number 17 to 19, but owing to the minute size of those beneath the beaks, they can not be readily counted and usually only 14 or 15 are clearly shown.

In the Wewoka formation this species occurs associated with a true Nucula of somewhat similar aspect and perhaps the same association is found in Nebraska, Indiana, and elsewhere. If so, a certain amount of confusion may have been introduced into the synonymy, for I have been unable to satisfy myself from the descriptions and figures that all of the citations really belong here. Authors seem not to have observed, or at least to have recorded, the characters by which I conceive this species to be distinguished—the ligamental grooves, the usually almost smooth surface, the projecting and sharply rounding anterior extremity, the little constriction at the anterior end, and the strongly convex ventral border back of the middle. Thanks to the courtesy of the American Museum of Natural History I have been able to examine the types of Hall's *Nucula ventricosa.* They are clearly conspecific with one another and with the form here under consideration. In the bivalve specimen the ligamental groove and the constriction are not so well marked as in some of those from the Wewoka formation; still, they are present. In the single (left) valve the ligamental groove is somewhat, and the constriction considerably, more marked than in the other. The chondrophore is not shown.

Without one exception the remaining citations have been retained in the synonymy, although it is probable that some of them, wholly or in part, belong elsewhere. The other form, if two really are involved, should be compared with that identified in the present report as *N. anodontoides.* In fact the only citation about which I do not feel considerable doubt is that of Keyes (1895). Meek apparently had characteristic specimens from Illinois [1] for he compares them with the English shell "*N. tumida*" (= *N. gibbosa*) which has the peculiarities of expression of *N. ventricosa* as here defined. Yet Meek regards his Nebraska shell (which, I suspect, is a true Nucula) as the same species. He also suggests that *Nucula beyrichi?* of the same report may be conspecific with *N. ventricosa.*

The only citation which I have withdrawn from the synonymy of *Nuculopsis ventricosa* is that of Hind in 1897. He figures a specimen from Illinois to show how it differs from the English species *N. gibbosa*

[1] Meek, F. B., U. S. Geol. Survey Nebraska Final Rept., p. 205, 1872.

and his figures seem convincing. But typical *N. ventricosa* has just the form of *N. gibbosa* and if Hind's specimen is distinct from the latter, it is also distinct from the former. It seems to agree, moreover, with the form here called *N. anodontoides*, and to that synonymy have I removed his reference.

Regarding *N. ventricosa* Hall and *N. gibbosa* Fleming, Meek [1] states that no satisfactory differences were observed; and a resemblance extremely close seems to exist between the shell here under discussion, which is typical *ventricosa*, and the figures which Hind gives of *N. gibbosa*. Although, as already noted, Hind regards the two species as distinct, offering for a comparison figures of a specimen from Illinois which he has received under the name of *N. ventricosa* Hall, and although I am satisfied that Hind's figures depict two distinct shells, I am also fairly satisfied that his figures of the American specimen do not appertain to typical *Nuculopsis ventricosa*. If it can be shown that the other characters are in agreement, it seems probable that both types belong to the same species, for no distinctive characters can be found, in the configuration at least.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Family LEDIDÆ.

The only genera occurring in our American Carboniferous which can be placed with the Ledidæ are Leda, Yoldia, and Paleoneilo, the last named being restricted in its occurrence to lower Mississippian and older horizons. The shells described under Nuculites are probably referable to other genera (Astartella and Paleoneilo). In the Pennsylvanian, therefore, the only representatives of this family belong to Leda and Yoldia. These two genera have a unity of expression that is quite lacking in the living representatives of the family, which present much greater variety and, in some of their modifications, show radical departures from the typical species.

The Carboniferous Ledas and Yoldias are very closely related to the living members of those genera, and their essential identity has usually been conceded. The excellent material representing these genera from the Wewoka formation has perhaps brought to light more differences than were supposed to exist. In the first place it seems probable that the chondrophore of these ancient shells differed from that of their living congeners in its relation to the dentition, for the denticles appear to constitute a single continuous series passing across the cardinal margin of the shell under the beak, the chondrophore being situated below them and not dividing them into two series, as it does in the living forms. This structure is not unmis-

[1] Meek, F. B., loc. cit.

takably shown by any of the specimens, but it is suggested by a number of them in several genera, not only in this family but in the Nuculidæ. Some difference also is found in the muscle scars. *Leda bellistriata* has large, deep anterior and posterior adductor scars, and in addition two pedal scars, one between the beak and the anterior adductor and the other between the beak and the posterior adductor. These smaller scars are found in the living shells also and are the points of attachment for muscles which extrude and draw back the foot. A fifth pair of scars is situated in the umbonal region. It is not certain that the living forms have anything exactly analogous to this. Many of them show in the umbonal region scattered depressed points irregular in number and distribution, which are not properly muscle scars, but points of attachment of the mantle to the shells. Similar markings occur in the Paleozoic forms also, and doubtless they had a similar origin. The structure observed in *Leda bellistriata* may be a localized and intensified manifestation of the same tendency, but it has more the appearance of a true muscle scar. If so, however, its function would be somewhat problematic. In *Yoldia glabra* the anterior adductor scars have not been observed, though by analogy they may be assumed to be present. Owing to the shell being thinner in this group, the muscular imprints are naturally less deep and distinct. On the other hand, the posterior auxiliary scar in *Y. glabra* seems to be double, consisting of a large elongate scar and a small compact one. So many points of muscular attachment are not known in the living Ledas and Yoldias.

As already noted, the two Pennsylvanian representatives of the family are very similar, both comprising transverse shells with beaks conspicuously pointed backward toward the long side of the shell, which is contracted and more or less pointed or attenuate. Yoldia, however, is distinguished from Leda by having a thin instead of thick shell, by being compressed instead of strongly convex, by having small instead of prominent beaks, by lacking a distinct umbonal ridge, and by being agape instead of closed at the posterior end.

If such distinguishing features are accepted, some of our Carboniferous Yoldias must without question be referred to other genera. Among the alien forms appear to be *Y. knoxensis*, *Y. oweni*, *Y. rushensis*, and *Y. carbonaria*. The first two, not only on account of their convexity and the prominence of their beaks, but especially because their beaks point toward the short end of the shell, can safely be removed from Yoldia. Provisionally, I am placing them with Anthraconeilo. The same disposition can be made of *Y. carbonaria*, though with much less certainty. Meek describes it as more convex than *Y. stevensoni*, a typical Yoldia in expression at least, but he does not mention the end toward which the beaks are directed. From his figure this would appear to be the short end. At all events, the general appearance of this shell seems to ally it with Anthraconeilo (Meek compares it with Paleoneilo) rather than with Yoldia. *Y. rushensis*, though almost certainly not a Yoldia, can not be disposed of so readily as the other forms. The shell is inflated and the beaks large and prominent. The general expression is suggestive of Nuculopsis, but the beaks are distinctly stated to be directed toward the long side of the shell. The dentition is not known, and it may prove to be nuculoid or something entirely different. If nuculoid, I should expect that *Y. rushensis* would prove to be representative of a new genus resembling Yoldia, but differing in configuration and doubtless in other particulars. Until more is known about it I am placing it in the genus Clinopistha, with which at least it has so much in common that the beaks point toward the long side of the shell. Although the expression of *Yoldia rushensis* differs sufficiently from that of the only known species of Clinopistha to prevent any question as to their specific distinction, yet the two are so generally similar that they may be included in the same genus. It is true that the typical species of Clinopistha shows radiating striæ but the variety *levis* lacks them entirely or shows only traces of them, whereas one of McChesney's figures of *Y. rushensis* suggests, by its crenulated concentric lines or lamellæ, a sort of radial sculpture.

Genus LEDA Schumacher

LEDA BELLISTRIATA Stevens.

Plate XIV, figures 1–9a.

1858. *Leda bellistriata.* Stevens, Am. Jour. Sci., 2d ser., vol. 25, p. 261.
Coal Measures: Danville, Ill.; Summit, Ohio.

1858. *Nucula (Leda) Kazanensis.* Swallow, Acad. Sci. St. Louis Trans., vol. 1, p. 190. (Not *N. kazanensis* Verneuil, 1845.)
Upper and Lower Permian: Valley of Cottonwood and near Smoky Hill Fork, Kans.

1858. *Leda bellastriata.* Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 717, pl. 29, figs. 6a–d. Lower Coal Measures: Illinois.

1884. *Nuculana bellistriata.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 146, pl. 31, figs. 8, 9.
Coal Measures: Vermilion, Sullivan, Vanderburg, and Warrick counties, Ind.

1887. *Nuculana bellistriata.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 40, pl. 4, fig. 26.
Coal Measures: Flint Ridge, Ohio.

1888. *Nuculana bellistriata.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 233. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Nuculana bellistriata.* Keyes, Missouri Geol. Survey, vol. 5, p. 122, pl. 45, figs. 4a, 4b. (Date of imprint, 1894.)
Upper Coal Measures: Gentry and Kansas City, Mo.

?1896. *Nuculana* aff. *bellistriata.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 245.
Upper Coal Measures: Scott County, Ark.

?1897. *Nuculana* aff. *bellistriata*. Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 35. (Date of imprint, 1896.)
Upper Coal Measures: Scott County, Ark.

1900. *Nuculana bellistriata*. Beede, Kansas Univ. Geol. Survey, vol. 6, p. 148, pl. 20, figs. 14, 14b.
Upper Coal Measures: Kansas City, Rosedale, Lawrence, Topeka, Kans.

1903. *Leda bellistriata?* Girty, U. S. Geol. Survey Prof. Paper 16, p. 442.
Hermosa formation: San Juan region, Colo.

NOTE.—A sulphur cast supposed to be of the type is probably a broken *Leda bellistriata*.

This well-known and characteristic Pennsylvanian species is exceedingly abundant in the Wewoka formation. The large number of specimens examined show considerable variation, and although most of the variations fall within a narrow range the extremes differ notably, especially in the prolongation of the posterior or longer side of the shell. Doubtless the other side varies also, but the variation is less conspicuous. The convexity is usually high, chiefly developed at the anterior end, the posterior extremity being more or less compressed. In many specimens a perceptible though not very distinct constriction passes obliquely downward, meeting the ventral border midway, or a greater or less distance back of the middle. It is chiefly perceptible near the margin. When the constriction is developed the posterior prolongation appears to be especially compressed and the shape is more or less fusiform. The umbonal ridge, though rounded, is fairly distinct; it is situated close to the dorsal border. In some specimens, though not in all, the actual cardinal edge appears above the umbonal ridge in the side view. This is because the shell between the umbonal ridge and the cardinal margin is more depressed and horizontal in some specimens than in others. The curvature of the surface here is concave, the shell bending upward to the cardinal margin. The escutcheon is large and well defined; the lunule is much smaller and less distinct.

The sculpture consists of fine, regularly arranged grooves or striæ, leaving between them relatively wide, more or less rounded intervals. The upper border of each interval next the stria that defines it on the dorsal side is more or less elevated so that the effect is somewhat that of a backward imbrication. This sculpture dies out along the umbonal ridge, but is renewed in many individuals on the escutcheon, showing fine, sharp liration near the cardinal line.

For the size of the shell the test is exceedingly thick; it bears an oblique internal ridge which extends from the beak toward the ventral border at or behind the middle point and is most distinct in the umbonal region. Possibly this is the internal expression of the obscure constriction observed on the exterior, though it is always more conspicuous. Owing to this internal ridge and the great thickness of the shell, internal molds have a very different shape from testiferous specimens. The conspicuous groove which the internal ridge produces on the mold of the interior seems to be characteristic of all Paleozoic species of the genus.

The teeth are large, stout, and from 23 to 25 in number. They extend across the median portion of the hinge, becoming much smaller, shorter, and crowded toward the middle. Those on the anterior portion are angular or arcuate. Their diminution in size under the beak is great and in some specimens is abrupt, but no satisfactory grouping can be made into anterior, posterior, and rostral. There are 11 or 12 (rarely 10) teeth on the short side and 10 or 11 (rarely 9 or 13) on the long side, with perhaps 1 or 2, possibly 3 very minute ones just under the beak. On one specimen there seemed to be 7 rostral teeth with only 6 on the anterior side and 11 on the posterior; the total number (24) is normal, though the arrangement appears to be unusual. Stevens reports 25 teeth with about 5 smaller than the others clustered under the beaks. Below the small median teeth is situated the chondrophore. This structure is not easy of observation, but I have seen fairly good evidence of it in a few specimens.

The muscle scars are usually deep and well marked. There is a large anterior scar a little above and posterior to the end of the shell on the shorter side and a corresponding large posterior scar near the cardinal border about two-thirds of the way from the beak. A small pedal scar has been observed along the cardinal border about halfway between the posterior scar and the beak, and still another occupies a similar position on the short side of the shell between the beak and the anterior scar. A small but strong scar is also found in the umbonal region on the oblique internal thickening or ridge, but its function is uncertain. It has no analogue in the muscular system of recent Ledas, and may perhaps correspond, in intensified and localized form, to the little scattered pits which in the living species mark the points of attachment of the mantle.

Stevens did not illustrate the species to which he gave the name *Leda bellistriata*, but in spite of some disagreements in his description (as pointed out by Winchell) there is hardly room for much doubt that Hall's identification in 1858 is correct, and that Winchell's identifications in 1862 and 1865 based on specimens from the Marshall formation (Mississippian) of Michigan, as well as his identifications in 1869 and 1870, based on specimens from the lower Mississippian of Tennessee, are incorrect. The Mississippian shells probably belong to the species which Stevens described from Battle Creek as *Leda pandoriformis* and to that synonymy I have accordingly transferred those four citations. The form from Arkansas which Smith compares with *L. bellistriata* is more probably *L. arata*, but for the present I am retaining his citations here.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. stations 2001, 2004, and 7193).

LEDA BELLISTRIATA var. ATTENUATA Meek.

Plate XIV, figures 10–11b.

1866. *Nucula Kazanensis*. Geinitz, Carb. und Dyas in Nebraska, p. 20, pl. 1, figs. 33, 34.
Upper Coal Measures: Nebraska City, Nebr.

1872. *Nuculana bellistriata* var. *attenuata*. Meek, U. S. Geol. Survey Nebraska Final Rept., p. 206, pl. 10, figs. 11a, 11b.
Upper Coal Measures: Nebraska City, Nebr.; Leavenworth, Kans.; Iowa; Illinois.
Lower Coal Measures: West Virginia.

1900. *Nuculana bellistriata attenuata*. Beede, Kansas Univ. Geol. Survey, vol. 6, p. 149.
Upper Coal Measures: Kansas City, Topeka, Kans.

These shells occur associated with *L. bellistriata* itself, from which they differ in being smaller, more finely striated, more slender, and more pointed at the longer end. They are not merely young examples of the larger species, for their convexity indicates that they are mature, and, moreover, the immature form of *L. bellistriata* is represented by small, coarsely striated shells of the same shape; on the other hand, they are hardly a distinct and independent species. Not all specimens have the peculiarities as strikingly developed as those selected for illustration. Some have the shape of *L. bellistriata* but much finer liration; others, perhaps intermediate in shape, liration that is still finer and that lacks but little of the degree of fineness shown by the extreme examples. No small specimens having the slender shape and elongate pointed anterior end have been observed with anything but very fine liration.

The largest specimen referred here is less than 15 millimeters wide.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2004 and 7193).

Genus YOLDIA Möller.

Dr. Wheelton Hind seems to doubt the occurrence of this genus in the Paleozoic and places all references to it, those of American authors included, in the synonymy of Nuculana (Leda). I am ready to admit and indeed have already shown in the present paper (p. 114) that at least two types have been referred by American authors to Yoldia, but Hind includes both of these under Leda. Only one type remains to be considered, and though I am not prepared to maintain that it is certainly congeneric with Yoldia, yet I feel very confident that it should not be assigned to Leda. It has a thin instead of a very thick test, low convexity without umbonal ridges, small beaks, and gaping ends.

The only American Yoldia which Hind[1] seems to have been able to examine is *Y. knoxensis*, a species which I should certainly exclude from the group here placed under Yoldia, but which I should also as certainly exclude from Leda, if, as McChesney states, the beaks are directed toward the short end, instead of toward the long one, as in Leda. Indeed, I am provisionally including it in the group for which the new name Anthraconeilo is here introduced and I believe that such will really prove its proper position. Hind mentions observing in *Yoldia knoxensis* the presence of the oblique internal ridge characteristic of Leda, a feature which I have not seen in *Anthraconeilo taffiana*, but he does not figure the specimen upon which this observation was made, so that there is no way of judging whether his shell was properly identified.

YOLDIA GLABRA Beede and Rogers.

Plate XIII, figures 9–15.

1899. *Yoldia glabra*. Beede and Rogers, Kansas Univ. Quart., vol. 8, No. 3, p. 133, pl. 34, figs. 4a,4b.
Coal Measures: Camerons Bluff, near Lawrence, Kans.

1900. *Yoldia glabra*. Beede, Kansas Univ. Geol. Survey, vol. 6, p. 153, pl. 21, figs. 4a, 4b.
Upper Coal Measures: Lawrence.

The shells included under this title are numerous in the Wewoka formation and some of them attain a large size, measuring probably as much as 30 millimeters in width.

Though distinctly anterior to the middle, the beaks are subcentral, small, and obviously pointed toward the long or posterior side. The shape is elliptical and very transverse. The posterior end is nearly as broad at its termination as the anterior and is regularly rounded in a similar manner, but most specimens are imperfect at this end; the greatest projection apparently lies above the middle. The beaks are so nearly central and the posterior extremity is in many specimens so little contracted that one is surprised when complete specimens are found, having expected this extremity to be more produced and tapered to a narrower shape. The convexity is very low, the beaks but little elevated, and no distinct umbonal ridge developed. The posterior and perhaps the anterior extremity are gaping. Some specimens show a very narrow, ill-defined area back of the beaks, suggesting an obscure escutcheon. The posterior edges of the shell are pinched together here so that they are in flat contact and have a vertical direction. This configuration hardly suggests a ligamental area, a similar structure on the short side of the beaks observable in some cases

[1] Hind, Wheelton, British Carboniferous Lamellibranchiata, vol. 1, p. 194, Paleontographical Soc., 1896–1900.

having more the appearance of ligamental grooves. If such is their nature, however, the entire orientation of the shell is changed and the genus is very distinct from Yoldia.

A broad, indistinct constriction, developed in most specimens near the center of the ventral border or a little posterior to the beaks, produces a slight emargination or sudden contraction in the ventral outline and gives this end of the shell a compressed appearance. It also influences the sculpture, which consists of delicate, rather distant striæ marked on the ventral side by a slight elevation of the shell. Near the constriction the striæ are deflected, narrowed, and more or less discrepant, some cutting obliquely, or as it were unconformably, across the rest, or running out on the ventral border. In the postcardinal region they seem to become indistinct.

The teeth are very small, equal, and not so numerous as one would expect from the size of the shell, probably because the gaping ends do not permit the dorsal edges to come in contact far from the beaks on either side. The denticles seem to number about 12 or 13 on the anterior and 7 or 8 on the posterior side.

The shell, in contrast to the other nuculoids and ledoids, is very thin and the muscular imprints are less well defined. There seems to be a large posterior adductor as in the other forms, but though doubtless such a muscle was present the anterior scar has not been observed. Two pairs of auxiliary scars, small, much elongated, and deeply impressed, are also found, one on each side of the beaks. That on the posterior side is close to the beak and appears to be double, the upper impression being large and narrow and the lower small and rounded. An ill-defined scar seems also to occur in the umbonal region of either valve, corresponding to structures in *Leda bellistriata*, but less deeply impressed. In a few specimens also a similar internal ridgelike thickening of the shell was observed but was not so pronounced as in *L. bellistriata*.

I am a little uncertain of the identity of this shell with *Yoldia glabra*, but hardly feel justified in introducing it as a new species, its general resemblance being in many respects so close. It attains a much larger size than the type of *Yoldia glabra* and even its average size is larger. The anterior and posterior ends are apt to be a little wider, especially in large specimens. The beak is also smaller and less prominent, but that may be due to a defect in the original illustration. The surface of *Y. glabra* is said to be crossed by fine, rather distant striæ, a word which unfortunately is used both for grooves and for ridges; the illustration seems to show slender concentric liræ separated by broad flat interspaces. This marking is of course quite distinct from that of the Wewoka fossils.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2004 and 7193).

Family PINNIDÆ.

Genus AVICULIPINNA Meek.

AVICULIPINNA AMERICANA Meek.

Plate XVII, figures 1, 1a.

1866. *Avicula pinnæformis.* Geinitz, Carb. und Dyas in Nebraska, p. 31, tab. 2, fig. 13. (Not *Solen pinnæformis* Geinitz, 1848.)
Nebraska City, Nebraska.
1867. *Aviculopinna americana.* Meek, Am. Jour. Sci., 2d ser., vol. 44, p. 282.
1872. *Aviculopinna americana.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 197, pl. 9, figs. 12a–d.
Upper Coal Measures: Nebraska City, Nebr.; Iowa.
1875. *Aviculopinna americana:* Meek, Ohio Geol. Survey, Paleontology, vol. 2, p. 337, pl. 20, fig. 2.
Lower Coal Measures: Ohio.
Upper Coal Measures: Nebraska City, Nebr.; western Iowa.
1887. *Aviculopinna americana.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 38, pl. 1, fig. 20.
Coal Measures: Flint Ridge, Ohio.
1892. *Aviculopinna americana.* Hyatt, Boston Soc. Nat. Hist. Proc., vol. 25, p. 338.
1895. *Aviculopinna americana.* Keyes, Missouri Geol. Survey, vol. 5, p. 115. (Date of imprint, 1894.)
Upper Coal Measures: Forest City, Mo.
1900. *Aviculopinna americana.* Beede, Kans. Univ. Geol. Survey, vol. 6, p. 143, pl. 18, fig. 2.
Upper Coal Measures: Kansas City, Lansing (Leavenworth County), Topeka, Kans.

Of this shell but two specimens have come to hand, one much more imperfect and obscure than the other. The size is rather small, the shape triangular, very transverse, and gradually tapering to the acute anterior end. Both upper and lower margins are straight. The posterior margin is straight above, meeting the hinge line at nearly, though distinctly less than, a right angle. The outline thus slopes forward from the hinge and, becoming more curved below, passes without break into the ventral outline. This is the condition of the specimen represented by my figures. The second specimen has the posterior outline sloping somewhat the other way, so that the posterior superior angle is obtuse instead of acute. The convexity is low, the highest points being localized very nearly along the median line, somewhat compressed above, with the merest suggestion of a broad furrow or sulcus. At the hinge the shell is again more prominent along a narrow linear band. This may be due to a thickening of the test or, as I suspect, it may correspond to an internal (or partly external) groove for the reception of a ligament.

The sculpture consists of rather fine, regularly arranged lamellæ following the outline of the posterior and ventral borders, but ending abruptly at the cardinal border. In fact, the foregoing description of the posterior outline is based on the direction of the lines of sculpture rather than on a completed specimen. Toward the ventral margin these lamellæ die down and at the same time they naturally become more crowded, so that near this border the shell is marked by fine, obscure striæ, more or less parallel to the edge.

The identification adopted for this form is not entirely satisfactory. The outline certainly does not have a perceptible emargination below the hinge in the specimens examined, and in one of them it slopes rather more distinctly forward than it does in Meek's figures, although in the other it is more in agreement with them. The same difference is found in comparing the specimens with *A. illinoisensis*, which has furthermore curved cardinal and ventral borders, though these can hardly be a normal character of the species, which may prove to be the same as *A. americana*. The shape of the posterior end of the specimen here figured is rather comparable to *A. consimilis* from the Eureka district of Nevada, but it seems improbable that the two forms are conspecific when the associated faunas are so different. Although these differences between the Wewoka specimens and *A. americana* are recognized, it would hardly be justifiable to introduce a name for the former (which would be the only alternative), because the differences seem almost too slight and too variable and because my knowledge as to the characterization of the two types is too imperfect.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005); Coalgate quadrangle, Okla. (station 2001).

Family PTERIIDÆ.

Genus PSEUDOMONOTIS Beyrich.

PSEUDOMONOTIS KANSASENSIS Beede.

Plate XVII, figures 4, 4a.

1858. *Monotis radialis.* Swallow, Acad. Sci. St. Louis Trans., vol. 1, p. 187. (Date of imprint, 1860.)
Upper Permian: Smoky Hill Fork, Kans.

1872. *Pseudomonotis radialis?* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 201, pl. 9, fig. 3.
Upper Coal Measures: Nebraska City, Nebr.

?1887. Cf. *Pseudomonotus radialis.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 145, pl. 14, fig. 26.
Coal Measures: Flint Ridge, Ohio.

1899. *Pseudomonotis? tenuistriata.* Beede, Kansas Univ. Quart., vol. 8, p. 81, pl. 18, figs. 1–1d; pl. 19, fig. 3.
Upper Coal Measures: Turner, Wyandotte County, Topeka, Auburn, Shawnee County, Kans.

1900. *Pseudomonotis kansasensis.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 133, pl. 14, figs. 1–1d, pl. 15, fig. 3.
Upper Coal Measures: Turner, Topeka, Auburn (Shawnee County), Kans.

1903. *Pseudomonotis kansasensis.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 428, pl. 8, fig. 4.
Rico formation: San Juan region, Colo.

Of this species our collection contains two specimens which seem to be growing, one on the other, somewhat as oysters grow, although, of course, not cemented. The smaller and more perfect specimen is uppermost and has a subcircular shape which contracts toward the rather short hinge. The ears are undefined and the beak is small. The convexity is rather high. The lower specimen is considerably larger and appears to have been more elongate and less convex.

The sculpture consists of sharply elevated, regular, radiating liræ, about 9 in 5 millimeters, and fine, regularly arranged, concentric, lamellose lines. The liræ are separated by striæ having variable width. The striæ near the center of the shell, if closely arranged, are narrower than the liræ, but in some places, especially at the sides, they are wider. The liræ are very nearly equal; they are, however, obscurely alternating. The lamellose lines are stronger on the liræ than on the striæ between, producing little scalelike projections.

This form, with a high degree of probability, belongs to the species which Beede described from the "Upper Coal Measures" of Kansas. In some respects it suggests the rare species to which Meek and Worthen gave the name *Placunopsis carbonaria*. The occurrence of the genus Placunopsis in the Carboniferous is, of course, a little unexpected, and it would perhaps be worth while for some one to examine that species with a view of determining whether it might not belong to the genus Pseudomonotis. Specimens of *Placunopsis carbonaria* have never come under my personal observation.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Family TRIGONIIDÆ.

Genus SCHIZODUS King.

SCHIZODUS ALPINUS Hall.

Plate XVII, figure 3.

1858. *Dolabra? alpina:* Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 716, pl. 29, fig. 2.
Lower Coal Measures: Alpine Dam, Iowa.

1864. *Schizodus alpina.* Meek and Hayden, Smithsonian Contrib. Knowledge, No. 172, p. 58.

1891. *Schizodus alpina.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 249. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

Shell of medium size, subcircular, slightly broader than long. Anterior end regularly rounded. Ventral border also rather regularly curved, bending more strongly in front than behind. Posterior outline subtruncate, slightly oblique. Cardinal margin rectilinear, oblique, meeting the posterior outline in an obtuse, more or less distinct angle. Convexity moderate, most prominent in the umbonal region. Beaks subcentral, small, fairly prominent. Umbonal ridge indistinct.

Surface smooth or marked only with incremental lines.

This rare species is almost exactly the shape of *S. alpina* as figured by Hall, though the beak is perhaps not quite so prominent. The identification seems very likely.

The figures of *Schizodus rossicus* given by Meek and Worthen from Illinois specimens also resemble the present form, but they are much smaller and appear to have a more distinct umbonal ridge.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (stations 2001 and 2004).

SCHIZODUS AFFINIS Herrick?

Plate XVII, figures 2, 2a.

1887. *Schizodus affinis.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 41, pl. 4, figs. 22, 22a.
Coal Measures: Flint Ridge, Ohio.

1899. *Schizodus affinis.* Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 582, pl. 72, figs. 4a–4f.
Upper Coal Measures: McAlester quadrangle, Atoka quadrangle, Okla.

Shell small, transverse, subtriangular. Anterior extremity broadly and rather regularly rounded, most prominent below the middle. Ventral border with a sinuate outline, slightly concave posteriorly, gently and regularly convex over anterior two-thirds of the border. Cardinal margin sloping obliquely downward. Posterior outline nearly straight, obliquely truncating the shell, about equal in length to the cardinal line and meeting it in an obscure obtuse angle. Inferior posterior angle acute, pointed. Convexity moderate, developed chiefly in the umbonal region. Umbonal ridge fairly distinct and obscurely angular. Post-umbonal slope slightly concave. A broad obscure constriction occurs near the ventral border a little in front of the umbonal ridge, producing an emargination of the outline. Posterior portion of the shell more or less compressed. Beaks small, subcentral. Surface smooth so far as shown.

In general appearance this shell is very similar to *S. affinis*, but if the difference existing between the single specimen from the Wewoka formation and Herrick's figure were constant, it would probably be advisable to regard them as distinct varieties. The smaller size, more prominent anterior extremity, smaller and less well defined beaks, and emarginate ventral border near the umbonal ridge are the only differences noted, and these are not very great. *S. ovatus* and *S. symmetricus* are also related forms, especially the latter, which is probably a synonym of *S. affinis*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (station 2001).

Family PECTINIDÆ.

Genus DELTOPECTEN Etheridge.

DELTOPECTEN TEXANUS Girty.

Plate XVI, figures 1–2b.

1904. *Limipecten texanus*. Girty, U. S. Nat. Mus. Proc., vol. 27, p. 722, pl. 45, figs. 1, 2, 3; pl. 46, fig. 4?; pl. 47, figs. 1, 2, 3.
Pennsylvanian (Cisco): Graham, Young County, Tex.

Shell large; length nearly equal to or slightly in excess of the width. The largest example observed must have been over 65 mm. long when complete. The hinge line is long, though somewhat shorter than the greatest width. The obliquity is slight but appears to be forward as in Lima.

The convexity of the left valve is moderate or strong in different individuals. The umbo is large, well defined, and incurved. The wings are broad and the outline is not strongly withdrawn beneath them. They are of nearly equal size, the anterior one being possibly a trifle larger than the posterior. It is also much more strongly defined, for while the posterior wing is depressed and slightly upturned, and therefore bounded by an ill-defined groove, the descent to the anterior wing is abrupt and angular. This wing is flattened and somewhat oblique. The surface is crossed by rather coarse and radiating ribs, which are more or less regularly unequal in size. Frequently three gradations can be distinguished, every fourth rib being large, those halfway between somewhat smaller, while others alternating with these two systems are still smaller. The ribs do not extend onto the wings, though sometimes traces of slender ones appear. The surface is also crossed by delicate concentric lamellæ, rather distant and irregular, which are much stronger and more crowded on and near the wings. They cross the shell in scalloped lines with pointed extensions in the striæ between the ribs.

The right valve is much flatter than the left and its surface ornamentation, though of the same general character, is so different that one would hardly think of the two belonging together, if found separately. The posterior wing is flat and not marked off from the rest of the shell. The anterior wing is, on the other hand, sharply defined, and the outline is strongly retracted beneath so as to make a deep byssal sinus. While the umbo of the left valve is prominent and well defined, the right valve practically lacks this feature altogether. The surface is marked by somewhat depressed ribs, which are much finer and more numerous than those of the opposite valve. They are, as a rule, obsolete over and near the wings, but a few faint and slender ones can sometimes be seen. The concentric lamellæ are in like manner finer and fainter than those of the left valve. They are obscure over most of the shell, and only distinct upon and near the wings.

There is a broad and massive hinge plate marked by structural lines parallel to the straight lower border, and just beneath the beaks a large distinct fossette for the resilium, which is very oblique and directed backward. Both valves seem to have this structure of the same character and force. Near the center, under the hinge plate, are several small depressions arranged in a row, and some distance apart, which may mark the position of the pedal muscle.

The shell is thick and massive, especially in the upper and older portion. It is conspicuously constructed of two layers, an outer one which is relatively thin and which carries all the more delicate surface ornamentation, and an inner which is much thicker and receives only the strong plications. The inner layer consists of laminæ approximately parallel to the surface. Because of the distinct demarcation of the outer layer I suspected that it might have a prismatic structure. Though in one or two instances fine parallel lines were thought to be observed running across this layer on broken surfaces, no prismatic structure is shown by thin sections. These indicate, however, that the outer layer had a distinct composition of its own, for it is defined by a sharp line from the massive inner portion and is, furthermore, nearly transparent, while the other transmits light but imperfectly. The fact that in its present condition the outer layer is transparent and structureless inspires and leaves room for conjecture as to what may have been its original arrangement.

This species, while presenting some resemblance to *Aviculipecten providensis* Cox, is distinct both from it and from every other American form known to me. The shape of the Texan species is somewhat different from that described by Cox, being broader at the hinge line. Furthermore, his description as well as his figure indicates that the main ribs are subdivided by longitudinal striæ into riblets. Nothing of this sort occurs in *Limipecten texanus*, the concentric lamellæ of which, on the other hand, are not mentioned as occurring in *Aviculipecten providensis*.

When *Deltopecten texanus* was first described it was made the type of a new genus, Limipecten. Since that time I have convinced myself that Limipecten is a synonym for the genus Deltopecten, which was founded on some Australian fossils and was not known to me when the name Limipecten was introduced. This species was originally described from the Cisco formation of Texas and a few fragments from the Wewoka formation have also been referred to it. As the more recent representatives are fragmentary, it has seemed best to reproduce the original description and figures.

Of the generic distinction between Deltopecten and Aviculipecten there can not be a doubt. To Deltopecten belong probably a considerable number of our Carboniferous shells, commonly cited under Aviculipecten. Among those which I have determined as having the characters of Deltopecten are *D. occidentalis*, *D. texanus*, as above, and *D. vanvleeti*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

DELTOPECTEN VANVLEETI Beede?

Plate XVII, figure 5.

1877. *Aviculopecten McCoyi.* White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 4, p. 149, pl. 11, fig. 2a.
Carboniferous: Near Bear Spring, Camp Wingate, N. Mex.

1902. *Aviculopecten vanvleeti.* Beede, Oklahoma Geol. Survey First Bien. Rept. Adv. Bull., p. 6, pl. 1, figs. 8, 8b.
Red Beds: Whitehorse Springs, Okla.

1907. *Aviculopecten vanvleeti.* Beede, Kansas Univ. Sci. Bull., vol. 4, No. 3, p. 159, pl. 5, figs. 2, 2e.
Whitehorse sandstone: Whitehorse Springs, Okla.
Quartermaster formation: Dozier, Tex.

1909. *Deltopecten vanvleeti.* Girty, U. S. Geol. Survey Bull. 389, p. 86, pl. 9, fig. 5.
San Andreas formation: Elephant Butte, San Andreas, and Engle, N. Mex.
Abo sandstone: Abo Canyon, N. Mex.

Of this type our collection contains a single rather small left valve, imperfect at the edges and preserved as an internal mold. The shape can not at present be accurately determined, but there is little doubt that it was typically pectinoid, not differing essentially from the well-known *D. occidentalis*. The wings are strongly and rather abruptly depressed, the anterior more so than the posterior. The sculpture consists of narrow, rounded costæ, separated by relatively broad, gently concave striæ. The radii are regularly and strongly unequal. Those of the larger size usually contain between them three very much smaller ones, and of these three the median one is slightly larger than its fellows. The major costæ appear to be nodose as if from the development of prominent squamæ.

This form is very similar to that which occurs in the Manzano fauna, and which I there identified as *Deltopecten vanvleeti*. It differs from the figured example, however, in having the major costæ more numerous and more closely arranged. The intermediate liræ in the Manzano form are finer and, owing to this fact and to the wider intervals between the larger ribs, more of them occur in the intermediate spaces. A series of specimens might show that these differences were not constant, and it does not seem justifiable to discriminate the two forms positively in this place.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Genus ACANTHOPECTEN Girty.

ACANTHOPECTEN CARBONIFERUS Stevens.

Plate XVII, figures 10, 10a.

1858. *Pecten carboniferus*. Stevens, Am. Jour. Sci., 2d ser., vol. 25, p. 261.
Coal Measures: Crooked Creek, Marion County, Ill.

1863. *Pecten Broadheadii*. Swallow, Acad. Sci. St. Louis Trans., vol. 2, p. 97. (Date of imprint, 1868.)
Upper Coal Measures: Harrison County, Mo.

1866. *Pecten Hawni*. Geinitz, Carb. und Dyas in Nebraska, p. 36, tab. 2, figs. 19a, 19b.
Coal Measures: Nebraska City, Nebr.

1872. *Aviculopecten carboniferus*. Meek, U. S. Geol. Survey Nebraska Final Rept., p. 193, pl. 4, fig. 8; pl. 9, figs. 4a, 4b.
Upper Coal Measures: Nebraska City, Nebr.
Coal Measures: Iowa, Illinois, West Virginia.

1873. *Aviculopecten carboniferus*. Meek and Worthen, Illinois Geol. Survey, vol. 5, pl. 26, fig. 8.
Coal Measures: Illinois.

1874. *Aviculopecten carboniferus*. Meek, Am. Jour. Sci., 3d ser., vol. 7, p. 489.

1884. *Aviculopecten carboniferus*. White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 144, pl. 28, figs. 5–6.
Coal Measures: Lick Branch, near Silverwood, Fountain County, and in Vermilion County, Ind.

1887. *Aviculopecten carboniferus.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 67, pl. 3, fig. 13.
Coal Measures: Flint Ridge, Ohio.

1895. *Aviculopecten carboniferus.* Keyes, Missouri Geol. Survey, vol. 5, p. 111, pl. 43, figs. 4a, 4b. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1896. *Aviculopecten carboniferus.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 243.
Lower Coal Measures: White and Conway counties, Ark.

1897. *Aviculopecten carboniferus.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 33.
Lower Coal Measures: White and Conway counties, Ark.

1900. *Aviculopecten carboniferus.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 117, pl. 13, fig. 9.
Upper Coal Measures: Kansas City, Turner, Eudora, Lawrence, Lecompton, Topeka, Kans.

1903. *Acanthopecten carboniferus.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 418.
Hermosa and Rico formations: San Juan region, Colo.
Pennsylvanian: Leadville region, Colo.

1906. *Aviculopecten carboniferus.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 282, pl. 14, fig. 2.
Carboniferous: Louisville, Nehawka, and Rock Bluff, Nebr.

1908. *Acanthopecten* aff. *A. carboniferus.* Girty, U. S. Geol. Survey Prof. Paper 58, p. 440.
Delaware Mountain formation: Guadalupe Mountains, Tex.

Of this species our collection contains a single specimen, a left valve, preserved as a mold but showing all the characteristic features. The shape is pectinoid with long straight hinge line and large projecting wings. The lower part of the shell is subcircular with a slight though distinct backward swing. The outline makes broad, concave curves beneath the wings. The posterior wing is depressed but is not well defined; the anterior wing is marked by an abrupt angular deflection of the shell.

The surface is crossed by broad, subangular, radiating plications. The ventral margin is serrated by reason of the shell projecting in large spinelike points from the sulci between the plications. This feature recurs at regular intervals, the renewed growth in each case beginning beneath the spiniferous layer, so that the shell is covered with rather distant regularly arranged lamellæ with jagged or dentate edges. There are also fine, regular, lamellose, concentric lines, strongest upon the ears, where no plications are developed.

The hinge characters consist of a narrow groove, parallel and close to the hinge line, which produce a welt on the exterior of the thin shell and probably served as the receptacle of a ligament. It diminishes in thickness from the cardinal angles toward the beak.

It seems highly probable that the name of this species will have to be changed to *Acanthopecten armiger*, which was described by Conrad in 1835, whereas Stevens's name was not introduced until 1858. For convenient reference I have reproduced Conrad's description and figure, from which it will be seen that his species is probably based upon nothing more than an elongate example of *A. carboniferus*. There can be little doubt, at all events, that it belongs to the group of Acanthopecten, and whether the difference in shape adequately distinguishes it from *A. carboniferus* is very doubtful.

Conrad's description [1] of *Pecten armigerus* is as follows:

Shell ovate, with angular costæ, and slender, erect, very prominent spines; ears unequal; one ear of the left valve elongated and pointed.

In slate; the interior of the left valve is the only specimen I have seen, but it is remarkably perfect and distinct.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Family LIMIDÆ.

Genus LIMA Bruguière.

The recent Limas are divided into the subgenera Lima s. s., Limatula, and Plagiostoma, according as the shell is provided with strong radial ribs, is medially ribbed and laterally smooth, or is smooth or finely striated. All these types of sculpture occur among the Limas of our American Carboniferous. To Lima itself would probably belong *L. retifera* and *L. chesterensis;* to Limatula would belong only the Guadalupian species *Limatula striaticostata;* [2] and to Plagiostoma has been referred *P. deltoideum* from the same fauna. Even in the fauna under consideration three correspondingly decorated types can be distinguished. Of the same type as Lima is *Lima retifera;* of the same type as Limatula is *Limatula fasciculata* n. sp., and similar to Plagiostoma in sculpture is *Plagiostoma? acosta;* but concerning its generic position with the Limas there is much doubt.

In this connection must be considered the genus Paleolima, proposed by Hind for certain English Limidæ, which, it seems highly probable, are congeneric with the American forms. Although the characters by which Paleolima is conceived to be distinguished from the recent genus have not yet been found in the American forms, yet I would refer them to Hind's genus, at least provisionally, on the strength of general probabilities and the absence of any evidence to the contrary, if it seemed that Paleolima were adequately established. Hind says of Paleolima: [3]

Generic characters.—Shell below medium size, obliquely ovate, almost equivalve, moderately swollen. Umbones small, pointed, almost central; ears small, depressed, apparently not slit for the byssus. Exterior surface smooth, or with well-marked radiating ribs and sulci. A deep groove between the umbones in each valve for the cartilage or ligament.

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[1] Pennsylvania Geol. Soc. Trans., vol. 1, pt. 2, p. 268, Pl. XII, fig. 3, 1835.

[2] By a slip of the pen this name was written *Limatulina striaticostata* in the original report.

[3] Hind, Wheelton, British Carboniferous Lamellibranchiata, vol. 2, p. 38, Paleontographical Soc., 1901–1905.

Observations.—This genus has been erected for shells which have somewhat the external form of Lima, but evidently differ from this genus in some details. So far as the hinge can be observed there are no hinge-teeth, and a strong ligament, which is external and lodged in a comparatively deep and broad groove, is therefore necessary. Three species are now referred to Palæolima.

As I understand the recent genus Lima s. s., it has all these characters with possibly one exception. Lima, according to my understanding, possesses both a cartilage along the area on either side of the beaks and a subinternal resilium beneath them.

Hind's expression seems to indicate the presence in Paleolima of the latter structure, for he would probably not speak of a deep groove between the umbones in describing an alivincular hinge. On the other hand, it would seem to be more natural to speak of the excavation for a resilium under the beak as a pit rather than a groove. In either event it would appear that a corresponding structure was present in Lima, from which, accordingly, no difference would exist in Paleolima, unless Hind wishes to imply that the other structure, whichever it may be, external ligament or subinternal resilium, is absent from Paleolima, and this he seems not to have established. Consequently, while the probabilities point to the generic identity of the American and British Carboniferous Limas they also point to the generic identity of the British Limas which constitute Hind's group of Paleolima, with the living genus.

Apparently Hind includes under Paleolima shells possessing the differences in sculpture that in the recent forms have led to the establishment of the subgenera Lima s. s., Limatula, and Plagiostoma. Whether corresponding subdivisions can profitably be made in Paleolima, provided its generic position can be established, remains to be determined.

Lima retifera Shumard.

Plate XVII, figure 8.

1858. *Lima retifera.* Shumard, Acad. Sci. St. Louis Trans., vol. 1, p. 214. (Date of imprint, 1860.)
Coal Measures: Valley of Verdigris, Kans.

1866. *Lima retifera?* Geinitz, Carb. und Dyas in Nebraska, p. 36, tab. 2, figs. 20, 21.
Upper Coal Measures: Nebraska City, Nebr.

1872. *Lima retifera.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 188, pl. 9, fig. 5.
Upper Coal Measures: Nebraska City, Nebr.; Verdigris River, Kans.
Coal Measures: Illinois.

1873. *Lima retifera.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 588, pl. 26, fig. 2.
Coal Measures: Springfield, Ill.

1884. *Lima retifera.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 138, pl. 28, fig. 4.
Coal Measures: Knox, Gibson, and Posey counties, Ind.

1887. *Lima retifera.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 29, pl. 4, fig. 25; pl. 5, fig. 3.
Coal Measures: Flint Ridge, Ohio.
1891. *Lima retifera.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 248. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.
1895. *Lima retifera.* Keyes, Missouri Geol. Survey, vol. 5, p. 108, pl. 42, fig. 1. Coal Measures: Clinton and Kansas City, Mo.
1896. *Lima retifera.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 244.
Upper Coal Measures: Poteau Mountain, Okla.
1897. *Lima retifera.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 34.
Upper Coal Measures: Poteau Mountain, Okla.
1900. *Lima retifera.* Beede, Kansas Univ. Geol. Survey, vol. 6, p. 112, pl. 13, fig. 5.
Upper Coal Measures: Lawrence and Topeka, Kans.

Only one specimen of this shell has thus far come to hand—an imperfect left valve. The general shape is ovate with a rather short hinge, toward which the outline contracts at both sides. The shell is moderately oblique, extended on the anterior side. Only the posterior auricle is shown by the specimen. It is small, undefined, slightly depressed, and recurved at the margin.

The surface is marked by regular, narrowly rounded radiating costæ separated by slightly wider, flattened interspaces. A few of the costæ bifurcate and they tend to become obsolete on the posterior side toward the hinge. This latter circumstance constitutes about the only difference of any moment which I can discern between my own imperfect shell and that which Meek described and figured as *L. retifera* in his Nebraska report.

Perhaps the fossil under consideration would, on account of the obsolescence of the striæ near the posterior border, be considered a representative of Limatula rather than of Lima s. s., whereas *L. retifera,* as described by Meek, would be a typical Lima. But it seems to me unjustifiable to assign these two forms to different subgenera when in fact it seems probable that they belong to the same species.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Genus **LIMATULA** Wood.

LIMATULA ? FASCICULATA Girty.

Plate XVII, figures 6, 7.

1911. *Limatula ? fasciculata.* Girty, New York Acad. Sci. Annals, vol. 21, p. 134.
Wewoka formation: Wewoka quadrangle, Okla.

Shell of medium size, elongate, slightly oblique. Hinge line short. Anterior and posterior outlines probably nearly straight above but becoming more and more strongly curved below where they merge with the (probably) regularly rounded ventral outline. The convexity is strong with a high area, so that a section cut longitudinally through the two valves would be wedge shaped. On the anterior side the shell descends steeply and abruptly, making a rounded angle with the median portion. The posterior side seems to fall away in a low regular flexure.

The surface is marked by regularly arranged costæ or groups of costæ. Near the anterior side the costæ are single and are separated by relatively wide spaces, but in the median and posterior regions they are in groups of three or, exceptionally, of two, their tops standing about level, and the dividing striæ are essentially equal in width to the groups of costæ. The anterior side, from the angulation to the margin, is smooth. Very likely the costæ die out toward the posterior side also.

The area is somewhat imperfectly shown by one of the two specimens obtained. It appears to be high and resupinate, so that the beak overhangs the hinge line, and it is also rather concave. It is marked by several strong, broad, transverse furrows, but shows no definite pit for a resilium, though the projection of the beak and the concavity of the area seem to produce, beneath the beak, an ill-defined hollow which is longitudinal rather than transverse to the area.

This species is based on a single incomplete specimen; but a second specimen, which shows similar sculpture but is much broader and rounder, is referred to the same species. It is defective in the upper part, which may have had the configuration of Aviculipecten, for the shape so far as shown is suggestive rather of the Pectens than of the Limas.

If Hind's Paleolima is a valid genus the present species would be called *Paleolima fasciculata*, for its characters, so far as observed, are consistent with Paleolima, but if that genus is to be divided into subgenera along the same lines as the living Limas, the present species would probably belong in a group as yet unnamed. For the present, however, I am not recognizing Paleolima as distinct from Lima, so that the generic designation to be used is probably Limatula, which is distinguished by being smooth laterally and by having the valves not gaping. The former character seems to be possessed by the present species, but the latter can not be determined as we have only one valve. The only other American species referred to this subgenus is the Guadalupian form *Limatula striaticostata*. By a lapsus calami *L. striaticostata* was described under Limatulina, but as the genus was ascribed to Wood instead of De Koninck, the group which I had in mind is apparent. The form is clearly not a Limatulina and the proper title is *Limatula striaticostata*. It differs from *Limatula ? fasciculata* in being much smaller, more oblique, and in having different surface ornamentation.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus PLAGIOSTOMA Sowerby.

PLAGIOSTOMA ? ACOSTA Cox.

Plate XVII, figures 11, 11a.

1857. *Avicula acosta.* Cox, Kentucky Geol. Survey Rept., vol. 3, p. 572, pl. 9, fig. 3. Coal Measures: Union County, Ky.; Gallatin County, Ill.

Shell equivalve, very inequilateral, small, aviculate. Shape subquadrate. Hinge line long, straight, somewhat shorter than the greatest width. Ventral border regularly rounded. Anterior outline oblique, somewhat sigmoidal, straight or slightly concave above, gently convex below, rounding into the basal outline without break. Posterior outline oblique, gently concave. Posterior inferior angle strongly and regularly rounded, gradually merging with the outlines of the posterior and basal portions. Anterior and posterior cardinal angles acute. Beaks subcentrally located on the cardinal line, small, slightly projecting. Convexity moderate, with the umbonal region rather prominent, more or less compressed around the free margins. Umbonal ridge indistinct, oblique, and backwardly curved. Posterior auricle rather flat, with a more abrupt descent from the umbonal elevation than occurs on the anterior side, this portion of the two valves being almost in contact.

Surface very nearly smooth, with fine, threadlike concentric liræ, which are rather regularly arranged.

In its specific relations this shell is very close to *Avicula acosta* of Cox, the resemblance being so great that I have really little doubt as to the specific identity of the two forms. The unique specimen under discussion appears to be slightly more oblique and to have a narrower and more rounded posterior inferior angle. The shape in brief is a little more aviculoid, whereas *Avicula acosta* is a little more pectinoid.

Though suggesting Avicula strongly in its general expression, it is unquestionable that the relationship of this shell to that genus is at most very remote. This is clear from the fact that the shell is equivalve without a byssal sinus in either valve, but with a ligamental furrow on both sides of the beaks along the outer edge of the hinge line. These are the characters of the Limidæ, but the shape is unlike that of most representatives of the family, which are rather conspicuously short hinged, by reason of the long projecting hinge line. The reference of the specimens to Plagiostoma is therefore provisional and is likely to be changed when the dentition (if any is present) is known. Not improbably the generic characters will show it to be new, and even if it belongs with the Limidæ there is little doubt that it will constitute a distinct and new subgenus.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Family MYTILIDÆ.

Genus MODIOLA Lamarck.

MODIOLA SUBELLIPTICA Meek?

Plate XVII, figure 12.

1866. *Clidophorus* (an *Pleurophorus*) *occidentalis*. Geinitz, Carb. und Dyas in Nebraska, p. 23, tab. 2, fig. 6. (Not *Pleurophorus occidentalis* Meek and Hayden.)
Upper Coal Measures: Nebraska City, Nebr.

1872. *Modiola? subelliptica*. Meek, U. S. Geol. Survey Nebraska Final Rept., p. 211, pl. 10, fig. 5.
Upper Coal Measures: Nebraska City, Nebr.; Riverside, 3 miles below Atchison, Kans.

?1881. *Pleurophorus subcostatus*. White, U. S. Geog. Surveys W. 100th Mer. Rept., vol. 3, Supp., Appendix, p. xxvii, pl. 3, fig. 8.
Carboniferous: Coyote Creek, N. Mex.

1900. *Modiola subelliptica*. Beede, Kansas Univ. Geol. Survey, vol. 6, p. 136.
Upper Coal Measures: Topeka, Kans.

1903. *Modiola? subelliptica*. Girty, U. S. Geol. Survey Prof. Paper 16, p. 420.
Hermosa formation: San Juan region, Colo.

This species is represented by a single bivalved specimen; from which, unfortunately, the anterior end has been broken away. It is a narrow transverse shell contracting toward the front and having an obliquely truncated posterior extremity. The convexity is moderate. A subangular umbonal ridge meets the ventral border a little in front of the posterior inferior angle and traverses the shell obliquely forward and upward; its direction in the lower part would bring it to the cardinal border distinctly posterior to the beaks did it not bend forward in the upper part so that its obliquity to the dorsal border is less distinct and so that doubtless it connects in the usual way with the umbones, which were presumably nearly terminal, at least if the provisional identification is approximately correct.

The shape, so far as it can be determined, the distinct subangular, curved, umbonal ridge, and its position with regard to the outline of the shell, are very suggestive of Meek's species cited above, but a satisfactory determination must await more complete data than are now available.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Family PHOLADELLIDÆ.

Genus ALLERISMA King.

ALLERISMA? sp.

Plate XVII, figure 13.

The subject of this note is a single small specimen having a transverse shape and nearly terminal beaks. The hinge line is long and straight. The ventral border is rather strongly curved, so that the greatest height is posterior to the middle, and the anterior end is somewhat abruptly contracted. The ends are regularly rounded, the anterior more sharply, the outline recurving there below the small, not very prominent beaks. A subangular inflection of the shell along the hinge line makes a narrow elongated escutcheon. There is no distinct umbonal ridge. The surface is marked by rather strong, regular concentric folds, which die out more or less completely over the postumbonal slope.

The specific relations of this little shell are not apparent. It may be a young example of *A. terminale.*

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Family PLEUROPHORIDÆ.

Genus ASTARTELLA Hall.

ASTARTELLA CONCENTRICA Conrad.

Plate XVIII, figures 2–9.

1842. *Nuculites concentricus.* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 8, pt. 2, p. 248.
Coal Measures: Pennsylvania.

1859. *Posidonia Moorei.* Gabb, Acad. Nat. Sci. Philadelphia Proc., p. 297. (Date of imprint, 1860.)
Coal Measures: Fort Belknap, Tex.

1860. *Posidonia Moorei.* Gabb, Acad. Nat. Sci. Philadelphia Proc., p. 55, pl. 1, fig. 2. (Date of imprint, 1861.)

Shell attaining a rather large size, more or less transverse and generally subquadrilateral in shape. Dorsal outline nearly straight or gently convex. Ventral border straight or slightly concave near the posterior extremity, more and more strongly curved toward the front, where it rounds in under the prominent beaks. Posterior outline straight or truncated, making an obtuse angle with the cardinal border. Beaks large, prominent, strongly incurved, and situated close to the anterior extremity.

Convexity high, chiefly localized in the umbonal region, the valves being rather compressed behind. Umbonal ridge angular, distinct to the inferior posterior angle. The surface between the umbonal ridge and the cardinal line is flattened or even depressed. The umbonal ridge is emphasized in some specimens by a shallow indistinct constriction, situated just in front and chiefly noticeable toward the margin, in which it produces a deflection or reentrant curve. The lunule and escutcheon are large and very sharply defined, the lunule by being abruptly bent inward, the escutcheon by the ridge formed by the recurved edge of the umbonal slope.

The surface is marked by regularly arranged, prominent lamellæ with relatively wide, flat interspaces. The latter are also marked by fine, regular, concentric liræ. This ornamentation does not continue onto the lunule and escutcheon.

The internal characters are not known. The valves show around their free edges a row of beading or denticles.

This form is abundant in the Wewoka formation, but the material, though showing considerable variation, can not be advantageously separated into distinguishable species and varieties. In shape the chief variation is found in the relations of length and breadth, some specimens being less transverse than others. In some specimens also the ventral border is more strongly rounded and has a less distinct emargination near the inferior posterior angle. Such shells, if of the less transverse type, have a nearly circular outline. Those of the more transverse type are also more or less distinctive. Some specimens examined attain unusual size.

In sculpture more or less variation is found in the closeness of arrangement of the lamellæ. The variation is not excessive between most specimens and it ranges toward, though probably not to, the striking species *A. varica*. It is worthy of remark in this connection that the ornamentation on shells from station 2010 is unusually coarse. However, here and there among all of the collections one or two specimens have been found in which the lamellæ are more coarsely arranged than normal. The most coarsely sculptured of these shells are very nearly comparable to the most finely sculptured of *A. varica*. In some larger, perhaps senile specimens, the sculpture about the margins loses its regularity and the projecting plates are less prominent and more crowded. Some specimens also clearly show evidence of radiating striæ in the depressed bands between the concentric lamellæ. In some cases, and perhaps in all, this appearance is due to exfoliation and is probably to be connected with the rows of granules with which the margin is progressively marked.

Six species of Astartella have been described from the American Carboniferous, the genus, so far as known, not occurring in the Mississippian. These are *A. concentrica* McChesney, *A. gurleyi* White, *A. nasuta* Girty, *A. newberryi* Meek, *A. varica* McChesney, and *A. vera* Hall. To these may be added *Posidonia moorei* Gabb, and *Nuculites concentricus* Conrad. The latter is clearly an Astartella and was recognized as such by Meek as early as 1875.[1] *P. moorei* also is, from its configuration, almost as certainly a member of the same group. Fort Belknap, the original locality, is in Young County, Tex., not far from Graham, and the geologic formation is, with but little question, the Cisco.

The characters which distinguish these species are shape and sculpture. *A. varica* stands forth from the other species by reason of the wide intervals between the heavy concentric ridges; *A. gurleyi* and *A. nasuta* are also probably distinct, differing by a combination of shape and sculpture; but *A. concentrica* Conrad, *A. concentrica*

[1] Ohio Geol. Survey, Paleontology, vol. 2, p. 341, 1875.

McChesney, *A. moorei* Gabb, *A. newberryi* Meek, and *A. vera* Hall are very closely related and possibly identical species, of which *A. concentrica* Conrad, 1842, was the first to be described. I am inclined also to believe that *A. vera* is a recognizable species, as I have seen a specimen, which seems to be typical, in which the ornamentation consisted of angular concentric ridges, more or less irregular in arrangement, rather than of thin lamellæ separated by relatively broad flat interspaces. The remaining species appear to be distinguished largely by peculiarities of outline, not all of which are very marked. Some species, as *A. newberryi*, were based on a single specimen, so that the range of variation and the characters of the average specimen are not known. After I had examined a rather extensive suite of specimens it seemed to me that it is not practicable in this group to distinguish species on slight variations in shape or slight variations in arrangement of the concentric lamellæ. It has therefore appeared best to identify the shells under investigation with Conrad's *A. concentrica,* with the description and figure of which some of my specimens seem to be in exact agreement, and to include in the synonymy only *Posidonia moorei,* to which species some of the specimens, not to be distinguished from the others, with but little question belong. Although I believe that *A. newberryi* will prove to be only an abnormal or compressed individual of the same species, it will probably be best to retain the name provisionally. *A. concentrica* McChesney seems with even less probability to be a valid species, and for this reason, although the name is preoccupied, I have not substituted a new one for it.

For the convenience of those who wish to compare the descriptions and figures of *A. concentrica* Conrad and *A. moorei* Gabb, I reproduce below the descriptions by both authors:

N. concentrica. Plate XV, figure 19.—Subtriangular, slightly ventricose, with rather distant sharp concentric striæ; umbonial slope obtusely angulated; posterior dorsal margin rectilinear, very oblique; posterior extremity truncated, the margin nearly direct; beaks near the anterior extremity; basal margin nearly straight in the middle.

Locality.—Inclined plane of the Alleghany Mountain; No. 3, in bituminous shale overlying coal (Carboniferous system).

Posidonia moorei.—Shell subquadrangular, slightly gibbous, cardinal edge straight; beaks small, near the anterior edge, and slightly projecting beyond the cardinal line; umbones prominent, anterior edge rounded; posterior edge straight above, rounded below to meet the basal margin, which is regularly curved; surface marked by about twenty prominent round concentric ribs.

Locality and position.—From a buff-colored limestone above the coal, near Fort Belknap.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, 2009, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

ASTARTELLA VARICA McChesney?

Plate XVIII, figures 1-1b.

1860. *Astartella varica.* McChesney, Desc. New Spec. Foss., p. 55. (Date of imprint, 1859.)
Coal Measures: Springfield, Ill.
1865. *Astartella varica.* McChesney, Illus. New Spec. Foss., pl. 2, fig. 7.
1868. *Astartella varica.* McChesney, Chicago Acad. Sci. Trans., vol. 1, p. 42, pl. 2, fig. 7.
Coal Measures: Springfield, Ill.
1875. *Astartella varica.* Meek, Ohio Geol. Survey, Paleontology, vol. 2, p. 341, pl. 19, fig. 2.
Coal Measures: Newark, Ohio.
1887. *Astartella varica.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 39, pl. 4, fig. 31.
Coal Measures: Flint Ridge, Ohio.

From a few points in the Wewoka formation specimens have been referred to *Astartella varica*, but not without some doubt. They intergrade with *A. concentrica*, with which they occur associated, and they present essentially the same modifications in shape, and I can not regard them as more than variations from the typical *A. concentrica*.

It may be that typical *A. varica* will prove to be no more than varietally distinct from *A. concentrica*, but as the fact is rather suggested than demonstrated by the evidence at hand, I am giving the species full specific recognition.

Horizon and locality.—Wewoka formation: Wewoka quadrangle Okla. (stations 2005, 2006, 2009, and 2010?); Coalgate quadrangle, Okla. (stations 2001 and 7193).

SCAPHOPODA.

Family DENTALIIDÆ.

Genus DENTALIUM Linnæus.

DENTALIUM SEMICOSTATUM Girty.

Plate XXV, figure 11.

1911. *Dentalium semicostatum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 135.
Wewoka formation: Wewoka quadrangle, Okla.

This type is represented by two fragments, which, so far as shown, indicate a straight or gently curved, slowly enlarging, conical shell. The cross section is distinctly elliptical, measuring in the larger fragment 7 millimeters in one direction and 6 millimeters in the other. The test is thick and is marked by rather fine, rounded, wavy, longitudinal costæ, separated by linear striæ, both confined to one side of the shell. About four or five costæ occur in 1 millimeter. There are also transverse constrictions and incremental lines which lie obliquely to the axis. The obliquity of these markings is in the direction of the long axis of the section, so that their most distal points occur down one of the narrow sides of the shell, and the most proximal down the other. The costæ also are confined to the narrow side—that on which the transverse striæ are farthest from the apex.

Dentalium semicostatum is somewhat similar to *D. mexicanum*, but it has slightly finer costæ of a considerably larger size, and they are restricted to one side of the shell.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

DENTALIUM INDIANUM Girty.

Plate XXV, figures 12, 12a.

1911. *Dentalium indianum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 135.
Wewoka formation: Wewoka quadrangle, Okla.

Shell rather small, gradually tapering, very slightly curved. Section circular or obscurely elliptical. Surface marked by numerous thin, sharply elevated, longitudinal costæ separated by intervals of about double their own width. The costæ can not be counted with accuracy but number not far from 42. There appear to be also fine, transverse, crenulating striæ.

This form stands nearest to *D. mexicanum* by reason of its numerous fine costæ. These are, however, more numerous and are separated by relatively wider intervals, while the shell itself is gently curved instead of straight, as in the western form.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

DENTALIUM SUBLEVE Hall.

Plate XXV, figures 13, 13a.

1858. *Dentalium obsoletum.* Hall, Rept. Geol. Survey, Iowa, vol. 1, pt. 2, p. 724, pl. 29, figs. 16, 17, 17a.
Coal Measures: Iowa.

1877. *Dentalium sublæve.* Hall, Miller's Am. Pal. Foss., 2d ed., p. 244.

1891. *Dentalium sublæve.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 252.
Lower Coal Measures: Des Moines, Iowa.

1903. *Dentalium sublæve.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 451.
Hermosa formation: San Juan region, Colo.
Maroon formation: Crested Butte district, Colo.

A single fragment represents this species and represents it somewhat doubtfully, for Hall's description is not specific and the specimen itself is not well preserved. It indicates a straight or nearly straight shell, very gradually tapering and having a circular section about 5½ millimeters in diameter. The test is rather thin and is marked externally by slender longitudinal ribs, in this specimen numbering 16.

These ribs are slender and abruptly elevated and the nearly flat interspaces are three or four times as wide as the costæ themselves.

Although my specimen does not show any curvature nor its partly defaced surface any transverse markings, I see no adequate reason for discriminating it from Hall's species. His description is indefinite, however, in not stating the number of costæ and the distance they are apart. My specimen might almost as appropriately be referred to *D. acutisulcatum*, if that species can be considered adequately established and if it is not the same as the older one described by Hall. It has, however, fewer ribs and retains them to a stage (size) at which they are apparently obsolete in *D. acutisulcatum*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2006? and 2005).

Genus PLAGIOGLYPTA Pilsbry.

PLAGIOGLYPTA ANNULISTRIATA Meek and Worthen.

Plate XXV, figures 15–16a.

1870. *Dentalium annulostriatum.* Meek and Worthen, Acad. Nat. Sci. Philadelphia Proc., p. 45.
Coal Measures: Danville, Ill.

1873. *Dentalium? annulostriatum.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 589, pl. 29, fig. 7.
Coal Measures: Danville, Ill.

1888. *Dentalium annulostriatum.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 234. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1891. *Dentalium annulostriatum.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 251. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1903. *Plagioglypta annulistriata.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 452.

Of this species it has been possible to examine nine specimens. They show a small form which enlarges with moderate rapidity and is distinctly curved in the course of growth. The section is circular and the largest fragments have a diameter of only 3 millimeters.

The surface is marked by relatively strong, obliquely transverse liræ, which are subangular and are separated by rounded striæ of somewhat greater width. The obliquity of the markings is generally strong, and is so directed that the points of greatest proximity to the large end of the shell occur along a line down the concave side. The liration varies exceedingly even on different parts of the same specimen, being fine and crowded in one place and coarser and more widely spaced in another, and more or less distinctly and variously alternating elsewhere. The larger specimens appear to be almost glabrous, but are included under the same species on the hypothesis that they represent a somewhat senile condition.

Authentic specimens of *Plagioglypta meekiana* and *P. annulistriata*, to both of which the present form is related, have not been at hand for comparison, but it seems to exhibit the sharp annulation of the latter rather than the finer, more obscure striations of the former.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005); Coalgate quadrangle, Okla. (station 2001).

PLAGIOGLYPTA MEEKIANA Geinitz.

Plate XXV, figures 14, 14a.

1866. *Dentalium Meekianum.* Geinitz, Carb. und Dyas in Nebraska, p. 13, tab. 1, fig. 20.
Dyas: Nebraska City, Nebr.

1872. *Dentalium Meekianum.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 224, pl. 11, figs. 16a, 16b.
Upper Coal Measures: Nebraska City, Nebr.

1873. *Dentalium Meekianum?* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 590, pl. 29, fig. 8.
Coal Measures: Danville, Ill.

1888. *Dentalium meekianum.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 234. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1891. *Dentalium meekianum.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 251. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Dentalium meekianum.* Keyes, Missouri Geol. Survey, vol. 5, p. 133. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1896. *Dentalium* conf. *meekianum.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 248.
Upper Coal Measures: Crawford County, Ark.

1897. *Dentalium* cf. *meekianum.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 38.
Upper Coal Measures: Crawford County, Ark.

1903. *Plagioglypta meekiana.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 452.

This identification is based primarily on a single specimen, which in its fragmentary condition has a length of 15 millimeters, and a diameter at the larger end of a little less than 4 millimeters and at the smaller end of a little over 2 millimeters. It is gently curved and the section is slightly elongated in the direction of this curvature. The surface is marked by obscure incremental lines and larger striæ due to irregularities of growth. These markings are somewhat oblique to the axis of the shell, the distal portion being on the concave side of the curvature and the proximal portion on its convex side.

This form quite closely resembles *P. annulistriata* and may be only a variety of it. It differs in the rather more irregular and much more obscure character of its surface markings, which appear in the one form more like mere irregularities of growth and in the other like sculpture or orientation.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

GASTROPODA.

Family PLEUROTOMARIIDÆ.

Genus PHANEROTREMA Fischer.

The name Phanerotrema was introduced by Fischer in 1885. The typical species is *P. labrosum* Hall, from the Helderberg group, and the original description cites the following characters: Shell turbinate; coils few, the last elevated; spire short. Region of the band of the sinus salient, aperture subrhomboidal.

Ulrich[1] discussed this genus in 1897, naming some characters not originally mentioned by Fischer, among them the fact that the inner lip is thick. This clearly refers to Hall's description of *P. labrosum*, where he says that the columellar lip is extremely thickened, the callosity extending to the outer lip. Ulrich further says: "Two of our Carboniferous species, however, *Pl. grayvillensis* Norwood and Pratten, and *Pl. marcouiana* Geinitz, appear to have all the essential characters of Phanerotrema, and we expect to find that they are actual continuations of the same generic type."

When I compare the specimens described below as *P. grayvillense* with these generic descriptions of Phanerotrema and with the typical species of the genus, I find numerous differences, most of which are perhaps of only specific importance. One, however, seems to have higher significance and leads me to doubt whether after all these Carboniferous species are congeneric with *P. labrosum*. The character in question is the very one mentioned above as having been added to the original description. The inner lip in *P. grayvillense* is formed by the preceding volution without any callosity at all. The outer lip, making much more than a semicircle, is somewhat thickened and reflexed on the inner side of its anterior end, the reflexed portion partly covering the umbilicus, or perhaps making a false umbilicus. In *P. labrosum*, on the other hand, there is a thick callosity forming the inner lip, which, to judge by Hall's figures, may extend beyond the tightly sealed umbilicus onto the outer lip. This feature is considered important in the classification of recent shells and appears to warrant doubt in the reference of the Carboniferous species to Phanerotrema.

PHANEROTREMA GRAYVILLENSE Norwood and Pratten.

Plate XXIII, figures 2–8c.

1855. *Pleurotomaria Grayvillensis*. Norwood and Pratten, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 75, pl. 9, figs. 7a, 7b.
Coal Measures: Grayville, Ill.; near mouth of Rush Creek, Posey County, Ind.; Shawneetown and Galatia, Ill.

[1] Ulrich, E. O., Minnesota Geol. and Nat. Hist. Survey, Final Rept., vol. 3, pt. 2, p. 952, 1897.

1866. *Pleurotomaria Grayvillensis.* Geinitz, Carb. und Dyas in Nebraska, p. 9, tab. 1, fig. 9.
Upper Coal Measures: Nebraska City, Nebr.

1872. *Pleurotomaria Grayvillensis.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 233, pl. 11, fig. 9.
Upper Coal Measures: Nebraska City, Nebr.; Illinois; Kentucky; Iowa; Missouri; Kansas.
Lower Coal Measures: Illinois and West Virginia.

1888. *Pleurotomaria gravillensis.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 238.
Lower Coal Measures: Des Moines, Iowa.

1895. *Pleurotomaria grayvillensis.* Keyes, Missouri Geol. Survey, vol. 5, p. 141. (Date of imprint, 1894.)
Lower Coal Measures: Kansas City and Pleasant Hill, Mo.

1897. *Phanerotrema grayvillensis.* Ulrich, Minnesota Geol. and Nat. Hist. Survey, Final Rept., vol. 3, pt. 2, p. 952.

1903. *Phanerotrema* cf. *grayvillense.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 455.
Weber formation: Leadville district, Colo.

Shell rather small, height and diameter about equal, final volution making up distinctly more than one-half the height. Volutions usually five, sometimes six. Whorl section at maturity more or less rhomboidal with a slit band on the peripheral angle. The upper surface of each volution is flat or slightly concave, declining rather strongly from the suture. The slit band, situated on the peripheral angle, is very narrow, deeply concave, and defined by two sharply projecting edges of about equal prominence. Below the slit band is a groove slightly wider than the band, below which the shell rounds regularly inward and then upward to the umbilicus. The slit band therefore is the most prominent portion of the whorl. The umbilicus is small, partly covered by a reflexed edge of the outer lip. The inner lip is formed by the preceding volution, without a callosity. The outline of the outer lip is moderately convex above and directed obliquely backward from the suture. At the periphery it is abruptly withdrawn into the slit which occupies about a sixth or an eighth of a volution. Below the slit the outline has a generally straight course to the umbilicus, but is gently flexed into two low, convex curves with a low concave curve between them. Each volution embraces the preceding one about to the band, with a general tendency to cover the band in the younger stages and to leave an uncovered space below it in the older. The tendency to leave an uncovered space begins at different ages in different specimens and correspondingly affects the shape. If it begins late it makes the spire low with a broad angle and a smooth ascent; if early it makes the spire higher, more acutely angular, and with steplike rise.

While maintaining the same general characters the surface shows much variation in detail in different specimens. It is crossed by regular revolving and transverse lines, but each system varies in coarseness and in strength, not only with reference to the other but on different parts of the surface. It is impossible to note all the little changes observed and my description must be confined to the general sculpture developed on the average specimen, together with some of the more important variations.

The revolving liræ show considerable diversity in number and arrangement. Above the slit band they number 7 to 10 (or less), and, of course, when the larger number are developed they are smaller and more closely arranged. In many specimens the one or two or even three nearest the suture are conspicuously larger than those below, which in some specimens, perhaps from abrasion, are very obscure. Below the band the revolving striæ number from 9 to 14 or even more. Those on the depressed portion below the band, three or four in number, may be finer than the others, and if they are so the coarser striæ may be introduced abruptly where the convexity begins; but in some specimens the increase in size is more regular. Near the umbilicus in many shells the revolving liræ are smaller. The transverse liræ are usually much less distinct than the others and follow the direction of the aperture. In connection with these the revolving liræ are strongly enlarged at regular intervals so that they look like rows of nodes or pustules more or less connected at the base by raised lines. The revolving ornamentation is usually much more conspicuous than the transverse, and the nodose appearance is more striking, as it is also coarser, below the band than above it. In some shells, however, the transverse markings are as strong as the revolving ones but they are less abruptly elevated. The nodes above the band near the suture are also especially coarse and prominent. The sculpture here may consist of one or two or even three revolving rows of nodes, rapidly decreasing in size from the suture and more or less connected into transverse as well as revolving lines. Or the transverse arrangement may predominate so that the appearance is that of single radiating, more or less elongate nodes or plications. Frequently the shell along the suture is thickened so that it stands up as a sort of ridge, crowned at intervals by the nodes. In this case the upper surface of the whorl is rather concave than flat. The slit band is marked by fine, regular, transverse, incremental lines having a concave curvature. It bears no revolving striæ.

The shape of the whorls and their sculpture undergo various modifications before reaching the mature condition, but the stages are not represented by young specimens in the collection and have to be studied on the apical portion of mature ones. Although hundreds of specimens have been examined but few show this portion with the characters clearly preserved. Apparently at first for a turn or a turn and a half the section is circular and the surface smooth, perhaps marked with fine transverse incremental lines. Shortly the upper surface becomes flattened and then indented in the middle so that the portion near the suture is elevated into a sort of ridge which soon becomes broken up into separate nodes. Later the revolving liræ are introduced. These begin earlier on some specimens than on others, or at least they can now be observed on older portions of the shell, but seldom can they be traced back for over two turns or, on large shells, for over three.

There can hardly be a doubt that this is the form described by Norwood and Pratten as *Pleurotomaria grayvillensis*. Only one difference has been noted between my specimens and their description. The spiral angle is given as 102°, distinctly greater than that in my specimens, in which it is invariably less than 90° and distinctly greater also than the angle shown by their figures. An additional character is given by Meek,[1] who says that in typical specimens of *P. grayvillensis* the liræ are in two series, two to four smaller ones lying between the larger. This is clearly not a feature of the shells here considered, though in a few specimens the liræ on the lower side of the whorls appear to be alternating.

Ulrich suggests that this species is a representative of Phanerotrema, and the only character at variance with that genus is the absence of a callosity on the inner lip. The specimens examined show no deposit against the preceding volution.

From the synonymy of this species I am removing three citations by White of a form from the Wild Band Pockets in northern Arizona. If his figure is at all accurate the form from Arizona is clearly not typical *grayvillense*. In many respects it recalls *P. manzanicum* but is probably an undescribed species.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Genus WORTHENIA De Koninck.

WORTHENIA TABULATA Conrad.

Plate XXII, figures 1–4a.

1835. *Turbo tabulatus.* Conrad, Pennsylvania Geol. Soc. Trans., vol. 1, pt. 2, p. 267, pl. 12, fig. 1.

1842. *Pleurotomaria tabulata.* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 8, pt. 2, p. 272.

Carboniferous: Inclined plane of the Allegheny Mountains.

1858. *Pleurotomaria tabulata.* Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 721, pl. 29, figs. 12a, 12b.

Coal Measures: Pennsylvania, Indiana, and Illinois.

1881. *Pleurotomaria tabulata.* White, Indiana Dept. Geol. and Nat. Hist. Second Ann. Rept., p. 519, pl. 18, figs. 4, 5. (Date of imprint, 1880.)

Coal Measures: Rush Creek, Posey County, Ind.

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[1] Meek, F. B., U. S. Geol. Survey Nebraska Final Rept., p. 233, 1872.

1884. *Pleurotomaria tabulata.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 160, pl. 32, figs. 4, 5.
Upper Coal Measures: Rush Creek, Posey County; Wagon-defeat Creek, Sullivan County; and Warrick County, Ind.
1895. *Pleurotomaria tabulata.* Keyes, Missouri Geol. Survey, vol. 5, p. 142. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.
1897. *Worthenia tabulata.* Ulrich, Minnesota Geol. and Nat. Hist. Survey Final Rept., vol. 3, pt. 2, pp. 949, 950, 953.
1903. *Worthenia tabulata?* Girty, U. S. Geol. Survey Prof. Paper 16, p. 456.
Hermosa formation: Sinbads Valley, Colo.
1910. *Worthenia tabulata.* Raymond, Carnegie Mus. Annals, vol. 7, No. 1, p. 157, pl. 26, fig. 2.
Brush Creek limestone: Donohoe, Pa.

The specimens thus far obtained from the Wewoka formation are immature or of small size. The spire is rather high and turreted. The height of the last whorl constitutes about one-half the entire height of the specimen, and its diameter is considerably less than the entire height. The volutions are flattened above, gently convex near the suture, gently concave near the carina. The upper surface declines rather strongly from the axis. A large, very prominent carina is developed a little above the middle of the whorl. Below the carina the surface is gently concave for a distance equal to about half the width of the upper surface. This lateral surface is nearly parallel to the axis, sloping slightly inward from the carina. By a rather abrupt change of direction, accompanied by more or less angulation, the surface becomes convex again, curving upward strongly when near the umbilicus, which is partly covered by a fold of the shell. Each volution embraces or conceals more or less of the lateral surface of the preceding one, but leaves a longer and longer open space below the band as the size of the shell increases, so that mature examples are more conspicuously turreted than young ones.

The surface is marked by sharp, revolving and transverse liræ which are of about equal strength and in general form a regularly reticulate sculpture. As a rule the revolving liræ are more persistent and prominent than the others and are arranged at wider intervals. On the upper half of the upper surface these markings are coarser and some of them assume the appearance of small nodes in radiating and revolving rows, of which there are three or four in a spiral direction. In general the points of intersection of the two sets of elevations tend to be represented by nodelike prominences. On the lateral surface the sculpture is again very fine, assuming abruptly a coarser arrangement with the angulation below. On the lower surface, as near the suture, the sculpture in many specimens resembles nodes connected at their bases by liræ of two decussating systems, of which the revolving one is the more conspicuous. The transverse liræ, following the shape of the aperture, are slightly convex above the carina and swing gently backward from the suture. Across the lateral surface they slope forward, and underneath it the direction is nearly direct to the umbilicus with a slight sinus or concavity below the angulation marking the junction of the lateral and inferior surfaces.

The slit band is situated on the carina. It is not depressed but is projecting and is marked by regularly and closely arranged prominences or crenulations. In many specimens the space between the crenulations is traversed by from one to three revolving liræ similar to those on the rest of the surface. The function of this portion of the shell as the slit band is clearly shown by the appearance in most specimens of thin lamellæ bounding it above and below.

In the young stages the cross section was nearly circular and smooth (?) for about two volutions. Then the median portion became depressed into a revolving groove, the lower of the two small ridges thus produced being the slit band. The reticulate sculpture seems to extend back onto or to the two or three earliest whorls.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

WORTHENIA TABULATA var.

Plate XXII, figures 5–6.

A few specimens in the collection seem to represent a distinguishable variety of *Worthenia tabulata* with which, however, they intergrade. The most conspicuous difference consists in the fact that their spire is lower, with of course a broader angle, and that it is also less turreted. This result seems to be due to two causes operating in varying degrees—to a more complete overlapping of the volutions and to a lower obliquity of the axis of the volution in its direction to the spiral axis. So far as observed, the shells under consideration do not attain the size of typical *W. tabulata,* which in the Wewoka formation appears to be somewhat below the normal.

In the variety under consideration the sculpture seems to be almost exactly the same as in the other form. The carina is perhaps a little less prominent, but it is crenulated in the same manner, with revolving liræ between the crenulations. In the same manner also the sculpture tends to be fine above and below the carina on the lower half of the upper surface and on the lateral surface, and to be coarser on the upper half of the upper surface toward the suture and on the lower surface. The revolving liræ are usually distinctly coarser than the transverse liræ and dominate them. The points of intersection of the two series are more or less nodose.

This form much resembles *W. speciosa* of Meek and Worthen, some specimens more than others. It seemed best not to identify it with that species, however, for the following reasons: The spire is usually more turreted and the junction between the lateral and lower surface more prominent and angular than is represented by Meek and Worthen's description and figures. The liræ appear to be somewhat more numerous, having one or two additional on both the lateral and upper surfaces. The transverse lines are of equal size, not having every fourth or fifth more prominent near the suture, and the revolving liræ are more delicate near the carina, a feature that is not specified in the description of *W. speciosa.*

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001 and 2004).

Genus ORESTES Girty.

1911. Orestes. Girty, New York Acad. Sci. Annals, vol. 21, p. 136.

This name is introduced for a group of pleurotomarioid shells which have a shape generally conical or slightly turreted with a gently convex basal portion. The band is not very strikingly defined and has a peripheral position distinctly below the middle of the whorl. The upper surface is in general flattened and oblique, with the zone which lies just below the suture more or less prominent and marked by nodes. The sculpture consists of fine, decussating, revolving, and transverse liræ. The slit band is relatively broad and carries one or more revolving liræ, which are sometimes nodulose and may conceal to a greater or less degree the structural character of this part of the shell. The slit has not been observed in any of the specimens seen, but it was probably short. The umbilicus was apparently closed, but a reflexed portion of the lower part of the outer lip produces a small excavation which resembles a minute umbilical opening.

The inner lip is without a callosity. In fact, the mantle seems to have had the power to resorb the shell on the inner side of the aperture, so that this portion of the preceding volution is smooth and slightly depressed below the external ornamented areas. This has been observed in many specimens and is surely not an accidental character.

In one extreme these shells suggest Euconospira, from which they differ in their less regular, conical shape, and in the development of nodes below the suture and of revolving liræ in the slit band. They suggest also Phanerotrema, but have a more conical shape with a slit band that is at once broader, less defined, and marked by distinctive sculpture, and is situated not near the middle of the peritreme but well below. Worthenia is in some respects the most nearly related group, at least in the ornamented character of the slit band. In

Worthenia the band is above rather than below the middle, is narrow instead of broad, and bears lunules which are much more prominent than the revolving liræ (in Orestes the lunules are hardly more than lamellose growth lines). Worthenia, too, has a more turreted, less conical shape. It is doubtful whether any of the groups mentioned have the peculiar eroded or resorbed character of the inner side of the aperture seen in the Wewoka specimens.

Orestes, then, is referred to a subgeneric position under Worthenia, although its relationship to Phanerotrema is also obvious. The generic name is intended to commemorate Orestes St. John, one of the early paleontologists of the United States and one of the early geologic explorers of Oklahoma.

Type species.—Orestes nodosus.

Orestes nodosus Girty.

Plate XXII, figures 7–10.

1911. *Orestes nodosus.* Girty, New York Acad. Sci. Annals, vol. 21, p. 137.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell small, irregularly conical. Diameter of last whorl about equal to greatest height, though less in some specimens. Height of last volution about equal to the height of the spire above. Volutions angular, most prominent below the middle. Spire somewhat turreted. Umbilicus apparently closed, but with the lower lip folded backward upon itself, so as to produce a small pit or false umbilicus. Suture considerably depressed. The shell projects strongly from the suture, then bends downward, and is flat or concave below to the first carina. Thus the upper third of the upper surface forms a sort of spiral ridge just below the suture. The lateral surface is about one-third as broad as the upper surface. It consists of two rather thick, rounded carinæ guarding between them a relatively broad concave channel in which the band is situated. The upper carina is better defined than the other, but does not project quite as far. The lower surface is nearly horizontal, gently convex, more tumid near the umbilicus. The swollen band below the suture is marked by a row of distantly arranged nodes, which appear to be independent of the superficial sculpture.

The surface is crossed by regular and nearly equal revolving and transverse liræ, the former heavier and dominant, the latter more closely arranged. The upper surface carries about five (four to six) revolving lines, arranged at regular and distant intervals. The upper line is on the subsutural prominence, just above which, in a few specimens, an additional lira is developed, giving the nodes a somewhat elongated double-topped appearance. The two carinæ bounding the slit are similar revolving somewhat larger liræ. Just within these two liræ are two small edges which define the true limits of the slit band. The band is medially traversed by another fine, revolving thread, or rarely by three threads. The lower carina carries about two fairly heavy liræ, and the lower surface is crossed by about twelve others, some of which may be fine and alternating with those of larger size. They are heavier and more crowded than the liræ above. The transverse liræ, doubtless following the outline of the aperture, bend strongly backward, being convex near the suture and straightened or gently concave near the band. Over the latter they are deeply concave, producing fine, regular, closely arranged crenulations or lunules. On the under side they run obliquely backward with a strong convex turn on the lower carina. For most of the distance they are thus nearly straight. In the region of the suture they seem to be fine, irregular, and crowded, passing just below the nodose zone into regular, rather distant liræ, which give a finely nodose appearance to the upper carina and generally tend to produce little prominences where they cross the revolving liræ. Even below the nodose zone, fine, intermediate, incremental lines are more or less conspicuous. The transverse liræ do not produce crenulations on the projecting edges of the band, but they have this effect to a greater or less extent on the revolving line or lines which traverse it.

The volutions embrace up to the edge of the band of the preceding one. They are about five in number.

For about one or one and one-half volutions the whorls are rounded and smooth. For about two subsequent turns also they are nearly circular in cross section, but are marked by a reticulate sculpture. Below this the two carinæ become prominent, producing a lateral angulation, and still later the zone below the suture becomes inflated and conspicuously nodose.

Almost constant variation marks the detail of sculpture in this species. In some specimens the zone below the suture is scarcely tumid at all. The nodes also may be absent, but the development of this tumid zone is correlated with the development of nodes, and both characters are usually present. The nodes may be elongated or double-topped or closely or distantly arranged. The tendency of the intersections of the revolving and transverse liræ to be strengthened into more or less conspicuous projections varies considerably. These are usually restricted to the immediate vicinity of the slit band, just above or just below. Rarely does the median lira of the band show this tendency. In a few specimens three liræ appear in the band, all of which may be thickened and nodulose, more or less obscuring the character of this zone as the slit band and giving the shell generally an appearance different from the normal. The one or two specimens in which this feature is most developed were thought at one time to belong to a distinct species or variety, but their relationship was traced so immediately into the normal type that this interpretation was abandoned. The character of the revolving liræ and their number are also subject to considerable variation, especially perhaps on the lower part of the volutions. They may be fine with wide interspaces or coarse and more or less crowded and interspersed with a greater or less number of small intermediate lines. Considerable variation is also shown in the relative height and diameter of different specimens and correspondingly in the spiral angle.

This species, while undoubtedly related to some shells from Texas which I have identified as *O. brazoensis*, is clearly distinct from that species, differing not only in the shape of the spire but in many details of sculpture, the present form being the more ornate and having a more highly differentiated surface. Shumard's description of *Pleurotomaria brazoensis* applies fairly well to *Orestes nodosus*—very nearly as well as to the form from Texas which I have referred to Shumard's species—but my specimens of *O. brazoensis* were found at the same general locality and horizon as the original specimens, whereas the present form is known only from Oklahoma. Furthermore, the present form shows a number of sculptural modifications not mentioned in Shumard's description and not found in my Texas fossils.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Genus TREPOSPIRA Ulrich.

TREPOSPIRA DEPRESSA Cox.

Plate XXI, figures 6–11c.

1857. *Pleurotomaria depressa.* Cox, Kentucky Geol. Survey Rept., vol. 3, p. 569, pl. 8, figs. 10, 10a. (Not *P. depressa* Phillips 1836.)
Coal Measures: Bonharbour, Daviess County, and Airdrie, Muhlenberg County, Ky.

1884. *Pleurotomaria illinoiensis.* Worthen, Illinois State Mus. Nat. Hist. Bull. No. 2, p. 4.
Coal Measures: Mercer County, Ill.

1888. *Pleurotomaria modesta.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 238, pl. 12, figs. 2a, 2b. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1889. *Pleurotomaria kentuckiensis.* Miller, North American Geology and Paleontology, p. 421.

1890. *Pleurotomaria illinoiensis.* Worthen, Illinois Geol. Survey, vol. 8, p. 135, pl. 23, figs. 6–6b.
Coal Measures: Mercer County, Ill.

1891. *Pleurotomaria modesta.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 252. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.
1892. *Pleurotomaria modesta.* Keyes, Iowa Acad. Sci. Proc., vol. 1, pt. 2, p. 22.
Lower Coal Measures: Near Des Moines, Iowa.
1895. *Pleurotomaria illinoisensis.* Keyes, Missouri Geol. Survey, vol. 5, p. 139. (Date of imprint, 1894.)
Coal Measures: Clinton, Knob Noster, and Kansas City, Mo.
1896. *Pleurotomaria modesta.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 249.
Upper Coal Measures: Crawford County, Ark.
1897. *Pleurotomaria modesta.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 39.
Upper Coal Measures: Crawford County, Ark.
1897. *Trepospira depressa.* Ulrich, Minnesota Geol. and Nat. Hist. Survey Final Rept., vol. 3, pt. 2, p. 958.
1897. *Trepospira illinoisensis.* Ulrich, idem, p. 958, fig. h on p. 1081.
?1897. *Trepospira convexa.* Ulrich, idem, figs. d, e, f, g on p. 1081.
1910. *Trepospira illinoisensis.* Raymond, Carnegie Mus. Annals, vol. 7, No. 1, p. 157, pl. 26, figs. 3, 4.
Brush Creek limestone: Donohoe, Pa.

Shell attaining a large size, the largest specimen being 30 millimeters in diameter. Shape discoidal. The final volution occupies about one-half the entire height and about three-fourths of the shell lies above the plane of its carina. The spire is low with slightly convex sides, each volution joining the preceding one without breaking the general rise of the spire, except for the sculpture, to be described later. The cross section of mature whorls might be described as subrhomboidal or as transversely ovate with a sort of truncation on the inner side by reason of the preceding whorl. The upper exterior surface is but slightly convex and declines gently from the suture. The lower surface, by an abrupt change of direction, extends inward and somewhat downward. The convexity, at first gentle, causes it to curve upward as it approaches the columella. A little before reaching the line of the axis, however, it bends more strongly, finally becoming almost vertical. The upper interior outline is gently concave, formed by the projection of the preceding whorl. The peripheral angle has a sharp edge, emphasized in many cases by a slight groove above or below or both. The slit band is situated just above the carina and is rather broad. Its upper outline is in many specimens so obscure that the relation of the shell to the Pleurotomarias is not apparent.

The surface, except at the suture, is smooth, few Wewoka specimens showing any trace whatever of growth lines. The shape of the aperture is therefore not to be determined in this way, and although this is one of the abundant forms of the fauna very few specimens have been observed that seem to show the unbroken aperture. In these specimens the margin bends rather strongly backward from the suture and is well curved with a shallow, rounded notch at the broad slit band. The lower part of the lip is not shown but it appears to be slightly posterior to the upper. Each whorl overlaps the preceding one so as just to cover the slit band, and the usually thin shell is thickened at that point so as to form a characteristic row of nodes. This gives the sutures a slightly depressed effect which they would have had in any event, though less abruptly. The row of nodes is mounted on a more or less distinct elevation or ridge, variable in different specimens but in all more prominent toward the aperture than on the earlier parts of the shell, where it is wanting altogether. The nodes vary considerably in arrangement not only in different specimens but in different parts of the same specimen. Usually the nodes are separated by intervals equal to or greater than their own width, but in some specimens they are more closely arranged. They are not rounded, but usually more or less distinctly elongated in directions radiating from the apex of the spire, and are more or less angular on top. Toward the aperture of some specimens they appear to be evanescent, but this feature is sporadic and has been observed not on the largest examples but on those of medium size. The umbilicus is depressed but is distinctly closed, and all the specimens show a thickening of the test, extending back from the edge of the aperture, its outer limit showing as a spiral ridge which makes about a single turn.

In its immature stages the shell shows characteristics differing considerably from the mature ones. The mature condition is found in about 3½ whorls in large shells and about 2½ in an average individual. It is characterized by the development of the row of sutural nodes, a feature not appearing on the immature whorls. The nodes are, of course, introduced gradually, the earliest being very small and the later ones more prominent, with their bases connected into a ridge which increases in height with the growth of the shell. The immature condition is found in about 2½ turns. The whorls are at first apparently circular in cross section, but later become more transverse and flattened on top. The earlier portion of the immature shell, occupying about a turn and a half, is apt to project somewhat above the rest of the surface as a tiny knob on the apex of the spire.

The surface of the shell in these immature stages is not well shown, but I have some evidence for believing that during the earliest stage, that with rounded whorls, it was marked by transverse striæ, extremely small in themselves but relatively coarse and strong for the size of the shell. During the second stage the surface appears to have been smooth, and during the third it was marked by the row of nodes along the suture above the slit band of the preceding whorl.

The literature of *T. depressa* may be summarized as follows: Eight species of Trepospira have been described from the Carboniferous of

America, all of Pennsylvanian or at least post-Mississippian age. These are *T. convexa*, *T. coronula*, *T. depressa*, *T. haworthi*, *T. illinoisensis*, *T. kentuckyensis*, *T. modesta*, and *T. sphærulata*. Of these *T. haworthi* may be at once dismissed, as it is only remotely related to Trepospira and manifestly belongs to some other genus. *T. coronula* of Hall is generally conceded to be a synonym of *T. sphærulata*, a valid species and the type of the genus. All the others can probably be regarded as representatives of a second species, as most of them are now generally acknowledged to be.

The first of these to be described is *T. depressa* of Cox, who introduced the name in 1857. In 1884 Worthen described *T. illinoisensis* which he recognized as being related to *T. depressa*, but which he believed to be distinct. In 1888 Keyes proposed *T. modesta*, which he regarded as probably the same as *T. depressa*, but pointed out that the combination *Pleurotomaria depressa* (under which genus all the species were then included) had been preoccupied. In 1889, or a year later, Miller, basing his action on the same grounds, but apparently ignoring Keyes and Worthen's work or accepting Worthen's judgment, proposed *P. kentuckyensis* as a substitute for Cox's name. In 1890 Worthen reprinted his original description of *P. illinoisensis*. In 1891 Keyes expressed himself as satisfied that the form which he had described as *P. modesta* was the same as *P. depressa* of Cox, the latter name being preoccupied. In 1892 Keyes reprinted his first description of *P. modesta*. Two years later he revised the synonymy, recognizing his own species *T. modesta* as the same as *T. illinoisensis* Worthen, previously described and not preoccupied, which name he therefore adopted, placing *P. depressa*, *P. modesta*, and *P. kentuckyensis* in the synonymy. In 1897 Ulrich proposed the genus Trepospira with *T. sphærulata* as the type and included in it the American species *T. depressa* and *T. illinoisensis*, which according to Keyes are the same species. He also figured but hardly described a new species, *T. convexa*, which I am inclined to think is the same as *T. depressa*, and this name, as the shell is now known to belong to another genus than Pleurotomaria, can with propriety be retained.

It is impossible to identify this Wewoka shell with entire satisfaction. It is at least fairly sure that it is distinct from *T. sphærulata*, which has a higher spire with a flatter top, the row of nodes elevated on a more prominent ridge, and the nodes themselves larger, though this difference is not so marked when compared with the coarse extreme of the present series. As to the other form, it will be noted that many of the shells from Oklahoma are rather large, whereas those specimens, figured under various names, are all much smaller. Cox's description of *T. depressa* is brief and his figures are very poor, but I am inclined to believe that the present form can be referred to it. The figures show two oblique views of a specimen that apparently has a nearly flat upper surface. This feature is also in accord with the description, according to which the shell has five volutions, though the figures do not show so many. Specimens of the present form of the same size as Cox's have about the same number of volutions, but show a slightly higher spire. Specimens about the same size as Worthen's *T. illinoisensis* agree with his description and figures, except that he counts but about 10 nodes on the last volution, whereas, though variable in the form under consideration, the number is probably greater than this on all specimens, and on some it is twice as great or more. Worthen also states that his shell differs from Cox's *T. depressa* in having more flattened volutions, a depressed band on the lower volution, and smaller and less conspicuous nodes. Ulrich describes *T. convexa* as differing from the other species in the gentle convexity of the upper side of the whorls. Both Ulrich's and Worthen's species have a higher spire than *P. depressa* appears to have. *P. depressa* therefore must have the upper surface of the whorls of low convexity. Ulrich gives figures of both *T. convexa* and *T. illinoisensis*, but the type of *T. convexa* is a very small shell, only about 8 millimeters in diameter, and my observations seem to indicate that the convexity of young specimens is relatively less than that of large ones. Furthermore, in the series of shells from Oklahoma, which I certainly believe it would be inadvisable to divide into separate species, the height of the spire differs so greatly that some very small specimens agree with *T. convexa* and some larger ones agree with *T. illinoisensis*.

Now, I have not the material on which to reach a conclusion of my own as to the specific relations of the five forms included in the synonymy and am therefore forced to rely largely on the opinions of others and to treat them as a single species, which indeed I think they will prove to be. The descriptions apparently indicate certain differences, which may be shown by critical study of typical or authentic material to be constant and characteristic, but I believe that they will prove to be due to individual peculiarities, age of the specimens (with which are correlated appreciable differences in the specific characters), and the like, and that all the forms will fall within the confines of a not extremely variable species. I may observe in this connection that although Worthen describes the final volution of *T. illinoisensis* as possessing only 10 nodes, Ulrich's figure, which is a side view and therefore shows only half the shell, represents 10, and consequently the total number must have been almost exactly that of the form from Oklahoma.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Pleurotomaria carbonaria Norwood and Pratten?

1855. *Pleurotomaria carbonaria.* Norwood and Pratten, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 75, pl. 9, fig. 8.
Coal Measures: Rock Creek, Williamson County, Ill.

1888. *Pleurotomaria carbonaria.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 239. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1891. *Pleurotomaria carbonaria.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 253. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1891. *Pleurotomaria harii.* Miller, Indiana Dept. Geology and Nat. Hist. Seventeenth Ann. Rept., Advance Sheets, p. 83, pl. 14, figs. 3, 4.
Upper Coal Measures: Kansas City, Mo.

1892. *Pleurotomaria harii.* Miller, Indiana Dept. Geology and Nat. Hist. Seventeenth Ann. Rept., p. 693, pl. 14, figs. 3, 4.
Upper Coal Measures: Kansas City, Mo.

1895. *Pleurotomaria carbonaria.* Keyes, Missouri Geol. Survey, vol. 5, p. 138. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1896. *Pleurotomaria harii.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 250.
Lower Coal Measures: Conway County, Ark.

1897. *Pleurotomaria harii.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 40.
Lower Coal Measures: Conway County, Ark.

1903. *Pleurotomaria?* cf. *carbonaria.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 459.
Carboniferous: Glenwood Springs, Colo.

1910. *Pleurotomaria carbonaria.* Raymond, Carnegie Mus. Annals, vol. 7, No. 1, p. 157, pl. 26, fig. 1.
Brush Creek limestone: Donohoe, Pa.

This type is represented by a mere fragment of the lower portion of a large pleurotomaroid shell of the *carbonaria* group, probably *carbonaria* itself. The surface is marked by angular, revolving liræ, of which 23 can be counted and there were probably a few additional ones on the portion now broken away. They are separated by rounded grooves, usually wider than the liræ and on the upper portion very much wider. The grooves increase in width from the closed umbilicus upward, the liræ remaining about the same, or at least not increasing in proportion. This sculpture is crossed by fine, sharp, regular, incremental lines, which proceed obliquely and rather strongly backward to the periphery where, along a narrow band, they make a lunate reentrant curve, thus defining the shallow slit or notch. They then pass downward and gently backward to the umbilicus. The slit band is fairly well defined, both by revolving lira above and below (of the same character as those which elsewhere ornament the surface) and by the crenulating transverse liræ. The band bears one revolving line along its middle. There is a rather abrupt change in the sculpture above and below this zone, the lower half having conspicuously finer spiral striations than the upper.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Family BELLEROPHONTIDÆ.

Genus BELLEROPHON Montfort.

BELLEROPHON CRASSUS var. WEWOKANUS Girty.

Plate XIX, figures 1–3b.

1911. *Bellerophon crassus* var. *wewokanus*. Girty, New York Acad. Sci. Annals, vol. 21, p. 138.

Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

The fossils under consideration are all small. They can be described most advantageously by comparing them with *Bellerophon crassus*, to which they are obviously very closely related. For this comparison it will be best to use the figures and description given by Meek and Worthen, not only because they are authentic, but because, although *B. crassus* has appeared in the literature not infrequently, few of the citations have been based on good and characteristic specimens. The most essential difference between Meek and Worthen's specimens and those from the Wewoka formation is that in the latter the umbilicus, instead of being partly open, is so solidly closed that there must have been a continuous imperforate columella. The Wewoka specimens, too, are very much smaller, the shape of the aperture is more transverse, and the band is possibly more elevated.

It may be that these differences are due to stage of growth, but shells which I am referring to *B. crassus* as representing a young condition are quite different. From these the Wewoka fossils differ in the following particulars: The volutions are relatively narrower; the slit band is broader and more prominent; the umbilici are more completely closed; the sculpture, instead of consisting of rather regular, transverse imbrications, is made up of fine, incremental lines which, at irregular intervals, become fasciculate, forming small angular costæ or incipient plications.

The fissure as shown on one of the Wewoka specimens is rather deep, but I am not sure that this feature may not have been exaggerated by abrasion of the projecting band. Furthermore, on the best specimens the callosity of the inner lip appears to be imperfectly developed.

It is possible that this form may prove to be the same as *B. incomptus*, but after comparing my specimens with Gurley's types (which I have had the privilege of examining, thanks to the courtesy of the Walker Museum of Chicago University) I am disposed to think that they are different. The differences appear to me to be those already mentioned as existing between the var. *wewokanus* and young *B. crassus*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2004 and 7193).

Genus PHARKIDONOTUS Girty.

1911. *Pharkidonotus.* Girty, New York Acad. Sci. Annals, vol. 21, p. 138.

The extensive and varied series of shells which in the course of time had been grouped under Montfort's genus Bellerophon have of recent years been distributed among a number of genera and subgenera. Waagen has very properly restricted the genus Bellerophon to types having a rather narrow, well-developed slit band, a moderately deep fissure, a strong callosity on the inner lip, and a sculpture consisting only of more or less strong growth lines.[1] Our well-known Pennsylvanian species *B. crassus* and the upper Mississippian *B. sublevis* are therefore typical Bellerophons.

The American Pennsylvanian faunas contain a species or perhaps a series of mutations which present well-marked differences from the characters possessed by typical Bellerophons, so that a subgeneric separation is justified if not demanded. The dorsum is elevated into a prominent nodose carina, on which traces of a slit band can be detected in only a few specimens, so that many appear to lack such a structure altogether and to be related to the Indian Warthia and Mogulia. Some specimens retain unmistakable traces of a slit band, however, and there can be little doubt that this structure is a normal feature of this type. That it is obliterated so generally is probably due to its prominence and also, perhaps, to the tumid condition of the median line of the dorsum.

From Bellerophon this type also differs in the development of coarse, heavy, angular, transverse plications, quite distinct from the growth lines, which are not conspicuous. These plications are also in some specimens strengthened at two series of points, one on each of the sides, so as to form more or less prominent nodes, especially as they may be more or less connected by revolving ridges, the linear arrangement of which produces two carinæ additional to the median one, which is the locus of the slit band.

Type species.—Bellerophon percarinatus.

Pharkidonotus percarinatus Conrad.

Plate XIX, figures 4–9c.

1842. *Bellerophon percarinatus.* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 8, p. 268, pl. 16, fig. 5.
Carboniferous: Inclined plane of the Allegheny Mountains, in black shale overlying the stratum of coal No. 7.

1883. *Bellerophon Harrodi.* Gurley, New Carb. Foss., Bull. No. 1, p. 5.
Upper Coal Measures: Near Oakwood, Vermilion County, Ill.

1884. *Bellerophon percarinatus.* White (pars), Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 158, pl. 33, figs. 12–14.
Coal Measures: Indiana.

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[1] Waagen, W., Salt Range Fossils: Geol. Survey India Mem., 13th ser., vol. 1, 1887, p. 130.

1886. *Bellerophon percarinatus.* Claypole, Wyoming Hist. and Geol. Soc. Proc. and Coll., vol. 2, pt. 2, p. 246.
Lower Coal Measures: Wilkes-Barre, Pa.

1887. *Bellerophon percarinatus.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 17, pl. 2, fig. 14.
Coal Measures: Flint Ridge, Ohio.

1888. *Bellerophon percarinatus.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 234. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Bellerophon percarinatus.* Keyes (pars), Missouri Geol. Survey, vol. 5, p. 153, pl. 50, figs. 2a, 2c, 2e. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1897. *Bellerophon percarinatus.* Ulrich, Minnesota Geol. and Nat. Hist. Survey Final Rept., vol. 3, pt. 2, p. 853.

1899. *Bellerophon percarinatus.* Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 592.

1899. *Bellerophon Harrodi.* Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 592.

1903. *Bellerophon* (s. s.) *percarinatus.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 470.
Hermosa formation: San Juan region and Sinbads Valley, Colo.
Weber formation: Leadville district, Colo.

There occur in the upper Carboniferous rocks of the interior basin two closely related species of Bellerophon, one of which, in fact, may be considered an intermediate stage or a stage of arrested development toward the other. Three specific names have been introduced for these shells, *B. percarinatus*, *B. tricarinatus*, and *B. harrodi*. By far the most common and best-known form is that generally called *B. percarinatus* and it is not improbable that both types have sometimes been included under that species.

In the form which passes as *B. percarinatus* the median line of the dorsum is raised into a prominent nodose carina and the sides are crossed by angular transverse plications, which are especially prominent not far from the middle of the shell. The regular repetition of these projections or nodes down the dorsum gives the appearance of two more carinæ, one on each side, especially if they are connected, as they tend to be, by a revolving ridge.

The second form has similar characters, the main difference being that the transverse plications are less strongly developed, and especially that they lack the regular recurring nodes, so that the dorsum appears to be marked by one medianly situated carina.

I have said that the former variety commonly passes as *Bellerophon percarinatus*, this interpretation apparently dating from Norwood and Pratten. Meek and Worthen later gave their powerful sanction to it and it has been followed by most, indeed by possibly all, subsequent authors. Reference to the original description and figure, however, leaves scarcely a doubt that it was the other form which was originally described as *B. percarinatus*. Perhaps the failure to note this is due to the facts that the two forms are closely related and may have been considered the same (as they really may be), and that the original work of Conrad is rare and perhaps has not been accessible to some of the paleontologists who have handled these species. For this reason I have reproduced Conrad's original description and figures. His brief description runs as follows:

Subglobose; back with a sharp, elevated, waved carina; sides with distant transverse acute ribs and intermediate minute striæ; volutions concealed.

Locality.—Inclined plane of the Alleghany Mountain, in black shale overlying the stratum of coal No. 7. Carboniferous system. Found by Dr. James Trimble, of Huntingdon, Pa.

This same form was subsequently described without figures by Gurley as *Bellerophon harrodi.* His work also is hard to come by, and I here quote his original description, and, thanks to the courtesy of the Walker Museum of the University of Chicago, I am also able to figure the original specimen upon which it is based. (See Pl. XIX, fig. 9.)

Shell commonly attaining a growth above the medium size, outer or body whorl, broadly and regularly expanding; aperture reniform.

Dorsal margin not reflexed, but conforming to the direction of the growth of the body whorl. Lateral margins rapidly thickening and slightly reflexed, forming a stout flat lip, which, in joining the volution, entirely closes and conceals the umbilicus.

Dorsum regularly rounded, full semicircular in section, with a sharp prominent mesial or longitudinal nodose ridge, the nodes being developed by the continuation across the ridge of a series of transverse costæ or undulations extending to the umbilicus. These undulations are quite prominent toward the back of the shell, but gradually become faint and indistinct along the last quarter of the outer volution, which is regularly marked by distinct lines of growth that occasionally thicken up, forming slight indications of undeveloped costæ or undulations, extending around the shell at irregular intervals.

Inner lip callous and in mature specimens it frequently swells out and thickens laterally, being quite prominent.

This species resembles *B. percarinatus* Conrad, but is easily distinguished from that form by being less compressed and not having the lateral nodose ridges which so strongly characterize that form. Again, this species shows more clearly the close relation existing between the concentric lines of growth along the latter portion of the body whorl and the undulating lateral costæ which ornament the shell back of the last quarter.

The specific name is given in honor of Dr. S. H. Harrod, of Canton, Ind., an untiring worker, and one to whom paleontologists are indebted for many new and interesting forms.

Position and locality.—Upper Coal Measures, near Oakwood, Vermilion County, Ill.

Comparison of the descriptions quoted above and the figures that illustrate them will, I believe, leave little room for doubt that *B. harrodi* and typical *B. percarinatus* are the same; and comparison of these data with those relating to the form commonly identified as *B. percarinatus* will make it equally clear that these two forms are not of the same species.

The form considered in the present work constitutes one of the rarer species of the fauna of the Wewoka formations though one of the more common Bellerophons. Most of the local collections contain representatives of this form, though only one of two specimens are in any one collection. The total number of specimens examined is therefore considerable, but most of them are poorly preserved. The majority are rather small, a width at the axis of 30 millimeters being about the maximum in examples confidently referred to this species. The volutions expand rapidly and the aperture projects strongly at the umbilicus. The umbilici are solidly closed, making a continuous imperforate columella. The dorsum is traversed by a large, blunt, prominent carina, which is thickened at regular intervals into heavy nodes. The sides are crossed transversely by regularly arranged, subangular costæ or plications separated by relatively wide, rounded furrows. In many individuals growth lines, more or less numerous and distinct, are also preserved. The strength of these costæ varies greatly in different specimens. In some they are low and appear like fascicles of the growth lines; in others they are high and sharp, with the growth lines inconspicuous or absent. They are most prominent near the carina but are obscure in a sulcus or depression by which the carina is emphasized on each side. They reappear on the carina itself, forming the nodes already referred to, which are frequently more prominent, more broad, and more rounded than the corresponding elevations on the sides.

Although many of the Wewoka shells show slight differences in one respect or another from the type specimen of *Bellerophon harrodi*, there can hardly be a doubt that they belong to the same species. Of the figured specimens one (fig. 5), though smaller and somewhat immature, is very similar to the type; another (fig. 6) seems verging toward the variety *tricarinatus*, having stronger costæ than *B. harrodi* and a more nodose carina. The carina of *B. harrodi* itself, however, is considerably less nodose, and the plications less strong near the outer lip than near the inner.

Although the plications of the shells under consideration vary much in strength and prominence, the difference, on the assumption that size is a true index of age, is not entirely one of ontogeny, specimens of about the same size being very dissimilar in this particular. Still, variation seems to be mainly proportional to size. Where the plications are most highly developed there is usually a point of especial prominence repeated down the line of costæ, suggesting an incipient condition of the feature which is so characteristic of the variety *tricarinatus*. It is, indeed, possible that this form is based on immature specimens of the latter, but I am inclined to believe rather that it represents in mature shells an incipient stage. At all events, it hardly seems advisable to regard the two as distinct species, the degree of their divergence probably being only varietal.

The slit band on these shells is usually obliterated, and they might be thought to be related to such types as Warthia and Mogulia were it not that a few specimens still retain unmistakable traces of the narrow band passing along the top of the carina. Thus a relationship is shown to the typical Bellerophon more close than is at first apparent and the form here called *Bellerophon crassus* var. *wewokanus* shows to some extent a transitional tendency in the fasciculation of the growth lines.

Several details of the synonymy of *P. percarinatus* deserve comment. Many of the works cited do not contain data sufficient for determining closely the character of the fossil identified, and such of course have been cited under the name given by the author. An exception has been made in my own citation of *Bellerophon percarinatus* in 1903 which should be placed with the variety *tricarinatus,* since I was then interpreting the species on the basis of the figures given by Norwood and Pratten and by Meek.

White undoubtedly included under *B. percarinatus* both the type which Gurley described as *B. harrodi* and which had already received the name *percarinatus* and the type which Norwood and Pratten identified as *B. percarinatus* and which was subsequently described by Shumard as *B. tricarinatus.* Keyes (1895) uses White's figures, although he does not say so. He has also confused his description of the figures so that there would appear to be three instead of two originals, and so that views of different specimens appear to be drawn from the same. White's citation, therefore, as well as Keyes's, appears in the synonymy of both varieties. Herrick's description, on the other hand, is taken almost verbatim from White and naturally covers both *percarinatus* and its variety, but his figure from a Flint Ridge specimen shows only the *percarinatus* type, and since the Survey collections from the same locality contain the one type but probably not the other, Herrick's citation belongs in the present synonymy only.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (station 2004).

Genus BUCANOPSIS Ulrich.

BUCANOPSIS MEEKIANA Swallow.

Plate XX, figures 4–6.

1858. *Bellerophon Meekianus.* Swallow, St. Louis Acad. Sci. Trans., vol. 1, p. 204. (Date of imprint, 1860.)
Middle Coal Measures: Lexington, Mo.
Lower Coal Measures: Howard County, Mo.

1884. *Bellerophon tenuilineatus.* Gurley, New Carb. Foss., Bull. No. 2, p. 10.
Upper Coal Measures: Near Oakwood, Vermilion County, Ill.

1895. *Bellerophon meekianus.* Keyes, Missouri Geol. Survey, vol. 5, p. 149. (Date of imprint, 1894.)
Lower Coal Measures: Howard County and Lexington, Mo.

1897. *Bucanopsis Meekana.* Ulrich, Minnesota Geol. and Nat. Hist. Survey Final Rept., vol. 3, pt. 2, p. 854.

1899. *Bucanopsis Meekana.* Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 591.

1899. *Bucanopsis tenuilineata.* Girty, idem, p. 591.

The fossils considered under this title are small and are rather variable in character. In some specimens the whorl section is more transverse and its peripheral surface is broadly rounded; in others the height is proportionally greater and the peripheral surface has more the shape of a gothic arch. The shell turns abruptly inward near the umbilicus, which is partly hooded over by a fold of the lip. The inner lip is well developed, concealing the sculpture. The aperture is reniform and is considerably expanded.

The surface is marked by fine, threadlike revolving liræ, which vary considerably in size and number. They are subequal in some shells and alternating in others. If the intermediate liræ are numerous the total number is of course greater and the sculpture is finer. A fairly typical specimen has 8 liræ on the slit band and 28 on each side, those on the sides becoming more irregular and more widely separated near the umbilicus. The liræ on the sides may number 30 or more, ranging commonly from 12 to 16 in 3 millimeters, but in some specimens numbering as many as 28. There are also transverse liræ which are in the main of the same character as the revolving ones. They may be slightly more or less prominent and slightly more or less closely arranged. In some specimens a few of the transverse liræ are more prominent than the others. They occur at relatively long and irregular intervals. The transverse markings are nearly straight but are deflected backward near the slit band, which is broad and may be elevated above the general curvature or depressed below it or on the same level with it. In some specimens of the type last named the margins are elevated. The band is marked by fine revolving liræ like those on the rest of the shell, and in some specimens it is not by any means a striking feature; nor are its boundaries easily determined. Even if it is not defined topographically it is distinguished by the striæ, which are likely to be somewhat differently arranged and are not crossed by the transverse markings. The band is marked on the outer lip by a rather abrupt notch, which is not completely shown by my specimens but which was probably not very deep. In general, the sculpture may be said to be regularly cancellated and so fine as to be almost microscopic. If anything, the revolving liræ are more persistent and noticeable than the transverse ones.

There can hardly be a doubt that this is the same form which Gurley described as *Bellerophon tenuilineatus*. I have been able to make comparisons with Gurley's type specimen, a privilege which I owe to the courtesy of the Walker Museum of the University of Chicago, and can find no important or constant differences. Some of the Wewoka shells show minor differences in one particular, others in another, but all agree in the main. The type specimen of *B. tenuilineatus* has the slit band depressed, a feature to which Gurley calls attention. It is also slightly depressed in some of my specimens, but it is slightly elevated in others. In some of my specimens the liration is a little coarser than that of the type; in others it is as fine if not a little finer. The transverse cancellating lines are generally but not invariably rather more distinct in the Wewoka fossils. In a few specimens, especially the larger ones, the dorsum is somewhat angular instead of being regularly rounded.

For the convenience of those who may not be able to consult Gurley's rare bulletin I quote his original description entire as follows, and am also able to supply figures of his type specimens (Pl. XX, figs. 4–4d):

Shell medium size, subglobose; body whorl, moderately expanding; aperture broadly subovate, reniform, arcuate; umbilicus distinct, partially concealed by the thin, recurved extremity of the lip, which along the greater portion of the margin conforms to the general direction of the growth of the shell; the lateral margins of the lip gradually curve backward to the mesial band, where they join each other with a sharp backward curve, thereby forming a shallow sinus, which distinctly divides the lip into two parts.

Surface marked by fine, closely arranged longitudinal striæ, which continue without interruption to the margin of the lip, there being about 35 on each side of the shell and 7 on the mesial band. The mesial band is small, slightly depressed, and barely distinguishable from the rest of the shell, being bounded on either side by a fine raised line, which is somewhat heavier than those on the lateral portions of the shell. Regularly arranged, faint transverse lines of growth cross the shell, with a moderate backward curve in the same direction as the margin of the lip; they are not sharp or prominent and do not interrupt the evenness of the revolving striæ.

This shell bears a strong resemblance to *B. marcouanus* Geinitz in its ornamentation, but does not possess the broad, flattened lip of that form, and also differs materially in the form of the mesial band, which in that species is distinctly elevated in the center, whilst in this form it is depressed.

Position and locality.—Same as the preceding [Upper Coal Measures, near Oakwood, Vermilion County, Ill.].

Gurley does not compare *B. tenuilineatus* with Swallow's *B. meekianus*, but I strongly suspect that they are the same species. Swallow's description, which is also found in a rather rare work, runs as follows:

Shell small, gibbous, broadly rounded on the dorsal margin, carinated near the aperture, ornamented with fine, crowded, longitudinal striæ and very minute transverse lines; aperture very much expanded, reniform, transverse, much modified by the preceding whorl; lip thickened and reflected over the umbilicus, with a linear callosity, extending back from the points of junction on to the adjacent whorl; volutions concealed; umbilicus shallow, distinctly modified by the thick reflexed lip.

Diameter, 0.77; width of aperture, 0.60; length of aperture, 0.35.

This beautiful little shell resembles the *B. perlatus* of Conrad (Jour. Acad. Nat. Sci. Philadelphia, vol. 8, p. 270), but his specimen has no transverse striæ, and ours is carinated only near the aperture. It is also similar to *B. witryanus* De Koninck (Animaux Fossiles, Pl. XXVIII, fig. 9, p. 341); but the latter is easily distinguished by its very large umbilicus. *B. decussatus* Fleming (Phillips, Geology Yorkshire, vol. 2, p. 231, Pl. XVII, fig. 13) may be identified by the greater depth of the umbilicus and its well-defined carina.

Missouri State collection from the Middle Coal Measures near Lexington; also by Mr. Price in the Lower Coal Measures in Howard County.

Both descriptions indicate essentially the same characters, the fact that the band is depressed in *Bellerophon tenuilineatus* being of less importance because forms with both elevated and depressed band occur among the specimens under consideration and are not distinguishable by other characters into separate species.

It is highly probable that *Bellerophon marcouanus* Geinitz, especially the form figured by Meek under that name, will prove to be the same as this species. But Geinitz's own figure, if accurate, shows features of the carina which would apparently exclude it, and until more complete information is at hand it seems unwise to disturb the existing status.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001 and 2004).

Genus PATELLOSTIUM Waagen.

PATELLOSTIUM MONTFORTIANUM Norwood and Pratten.

Plate XX, figures 1–3b.

1855. *Bellerophon Montfortianus.* Norwood and Pratten, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 74, pl. 9, figs. 5a–c.
Coal Measures: Galatia, Ill., and 5 miles below New Harmony, Ind.

1866. *Bellerophon Montfortianus.* Geinitz, Carb. und Dyas in Nebraska, p. 8, tab. 1, fig. 13.
Coal Measures: Nebraska City, Nebr.

1866. *Bellerophon interlineatus.* Geinitz, idem, p. 8, tab. 1, fig. 14.
Coal Measures: Nebraska City, Nebr.

1872. *Bellerophon Montfortianus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 225, pl. 11, figs. 15, 12?.
Upper Coal Measures: Nebraska City, Nebr.
Coal Measures: Nebraska, Kansas, Iowa, Missouri, and Illinois.
Lower Coal Measures: West Virginia.

1876. *Bellerophon Montfortianus.* White, U. S. Geol. and Geog. Survey Terr., 2d div., Powell's Rept. Geology Uinta Mountains, p. 92.
Upper Aubrey group: Confluence of Grand and Green rivers, Utah.

1887. *Bellerophon Montfortianus.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 19, pl. 2, fig. 1; pl. 5, fig. 8, 8A.
Coal Measures: Flint Ridge, Ohio.

1888. *Bellerophon montfortianus.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 235. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1891. *Bellerophon montfortianus.* White, U. S. Geol. Survey Bull. 77, p. 26, pl. 3, figs. 15, 16.
Permian: Goodwin Creek, Baylor County, Tex.

1891. *Bellerophon montfortianus.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 254. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Bellerophon montfortianus.* Keyes, Missouri Geol. Survey, vol. 5, p. 151. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1897. *Patellostium Montfortianum.* Ulrich, Minnesota Geol. and Nat. Hist. Survey Final Rept., vol. 3, pt. 2, p. 854.
Coal Measures.

1899. *Patellostium montfortianum.* Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 589.

1903. *Patellostium montfortianum.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 473.
Hermosa formation: San Juan region, Colo.
Weber formation: Leadville district, Colo.

I shall not presume to give a complete description of the well-known species from specimens occurring in the Wewoka formation, but shall confine my comments to a few points of especial interest. The greatly expanded, bell-like outer lip is, as usual in this species, more or less broken in the Wewoka specimens, and in most of them no trace of it remains. The largest specimen, one in which this feature is retained in greatest completeness, has a length of 20 millimeters. Whether this development ever took place in the small or, at least, in the immature examples is doubtful. It does not appear that this excessive expansion is a progressive development but rather that it was abruptly introduced at maturity and marks the end of increase in size. The younger stages were apparently either without it or else it suffered resorption. That resorption took place does not seem probable, and it is a pertinent question whether the younger stages do not possess the characters of Bucanopsis, or, per contra, whether some of the shells ascribed to Bucanopsis would not have grown into a shape like Patellostium.

The umbilicus is not filled in, though it is partly covered over by a reflexed portion of the shell. The most striking sculptural feature is the series of strong, angular, transverse plications, by which the surface is crossed. These vary in prominence in shells of the same size but generally are fainter on small shells than on large ones. They are also lacking on the prolonged and expanded apertural areas. The slit band is but slightly affected by these plications and forms, as it were, a narrow, slightly undulating pathway down the middle of the dorsum. Longitudinally the shell is marked by rounded liræ of two or three different orders. Most prominent is a series of regularly arranged liræ set at intervals considerably greater than their own width. The intermediate spaces are marked by liræ much finer than the others, usually three to five or more in number, with the middle one slightly larger than the rest. Toward the sides and possibly also on the flaring portion the liration tends to become more uniform, owing to the decrease in size of the liræ of the first order, together with the nondevelopment of some of the smaller ones. Transverse markings are usually obscure and sporadic—chiefly noticeable on the slit band.

The exact limits of the slit band are not always easy to determine. It does not occupy the whole of the depressed zone down the dorsum, but is bounded on either side by several fine liræ still within that zone. Usually the edges of the band are slightly more elevated than the other liræ occurring upon it; the median one of the latter is prominent above the others with one or possibly two intermediate ones on either side, making five in all, three large and two small. There is considerable variation in these details, and in some shells the liration of the depressed zone appears to be uniform. As already noted, the apertural prolongation has been observed in but one or two specimens, and in these the band is defined by two rather strong striæ.

The inner lip is well developed, continuing across the dorsum from the reflex edges, which partly cover the umbilici. Just within the aperture this thickening is often intensified into a large, bluntly pointed knob directed somewhat forward or outward.

The citation of this species from the Permian of Texas by White in 1891 is probably in error. His figures suggest much rather a Bucanopsis of the type of *B. bella*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001 and 2004).

Genus **EUPHEMUS** McCoy.

EUPHEMUS CARBONARIUS Cox.

Plate XXI, figures 1–3b.

1855. *Bellerophon Urii.* Norwood and Pratten, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 75, pl. 9, figs. 6a–c. (Not *B. urii* Fleming 1828.)
Coal Measures: Galatia and Grayville, Ill., and 5 miles below New Harmony, Ind.

1857. *Bellerophon carbonarius.* Cox, Kentucky Geol. Survey Rept., vol. 3, p. 562.
Coal Measures: Kentucky.

1860. *Bellerophon vittatus.* McChesney, Desc. New Spec. Foss., p. 59. (Date of imprint, 1859.)
Coal Measures: Mouth of Rush Creek, Ind.; Grayville, Ill.

1860. *Bellerophon blanyanus.* McChesney, Desc. New Spec. Foss., p. 60.
Coal Measures: Saline and Peoria counties, and Danville and Grayville, Ill.

1865. *Bellerophon Blaneyanus.* McChesney, Ill. New Spec. Foss., pl. 2, figs. 5a–c.

1866. *Bellerophon carbonarius.* Geinitz, Carb. und Dyas in Nebraska, p. 6, tab. 1, fig. 8.
Upper Carboniferous: Nebraska City, Nebr.

1868. *Bellerophon Blaneyanus.* McChesney, Chicago Acad. Sci. Trans., vol. 1, p. 45, pl. 2, figs. 5a–c.
Coal Measures: Saline and Peoria counties, Ill.; Danville and Grayville, Ill.

1872. *Bellerophon carbonarius.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 224, pl. 4, fig. 16, pl. 11, figs. 11a–c.
Upper Coal Measures: Nebraska City, Nebr.
Coal Measures: Iowa, Kansas, Missouri, Illinois, Kentucky, Indiana.
Lower Coal Measures: West Virginia.

1884. *Bellerophon carbonarius.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 158, pl. 33, figs. 6–8.
Coal Measures: Indiana.

1887. *Bellerophon carbonarius.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 19, pl. 2, fig. 20.
Coal Measures: Flint Ridge, Ohio.

1888. *Bellerophon urii.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 235. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1891. *Bellerophon urii.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 255. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Bellerophon urii.* Keyes, Missouri Geol. Survey, vol. 5, p. 149, pl. 50, figs. 5a–c. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1896. *Bellerophon carbonarius.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 149.
Lower Coal Measures: Conway County, Ark.

1897. *Bellerophon carbonarius.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 39.
Lower Coal Measures: Conway County, Ark.

1897. *Euphemus carbonarius.* Ulrich, Minnesota Geol. and Nat. Hist. Survey Final Rept., vol. 3, pt. 2, p. 855.

1899. *Euphemus carbonarius.* Girty, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 3, p. 592.

1906. *Bellerophon carbonarius.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 282.
Carboniferous: Weeping Water, Nebr.

This well-known species is certainly the most common Bellerophon in the Wewoka fauna. The specimens examined show considerable variation in breadth, sculpture, and configuration, as noted below.

The shell may be considered as divided into an anterior or apertural portion which is smooth, and a posterior or somatic portion which, as is well known, is marked by revolving liræ. The dorsum of both portions is generally more or less regularly rounded, but in many specimens the middle of the dorsum on the somatic portion is slightly depressed into a scarcely perceptible sulcus, and in a few the sides of the anterior portion are flattened, giving it a peaked or subangular appearance. Toward the umbilicus also the sides of the apertural portion are more or less flattened, expanded. and abruptly turned inward.

The columella is solid, the thickened sides of the outer lip closing the umbilicus and extending obliquely upward as if forming a deflected part of the columella. The shell is more or less strongly excavated at either side of this in the axial region.

The revolving liræ are rigid, thin, abruptly elevated, and separated by relatively wide, gently concave interspaces or striæ. They vary considerably in number. Meek states that there are from 18 to 25, and these extremes seem to be about those shown by the Wewoka specimens. Owing to variation in the number of these striæ and in the width of the shell some examples are finely and others coarsely striated. The liræ are rather irregular, chiefly down the center of the dorsum and at the sides toward the umbilicus. The irregularities consist of the introduction of new liræ and the intermittence of the old ones. Generally speaking, the number of liræ seems to remain about constant on the same individual, but a few new ones may be introduced by intercalation. Very rarely do two unite into one. More commonly a lira stops for a shorter or longer space and is renewed beyond. It may be renewed along the same line of revolution, but oftener the continuation is offset slightly, so that the two overlap, the one beginning just before the other terminates. The tendency to be discontinuous is especially strong at the sides, and on this account it may be impossible to count the liræ closer than within three or four.

The mesial band is obscure over the striated portion of the shell. That the mesial line is more or less specialized, however, is indicated by the fact that there is frequently a slight sinus and that two or three of the mesial liræ are slightly finer and more crowded than the rest. Over the smooth anterior portion, however, the band is fairly distinct, rather broad, and marked by somewhat irregular, concave, incremental striæ. In some shells it is traversed by a linear groove or stria passing up the center. It may be either slightly elevated above the general curvature, or it may lie in about that curvature, though distinctly defined by elevated lines along its sides.

The smooth anterior portion is generally more or less broken away, but when complete it occupies a little less than one-half a volution. Its posterior boundary is concave, owing to a marked prolongation of the striated portion at the sides, the liræ being there more or less strongly intermittent. Its anterior outline is bilobate, owing to a rather shallow fissure with rounded reentrant edges. This area is almost smooth and characterless but for the band above described.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Family EUOMPHALIDÆ.

Genus SCHIZOSTOMA Bronn.

The species here to be considered was originally described under the genus Inachus as *I. catilloides*, but it has generally been cited as Euomphalus and more recently as Straparollus, and a related species has been placed with Phymatifer. The relations of these genera have been discussed by De Koninck,[1] whose investigation seems to show that Straparollus (type *S. dionysii*) was based on a shell having a high spire, a deep umbilicus, and a rounded whorl section. Under Euomphalus (type *E. pentangulatus* Sowerby), a group containing both high-spired and low-spired species, he includes species having a single angular carina on the upper surface of the volutions, which are otherwise rounded. Phymatifer was a name introduced for shells of the general type of Euomphalus but having a series of nodes developed on the lower surface and the carina of the upper surface more or less replaced by a similar row of nodes. Under Schizostoma (type *S. catillus*) are grouped a few species having a discoidal shape, a flat or concave upper surface, two carinæ, and a trapezoidal aperture.

Of these groups *S. catilloides* agrees very closely with the last. The chief difference that I can point out is the tendency in the American form to fasciculation of the growth lines and a development of correlated transverse ridges and in some shells of nodes along the carinæ. This tendency is carried still further in *Euomphalus pernodosus*, which has been referred by Frech to Phymatifer. The present species bears a less marked resemblance to Phymatifer and seems more closely allied to Schizostoma by reason of the depressed spire, flattened upper and lower surfaces of the volutions, generally quadrate aperture, and the inconspicuous and sporadic development of the nodes, which seem to occur mostly on the upper surface.

Although the different groups recognized by De Koninck doubtless intergrade to some extent, and although there may be a difference of opinion as to the rank which they should occupy, whether generic, subgeneric, or group, it seems to me that they exhibit real differences which it is desirable to recognize. Furthermore, it seems to me that it will be more convenient if each group receives a distinctive name, and that in the main at least the names employed by De Koninck are used for species closely allied to those which in each case may properly be regarded as typical. If these criteria and this nomenclature be applied to the American species the following division results: To Schizostoma belong without much question *S. catilloides*, *S. subquadratus*, *S. sulcifer*, and also probably the variety of *S. sulcifer* called *angulatus*, though by the modification of some of its characters *angulatus* in a measure suggests the genus Euomphalus.

All the American species of Schizostoma are of upper Carboniferous age. They differ from the lower Carboniferous forms figured by De Koninck in having the upper and lower surfaces of the peritreme more nearly parallel and the two carinæ more nearly marginal. This brings them into a position to some extent intermediate between the lower

[1] Faune du calcaire carbonifère de la Belgique: Mus. roy. hist. nat. Belgique Annales, tome 6, vol. 2, pp. 106 et seq., 1881.

Carboniferous forms of De Koninck and the Triassic genus Discohelix. The latter seems to be absolutely complanate and symmetrical with regard to a plane dividing the shell perpendicularly to the axis. The upper Carboniferous Schizostomas are of course distinctly asymmetric.

Under Straparollus I would include the following forms, all of which have at one time or another been referred to that genus:

Straparollus ammon White and Whitfield.
S. blairi Miller.
S. macromphalus Winchell.
S. missouriensis Miller and Gurley.
S. obtusus Hall.
S. ophirensis Hall and Whitfield.
S. planispira Hall.
S. quadrivolvis Hall.
S. spergenensis Hall.
S. spergenensis var. planorbiformis Hall.
S. spirorbis Hall.
S. springvalensis White.
S. subumbilicatus Worthen.
S. varsoviensis Worthen.

The Straparolli are all of Mississippian age, no Pennsylvanian species being known. They vary from nearly flat, discoidal shells to those having a high spire and a strongly conical shape, such, in fact, as is found in the typical species. Some have the volutions more or less flattened on top, thus seeming in a manner transitional to the genus Euomphalus, so that it is not always possible to determine satisfactorily, at least from literature, whether such forms belong to one group rather than the other.

The representatives of Euomphalus s. s. are all Mississippian and all more or less discoidal or at least low spired except *E. umbilicatus*, which is of Pennsylvanian age and has a high spire. To this group belong the following species:

Euomphalus angularis Weller.
E. boonensis Swallow (possibly Schizostoma).
E. exortivus Dawson.
E. latus Hall.
E. luxus White.
E. planidorsatus Meek and Worthen.
E. roberti White.
E. similis Meek and Worthen.
E. similis var. planus Meek and Worthen.
E. umbilicatus Meek and Worthen.
E. Utahensis Hall and Whitfield.

To Phymatifer Frech[1] has referred the American shell *Euomphalus pernodosus* Meek and Worthen, and probably *Euomphalus cornudanus* Shumard belongs to the same group. Both species are of Pennsylvanian age.

The species thus enumerated comprise most of those which have been referred to the genera Straparollus and Euomphalus. There yet remain two forms whose characters debar them from any other groups so far considered. One of these is *Euomphalus lens* Hall, which presents many of the characters possessed by the shells which De Koninck has included under Raphistoma. It is improbable that this disposition of them is correct, but as the American species clearly does not belong to any of the other Euomphaloid genera it may provi-

[1] Lethæa Geognostica; Lethæa Palæozoica, vol. 2, Lieferung 2, pp. 350, 373, 391, 393, 1899.

sionally be referred to Raphistoma. A better reference is at all events impossible from the description and figures.

Another species which clearly does not belong to any of the genera thus far considered is *Straparollus magnificus* Shumard. On the assumption that this form is a gastropod its affinities are probably with the genus Porcellia and in that group I am provisionally including it. Because of the very large size of this shell and the fact that the peripheral portion is indented or concave I am inclined to believe that its real affinities are with the Nautiloidea and that it will ultimately find place in Cœlonautilus or some related genus.

SCHIZOSTOMA CATILLOIDES.

Plate XXI, figures 4–5b.

1842. *Inachus catilloides.* Conrad, Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 8, pt. 2, p. 273, pl. 15, fig. 3.
Carboniferous: Inclined plane of the Alleghany Mountain, Pa.

1858. *Euomphalus rugosus.* Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 722, pl. 29, figs. 14a–c.
Coal Measures: Illinois.

1866. *Serpula (Spirorbis) Planorbites.* Geinitz, Carb. und Dyas in Nebraska, p. 3, tab. 1, fig. 6.
Upper Coal Measures: Nebraska.

1872. *Straparollus (Euomphalus) rugosus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 230, pl. 6, figs. 5a, 5b; pl. 11, figs. 4a, 4b.
Upper Coal Measures: Nebraska City, Rock Bluff, Aspinwall, and Cedar Bluff, Nebr.
Coal Measures: Kansas, Missouri, Iowa, Illinois.

1873. *Straparollus (Euomphalus) subrugosus.* Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 607, pl. 29, fig. 11a–c.
Coal Measures: Springfield, Ill.

1874. *Euomphalus rugosus.* Meek, Am. Jour. Sci., 3d ser., vol. 7, p. 583.
Coal Measures: Illinois.

1884. *Euomphalus (Straparollus) subrugosus.* Walcott, U. S. Geol. Survey Mon. 8, p. 255, pl. 18, fig. 19.
Lower Carboniferous: Eureka district, Nev.

1884. *Euomphalus rugosus.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 161, pl. 32, figs. 11, 12.
Coal Measures: Indiana.

1888. *Euomphalus rugosus.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 241. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

1891. *Straparollus catilloides.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 255. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Straparollus catilloides.* Keyes, Missouri Geol. Survey, vol. 5, p. 160. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.; Atchison, Kans.

1903. *Euomphalus catilloides.* Girty, U. S. Geol. Survey Prof. Paper 16, p. 465.
Hermosa formation: San Juan region and Sinbads Valley, Colo.
Maroon formation: Crested Butte district, Colo.

1906. *Euomphalus rugosus.* Woodruff, Nebraska Geol. Survey, vol. 2, pt. 2, p. 282, pl. 15B, figs. 7, 8.

Carboniferous: Cedar Creek and Nehawka, Nebr.

1910. *Euomphalus catilloides.* Raymond, Carnegie Mus. Annals, vol. 7, No. 1, p. 157, pl. 25, fig. 5.

Brush Creek limestone: Donohoe, Pa.

Shell rather small, thin, discoidal, with flat sides, the volutions numbering 5 or 5½. On the interpretation that the shell is dextral the upper surface is generally rather strongly concave and the lower nearly flat, though in some specimens the concavity of the two sides is about equal.

The volutions have a generally quadrate section, more or less elongated in a radial direction and contracted toward the axis. The surface is sharply divided by two carinæ into lateral and upper and lower areas or zones. The lateral zone usually slopes somewhat outward from the upper carina but in some shells it is about vertical. It is traversed by two rather well marked narrow sulci, situated one near the upper and the other near the lower margin. The intervening band may be convex, in which case the sulci are conspicuous, or it may be flat, in which case they are not so noticeable. The upper and lower surfaces contract toward the axis. Each of these also is marked by a revolving groove or sulcus situated near the external border, the upper one usually nearer the edge than the lower. As a rule the lower carina is more prominent and is defined by sharper sulci than the upper, which in some specimens has more the appearance of an angle than a carina.

The surface is crossed by fine, sharp, transverse liræ which, toward the carinæ, become more or less prominent and fasciculate. The carinæ on some specimens are marked by rather well-developed nodes at somewhat distant and irregular intervals. On other specimens there are angular transverse ridges, more or less lamellose and connected with the fasciculation or exaggeration of the liræ. The two styles of ornamentation, in extreme cases rather strikingly unlike, appear to merge with one another. The lamellose or crenulated type has usually a closer arrangement than the nodose. These markings are entirely superficial, due to thickening of the shell, the internal section being rounded. As a rule they are more strongly developed on the upper carina than on the lower, the upper being nodose, and the lower somewhat crenulated, but the two carinæ may show similar characters. The lines of growth slope gently backward in passing around from the inner edge of the upper surface to the inner edge of the lower surface and are generally straight, though in some specimens slightly deflected by the carinæ and sulci.

The volutions are not indented by their contact and are usually arranged very neatly, without overlapping above or below, and with a distinct but linear suture. In some shells the union of the volutions was not so exact, the later volution being deflected upward or downward.

The earlier volutions appear to have been circular in cross section and to have been gradually but rapidly developed to the mature shape, which was assumed at an early period.

The following is Conrad's original description:

Inachus catilloides.—Discoidal; both sides concave from the outer margin to the center; all the volutions exposed, transversely wrinkled; large volution carinated on the margins; back obtusely carinated in the middle.

Length, three-eighths of an inch.

Locality.—Same with *Pleurotomaria tabulata* described above. [Inclined plane of the Allegheny Mountain.]

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Family PYRAMIDELLIDÆ.

The genera from the Wewoka fauna included in this family are Zygopleura, Holopea, Sphærodoma, Meekospira, and Bulimorpha.

Great differences of opinion exist as to the family relations of these genera, even between authors of works of high authority, such as Fisher's Manual of Conchology and Zittel's Textbook of Paleontology. Fisher recognizes two families, the Pyramidellidæ and the Pseudomelaniidæ; Zittel recognizes but one, placing the genus Pseudomelania in the Pyramidellidæ. Zittel refers Zygopleura and Loxonema to the Pyramidellidæ; Fisher refers Loxonema to the Pseudomelaniidæ but does not mention Zygopleura, which, as a division of Loxonema, would doubtless be placed with it in the same family. Neither author includes Sphærodoma in his work, but both recognize Macrocheilus (instead of Macrocheilina), Fisher referring it to the Pseudomelaniidæ and Zittel to the Pyramidellidæ. Both authors also omit Meekospira, and it is difficult to judge from other references where they would be likely to assign it. The type species was first doubtfully referred to Polyphemopsis, a genus which both Fisher and Zittel place in the synonymy of Subulites. Zittel in a manner includes Subulites in the Pyramidellidæ, at the same time suggesting, that with certain other genera, it represents a new family. With coincident view, apparently, Fisher recognizes a family, the Subulitidæ, in which he includes not only Subulites but Bulimorpha, which, together with Polyphemopsis, he regards as a synonym of that genus. Zittel does not mention Bulimorpha. The new family which he suggests, presumably the Subulitidæ of Fisher, was to include with Subulites also the genus Soleniscus; but Fisher refers Soleniscus not to the Subulitidæ but to the Pseudomelaniidæ.

I have in the main been following Zittel's classification in this work; but here, by reason of conflicting views and omissions on the part of my authority, it is difficult to adhere to him; therefore, while recognizing the fact that these genera probably represent more than one valid family, I am provisionally referring them to the Pyramidellidæ.

The status of Holopea is somewhat different. The relations of that genus are still in doubt, but both Zittel and Fisher agree in placing it provisionally with the Littorinidæ. I am provisionally extending Holopea to include a number of species which have a certain general resemblance to that genus, but which may prove, when more completely known, to belong to several genera. Some of these, at least, probably represent a type which it has been the custom to refer to Loxonema, and I have accordingly included Holopea with that genus in the Pyramidellidæ without, however, compromising authentic Holopea, which may be a distinct type and may have different zoologic relations.

Genus ZYGOPLEURA Koken.

The generic name Loxonema as applied to shells from the Carboniferous of North America includes a number of different types. One of the most well defined and easily recognized is that for which Koken in 1892 [1] proposed the genus Zygopleura. Zygopleura was said to be related to Loxonema but to be characterized by distinct transverse furrows, which do not have the sigmoidal shape of the liræ of Loxonema but are gently concave toward the aperture. The volutions are more or less arched.

In his monumental work on the fauna of the Carboniferous limestone of Belgium, De Koninck discriminated a great number of species of Loxonema, which seems to have shown remarkable variability, and he divides these into two groups, the *lævigata* and the *costata*. Among the latter are some which are not without claim to be referred to Koken's genus of Zygopleura. Although perhaps more readily distinguishable than the other types, one can, in a good series of species such as is figured by De Koninck, almost see how the plicated group (Zygopleura) is developed from the striated one (Loxonema s. s.). In fact, there are suggestions of two origins for the type of sculpture characterizing Zygopleura, the one by fasciculation of the usually fine liræ until the surface becomes marked by longitudinal grooves and ridges; the other by the development of a row of nodes, the progressive prolongation of which eventually produces a similar result.

In the American faunas all the Zygopleuras occur in Pennsylvanian rocks, just as all the typical Loxonemas occur in the Mississippian. To this genus may probably be referred the following species, some of which, as they have not been figured, are doubtfully included:

Zygopleura attenuata Stevens. Described as a Chemnitzia and referred to Loxonema by Weller. The whorls are said to exhibit numerous scooped-out indentations which are continued to the upper edge of each volution, giving at the suture a nodulated appearance. This seems to indicate one of the Zygopleuras, to which group the species is provisionally transferred.

[1] Neues Jahrb., 1892, vol. 2, p. 30.

Zygopleura cara Dawson. Described without figures as a Loxonema. From the description and comparisons apparently a Zygopleura.

Zygopleura multicostata Meek and Worthen. Described as a Loxonema and clearly a finely plicated member of the group for which the name Zygopleura was introduced.

Zygopleura parva Cox. Described as a Chemnitzia and referred to Loxonema by Weller. Specifically very closely related to the foregoing.

Zygopleura plebeia Herrick. Described as a Loxonema and closely related to *Z. multicostata*.

Zygopleura plena Herrick. Described as a Loxonema. A characteristic Zygopleura and the largest known from this continent.

Zygopleura plicata Whitfield. A very slender species described as a Loxonema.

Zygopleura rugosa Meek and Worthen. Described as a Loxonema and always cited as such.

Zygopleura scitula Meek and Worthen. Described and always cited as a Loxonema.

Zygopleura swallowiana Shumard. Described as a Chemnitzia but never figured. The description, however, indicates pretty clearly that the generic relations are with Zygopleura.

Zygopleura? terranovica Dawson. Described as a Macrocheilus and by Weller; doubtfully referred to Soleniscus. In shape this species appears to be made up of five strongly shouldered whorls and to have a rather broad spiral angle. The lower volutions are said to be marked each by 12 or 13 vertical ribs, more strongly developed at the suture and fading out below. This sculpture, which, as described, recalls that of the much slenderer species *Z. attenuata*, is not like that of any known form of Macrocheilus (Sphærodoma) or Soleniscus and is very suggestive of Zygopleura. This species and *Z. cara* seem to be exceptions to the statement that all the American Zygopleuras occur in Pennsylvanian rocks, but there is considerable doubt about *Z. terranovica* belonging to Zygopleura and I am not satisfied that all the limestones in Nova Scotia grouped with the Windsor formation as "Lower Carboniferous" really correspond to our Mississippian.

ZYGOPLEURA RUGOSA Meek and Worthen.

Plate XXV, figures 1, 1a.

1860. *Loxonema rugosa.* Meek and Worthen, Acad. Nat. Sci. Philadelphia Proc., p. 465. (Date of imprint, 1861.)
Upper Coal Measures: Springfield, Ill.

1866. *Loxonema rugosa.* Meek and Worthen, Illinois Geol. Survey, vol. 2, p. 378, pl. 31, figs. 11a–c.
Upper Coal Measures: Springfield, Ill.

1881. *Loxonema rugosa.* White, U. S. Geog. Surveys W. 100 Mer. Rept., vol. 3, Supp., Appendix, p. xxxv, pl. 3, fig. 7a.
Carboniferous: Near Taos and Coyote Creek, N. Mex.

Shell of medium size, elongate-conical, consisting of 8 or 9 volutions. Aperture less than one-third the entire height. Volutions rather regularly and strongly rounded. Suture depressed. Sculpture consisting of rather strong, subangular, longitudinal plications which are arranged so as to be more or less consecutive from apex to aperture. About 16 to 18 occur on each volution. The plications are direct or slightly oblique, dying down both toward the suture above and rather abruptly in the other direction a little below the middle; marked by growth lines, of which they may perhaps be considered fascicles. Aperture oval.

I can hardly doubt that the Wewoka fossils belong to Meek and Worthen's species, though they show some slight deviations from their description and figures. They are somewhat larger and consequently have one or two more volutions. The plications are perhaps a little more angular than Meek and Worthen apparently describe them, and the sides of the volutions a little more gibbous, so that the sutures are more depressed.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

ZYGOPLEURA MULTICOSTATA Meek and Worthen?

Plate XXV, figure 2.

1861. *Loxonema multicostata.* Meek and Worthen, Acad. Nat. Sci. Philadelphia Proc., p. 146. (Date of imprint, 1862.)
Coal Measures: Hodges Creek, Macoupin County, Ill.

1866. *Loxonema multicosta.* Meek and Worthen, Illinois Geol. Survey, vol. 2, p. 378, pl. 31, figs. 12a–c.
Coal Measures: Macoupin County, Ill.

1891. *Loxonema multicosta.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 260. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Loxonema multicosta.* Keyes, Missouri Geol. Survey, vol. 5, p. 206. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

A few specimens of Zygopleura in the Wewoka collection are distinguished by having very fine plications. Unfortunately all are fragmentary and the surface is so poorly preserved that the number of plications can not be counted, but there must have been at least 30 and perhaps nearly 40 on the last volution which is about 10 millimeters in diameter. The shell is robust and the longest specimen seen can hardly have been less than 24 millimeters in length or have had less than 8 volutions. The volutions are regularly and moderately rounded and the sutures are well defined.

The shape and general characters of this form ally it with *Zygopleura multicostata*, but my specimens indicate a larger size and distinctly though not much finer plications. Better material might show that it is a different species, but provisionally it may be referred to *Z. multicostata.*

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

ZYGOPLEURA PARVA Cox?

Plate XXV, figures 3–3b.

1857. *Chimnitzia parva.* Cox, Kentucky Geol. Survey Rept., vol. 3, p. 567, pl. 8, figs. 3, 3a.
Coal Measures: Daviess County, Ky.

1898. *Loxonema parvum.* Weller, U. S. Geol. Survey Bull. 153, p. 335.

1903. *Loxonema parvum?* Girty, U. S. Geol. Survey Prof. Paper 16, p. 460.
Carboniferous: Glenwood Springs, Colo.

Two specimens resemble *Zygopleura multicostata* in the fineness of the longitudinal plications but differ in having a wider spiral angle and in being considerably smaller. I am not sure, however, that they would not better be considered as a variety of that species than be identified even provisionally with *Z. parva*. They are as much larger than the latter species as smaller than the former, and the spiral angle is greater, though not to the same degree.

The specimens are so few and their condition so unsatisfactory that a proper disposition of them is hardly possible, whether it be identifying them with some known form or describing them as new.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

ZYGOPLEURA PLEBEIA Herrick?

Plate XXV, figures 4, 4a.

1887. *Loxonema* sp. Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 147, pl. 14, fig. 8 (*L. plebium* (n. sp.) in explanation of plate).
Coal Measures: Flint Ridge, Ohio.

Of this form our collections contain a single rather ill-preserved specimen. It is now 10 millimeters long but must have measured about 13 millimeters and have consisted of 8 or more volutions, the sides of which are rather flattened, so that the sutures are not as depressed as in some other species. The plications on the last volution number about 20. They are nearly direct and consecutive.

In so far as the evidence at hand is concerned I see no reason for separating this shell from *Z. plebeia,* though the affirmative evidence is not conclusive. In its slender shape it resembles *Z. plicata,* but it is much more finely plicated. From the associated *Z. rugosa* it is distinguished by its more slender shape and finer plications.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

Genus HOLOPEA Hall?

The generic name Loxonema has been made to include a great variety of forms. Even after the removal of species clearly belonging to other genera (such as Macrocheilus = Sphærodoma) the Loxonemas of the American Carboniferous faunas are very heterogeneous. Most of the species have a high spire composed of numerous rounded volutions, a short body whorl, and an oval or subcircular aperture. Among the shells to which Loxonema is thus applied three fairly distinct types can be distinguished, though these groups do not necessarily include all the species, nor have, with regard to one another, sharply defined boundaries.

One group, that of typical Loxonema, is marked with the characteristic sculpture of moderately coarse, regular, transverse liræ, which frequently have a sigmoidal course, being curved backward above and forward below. In many species the surface of the volutions is flattened or gently concave in the upper part. Very few Carboniferous shells from North America possess these characters and they are all of Mississippian age. Here belong probably *Loxonema delphicola* Hall, a Devonian species but cited by Herrick from the Waverly group, *L. difficile* Sardeson, and possibly *L. yandellanum* Hall.

Another group has rounded whorls, marked by retrally concave longitudinal plications, which do not extend to the suture above nor to the under portion of the volution. This group is distinguished from typical Loxonema especially by the fact that the sculpture is not sigmoidal and that it is usually very much coarser. Shells of this type have received from Koken the generic name Zygopleura. As noted on another page, there are 11 species which with varying certainty can be placed under Zygopleura.

Weller's bibliography recognizes 25 species of Loxonema, to which may be added several others that were omitted or that have been subsequently described. If from these there be removed the 3 typical Loxonemas and 11 Zygopleuras there remain 15 species of varied generic affinities.

The difficulty of distinguishing some of the Loxonemas, especially the smooth forms, from other genera, particularly Macrocheilus and Polyphemopsis, has always been apparent and troublesome. De Koninck says that Loxonema is easily separated by the elongate form and especially by the absence of the twisted callosity on the columella, and, where present, by the striæ and folds on the surface of the shell. It is, however, difficult to see any distinction between some of his Loxonemas and Macrocheilinas which name he uses as a substitute for the older but preoccupied term Macrocheilus. Meek points out [1] that Loxonema may be distinguished from Polyphemopsis by lacking the truncated base of the columella and by the striated surface. From Macrocheilus, according to the same author, it is distinguished by its usually more elongated spire, by its less callous inner lip without fold or ridge, and by its striated surface. It is not surprising, therefore, to find that a number of these species of Loxonema probably belong in fact to the groups for which the names Macrocheilus and Polyphemopsis have been used. Such species are:

Loxonema acutulum Dawson. Described as a Loxonema but not figured. An extremely slender species composed of 15 or more whorls which are marked with traces of 5 revolving lines. This species may be provisionally removed to Solenospira, if, as suggested by Ulrich, *S. attenuata*, *S. turritella*, and *S, vermicula* properly belong there, for to these *Loxonema acutulum* appears to be closely related.

[1] Meek, F. B., Illinois Geol. Survey, vol. 2, p. 373, 1866.

Loxonema bellum Walcott. Provisionally referred to Meekospira on account of the flattened volutions and elongated aperture.

Loxonema danvillense Stevens. Described without figures and never reidentified. The body whorl is said to be inflated and the pillar lip to have a slight fold. The generic relations therefore appear to be with Sphærodoma.

Loxonema halli Norwood and Pratten. A unique species which will probably some time be made the type of a new genus. Provisionally placed with Soleniscus because of the elongate and canaliculate anterior end of the aperture, though this may be accidental.

Loxonema nodosum Stevens. A puzzling species on account of the nodose surface. From its apparent shape (it was described without figures) and from its lack of a fold on the columella it is provisionally placed with Bulimorpha.

Loxonema politum Stevens. Like other species of Stevens, described but never figured. From the shape and from the slight fold on the columella probably a fusiform type of Sphærodoma.

Loxonema semicostatum Meek. First described as a variety of *Loxonema attenuatum* and then as an independent species. From the absence of plications on the lower half of the shell, it may be placed with Eustylus rather than Zygopleura.

Loxonema tenuicarinatum Stevens. From the shape and other characters mentioned by Stevens this might be regarded as a species of Sphærodoma, but the body whorl is said not to be inflated and the pillar lip to be without a fold. This suggests a provisional reference to Bulimorpha.

Loxonema tenuilineatum Shumard. Originally described as a Chemnitzia and referred by Keyes to Loxonema. The shape and the sculpture, which comprises revolving liræ with about 15 on the final volution, suggest Aclisina and I am assigning it to that genus.

There remain after the removal of these miscellaneous types six species which may be equally miscellaneous when their characters are completely known, but which agree in a general way in being more or less slender and many whorled, in having rounded volutions and deep sutures, and in being smooth or marked by only obscure or microscopic growth lines.

Forms similar to these have often been cited under Loxonema, forming a smooth section of the genus distinct from Zygopleura and Loxonema s. s. It seems to me that it would aid in the determination of species if Loxonema and Zygopleura were reserved for those types which are characteristic, the remaining smooth forms being retained under a separate generic name or distributed among other groups according to their intrinsic characters. Although recognizing the fact that no arrangement of these forms which even approaches finality can be made from the published figures alone, or even, for some of the forms, from specimens as imperfect as some of the actual types, I shall try to carry out this proposal.

In looking about for a genus which has the general characters mentioned above, it appears that Holopea, species of which have already been described from the Carboniferous of America, may best be used for the reception of such forms. It is true that some of the species transferred to Holopea have a rather higher spire than the typical ones, but except within certain limits this can hardly be made a generic character. Although the species are assembled in this way, it is with no understanding that all have close zoological relationships either with one another or with the Ordovician genus. They merely look alike—have many of the characters, or perhaps I should say the lack of distinctive characters, existing in the Ordovician and Carboniferous species alike. The most distinctive generic character of Holopea, the entire peristome, can not be determined from most of the descriptions and figures.

Holopea already contains five species from the Carboniferous of America, *H. conica*, *H. grandis*, *H. newtonensis*, *H. proutana*, and *H. subconica*.

H. grandis, however, is clearly not a member of the genus, differing not only in shape but in sculpture, for it is marked by a number of revolving costæ and the transverse liræ, as shown in the illustration, curve backward both from above and below, indicating a deep angular notch in the outer lip. On account of this character it can hardly be placed with Cyclonema, under which genus it might otherwise have been entered, but may provisionally be referred to Pleurotomaria in spite of the absence of a distinct slit band. The four remaining species have in a general way the characters of the six Loxonemas enumerated above, though each of them appears to present peculiarities incident possibly to their imperfect condition or to the position in which the specimen was posed for illustration.

Holopella furnishes some of the species which may be included in this group, but before these are discussed the genus itself may be considered. Holopella was briefly described by McCoy as follows: "Shell spiral, elongate, slender, of numerous gradually increasing whorls, generally crossed by slightly arched striæ; mouth circular, with the peristome entire; base rounded, with or without a minute umbilicus." A number of species are then cited, of which the first is *H. cancellata* Sowerby, which would naturally be taken as the type, but McCoy arranged his species alphabetically, and *H. cancellata* is marked by a few sharp, revolving liræ, a feature not possessed, I believe, by any of the other Holopellas, nor mentioned in the original description. It would be reasonable, perhaps, to pass over *H. cancellata* in selecting a genotype, for the remainder of the group is clearly more in accord with the generic diagnosis. If this is done, Holopella would appear to be merely a more elongate and attenuate type of Holopea. It would almost appear that McCoy introduced the name without a knowledge of Hall's genus. He does not refer to it, and certainly comparisons with Holopea are necessary, if with any genus. Nor does he give Holopea as the etymologic derivation from which he formed his generic name, but goes back to the original Greek words which Hall had used.

If, however, *H. cancellata* be taken as the type, Holopella to all appearances might be one of the Pleurotomarias, closely allied, perhaps, to Solenospira Ulrich. In view of this uncertainty, it seems desirable to neglect Holopella for the present in considering the nomenclature of American shells.

Only one American species has been referred to Holopella, *H. mira*, and this Mr. Weller regards as forming, with *Holopea conica* and *H. subconica*, two species mentioned above, a single specific group. The name *subconica* in fact seems to have been preoccupied by Hall.

From Macrocheilus may be included here a species which I provisionally referred to that genus with the specific name *micula*. It clearly does not belong to the Sphærodoma group but has rather the appearance of the present one. In fact, it is in miniature almost a representative of *H. newtonensis*.

But few American species have been described under or referred to Macrocheilina, but one of these, *M. modesta*, from the Guadalupe Mountains, appears to possess the characters of the present group. It much resembles the Kinderhook species *H. conica*.

Thus from different sources are assembled the following series of forms which may be advantageously kept together as a provisional, and doubtless intrinsically more or less artificial, group until more complete knowledge determines their real affinities. Then many of them will probably be removed to other genera.

Holopea blairi Miller. Described as a Macrocheilina and placed by Weller under Soleniscus? It closely resembles *H. proutana* and apparently was referred to Macrocheilina without substantial reason.

Holopea conica Winchell. Regarded by Weller as the same as *H. subconica* and *Holopella mira*. Described under the present genus.

Holopea cerithiiformis Meek and Worthen. Described as a Loxonema. A slender, many-whorled, high-spired type with little nodes along the suture. A Holopella according to Waagen, and doubtfully included here.

Holopea cooperensis Swallow. Described but never figured. The original reference was to Macrocheilus and Keyes placed it under Sphærodoma and later under Soleniscus, whereas Weller cites it as Sphærodoma. According to our very imperfect knowledge, it might better belong in the present group in close relationship with *H. conica*, *H. modesta*, and *H. proutana*.

Holopea fasciata King. A European species which Swallow cites as a Loxonema from Kansas. With probability proportionate to the closeness of his identification his species, which doubtless was not identical with the English one, was a fairly slender, many-whorled representative of the present group.

Holopea inconspicua Girty. Described as a Loxonema? A species closely related to that last mentioned.

Holopea keokuk Worthen. Described as a Polyphemopsis? and by Weller cited under Bulimorpha. A large species based on imperfect material which hardly deserves recognition and probably belongs to neither of the two genera mentioned, but is more likely a representative of the present group or else of typical Loxonema.

Holopea micula Girty. Described as a Macrocheilus but apparently belonging to the present group and closely related to *H. newtonensis*.

Holopea mira Winchell. Described as a Holopella and referred to the present genus by Weller, who regards it as identical with *Holopea conica* and *H. subconica*.

Holopea modesta Girty. Originally described as a Macrocheilina? In its specific characters much like *H. conica*.

Holopea newtonensis Whitfield. Originally described and always cited under this genus.

Holopea oligospira Winchell. Described as a Loxonema. Weller states that the surface is almost absolutely smooth and his figure seems to show a form congeneric with *H. conica*, though not specifically the same.

Holopea peoriensis Worthen. A slender species with numerous somewhat flattened whorls which clearly does not belong to Loxonema s. s. nor to Zygopleura, but is doubtfully included in the present group. It has always been known as a Loxonema.

Holopea permiana Beede. Described as a Loxonema and said to be related to the foregoing but almost too imperfect to deserve recognition.

Holopea proutana Hall. Always cited under this genus.

Holopea shumardiana Winchell. Described as a Murchisonia. Weller states that it clearly does not belong to that genus and refers it to Loxonema. Though larger, it seems to be closely similar to *H. conica* from the same group of rocks and to be congeneric with it.

Holopea subconica Winchell. Said by Weller to be the same as *H. conica*. The specific name was preoccupied by Hall.

Holopea subcorpulenta Whitfield. Described as a Macrocheilus and referred by Keyes to Sphærodoma. In shape it resembles *H. modesta*, *H. proutana*, and *H. shumardiana*. It is not clear why Whitfield referred this to a different genus from *Holopea newtonensis*.

Holopea turritiformis Hall. A species so imperfectly described (and without figures, too) as hardly to deserve recognition, but so far as the characters are known they are not at variance with the present group. The original reference was to Loxonema.

In shape these 19 species show a fairly continuous transition from broad-angled, low-spired forms like *blairi*, *cooperensis*, *micula*, *newtonensis*, *oligospira*, *proutana*, *shumardiana*, and *subcorpulenta* to very slender, many-whorled forms, like *cerithiiformis* and *peoriensis*. As to geologic age, it appears that most of these species belong in the Mississippian (13 in all) and that the Mississippian types comprise chiefly species with broad spiral angle and few whorls, while most of the slender, many-whorled types are Pennsylvanian or Permian, though with each are some which are more or less intermediate. Of the intermediate type occurring at the higher horizon *H. modesta* is an example, while *H. keokuk* and *H. turritiformis*, neither of which may really belong to the present group, are the Mississippian species which most clearly approach the *peoriensis* section. The slender, many-whorled, chiefly upper Carboniferous types might, perhaps, be regarded as more properly belonging in the genus Holopella, but it would be difficult to draw a generic separation between them and the others.

HOLOPEA PEORIENSIS Worthen?

1884. *Loxonema peoriensis*. Worthen, Illinois State Mus. Nat. Hist. Bull. No. 2, p. 7.
Coal Measures: Peoria County, Ill.

1890. *Loxonema peoriense*. Worthen, Illinois Geol. Survey, vol. 8, p. 139, pl. 23, figs. 10, 10b.
Coal Measures: Peoria County, Ill.

1903. *Loxonema? peoriense*. Girty, U. S. Geol. Survey Prof. Paper 16, p. 640, pl. 10, fig. 8.
Rico formation; San Juan region, Colo.

The unique specimen here under consideration is an internal mold and is scarcely deserving of detailed mention. It is a many-whorled, gradually tapering form, much like the species named above, but considerably smaller. The volutions are at present rounded and the sutures deep, but such may not have been the original condition. The height is 7 millimeters and the greatest diameter a little over 2 millimeters. About 10 volutions are preserved. The sutures are but slightly oblique and the volutions overlap little if at all.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus SPHÆRODOMA Keyes.

The shells of this group, most of which at one time or another have been cited under the generic title Macrocheilus, have presented difficulties to all the paleontologists who have dealt with them and have been the subject of wide differences of opinion. Meek and Worthen, who very carefully considered a number of American species, and to American species exclusively my own remarks refer, distinguished three groups, which they placed in the genera Macrocheilus, Polyphemopsis, and Soleniscus. To Soleniscus they referred but a single species and, while noting the general resemblance to Polyphemopsis and Macrocheilus in certain respects, they remark, "but the possession of a distinct canal and straight columella remove it widely from these genera."[1] The two other genera they recognized as standing mutually closer. Of Macrocheilus they say:

> The elongated species of this genus are not always easily distinguished from certain forms of Polyphemopsis, especially when the aperture and columella can not be seen. They, however, differ entirely in their thickened inner lip, usually provided with an obtuse fold, and in generally having the body whorl proportionally larger. They also differ in having a larger aperture, which is more rounded below.[2]

Regarding this same point they speak again under Polyphemopsis, as follows:

> Where the aperture and columella can not be seen, it is sometimes difficult to distinguish these shells from elongated forms of Macrocheilus, from which they differ in wanting the callosity and fold, or revolving ridge, of the columella, characterizing that type, and in the truncated base of the columella.

And again:

> The presence of an inner lip below the middle of the columella, of some species of this genus, is stated with doubt in our diagnosis because we have only seen it in one species (our *P. peracuta*), which may possibly not belong properly to this genus.[3]

Here it may be recalled that *Polyphemopsis peracuta* was later made by Ulrich the type of a new genus, Meekospira, in which he included also *P. nitidula* and *P. inornata*.

[1] Illinois Geol. Survey, vol. 2, p. 384, 1866. [2] Idem, p. 369. [3] Idem, p. 373.

Meek and Worthen gave especial consideration only to such species as came before them in connection with the State Survey of Illinois, but the investigation involved a careful consideration of their generic relationships. At a much later date Keyes attempted a revision of the whole American representation of these genera but seems to have based much of his study, as I have based much of mine, on the literature.

Keyes[1] arranges the species somewhat differently from Meek and Worthen. Their group of Polyphemopsis he retains but under the generic title Bulimorpha. Notably, he excepts *Polyphemopsis peracuta,* which he says manifestly does not belong to the Bulimorpha group. He retains it in the genus Polyphemopsis but adds that the original reference to Eulima is probably correct. The species which Meek and Worthen singled out and made the type of their new genus Soleniscus, Keyes unites with the forms which they called Macrocheilus, and the species thus assembled, together with species described under Macrocheilus and other genera by other authors, and not discussed by Meek and Worthen, he divides into two groups, characterized externally by shape, the one comprising globose, the other fusiform species. For the fusiform shells he employs the generic term Soleniscus, which thus is made to include Soleniscus and part of Macrocheilus as identified by Meek and Worthen, and for the globose ones he introduces the new term Sphærodoma, with *S. ponderosa* as the type, a species which, as *Macrocheilus primigenium,* Meek and Worthen included with the more slender forms in Phillips's genus. Keyes apparently at first included the entire series of forms under Soleniscus, distinguishing, however, two groups among them, but later restricted the name to the fusiform group, which is of the same general character as *Soleniscus typicus,* and proposed Sphærodoma for the other.

In this connection it may be said that it was not the typical *S. ponderosa* of Swallow which Keyes had in mind and which must be taken as the type of Sphærodoma, but a form finely illustrated by White and incorrectly referred by him to Swallow's species, which I believe to be identical with *S. primigenia* Conrad. The latter species then, if I am correct, becomes the type of Sphærodoma.

One conspicuous feature which Soleniscus has in common with many of the Macrocheilea is a pronounced fold on the columella. Of the two differences by which Meek and Worthen thought Soleniscus was widely separated from Macrocheilus, Keyes explained one, the anterior prolongation or canal, as due to breakage. He says:[2]

> By the removal of the lip the anterior portion of the shell seems more extended than in the unbroken specimen; and this feature was made unduly conspicuous by Meek and Worthen when they established the genus under consideration.

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[1] Keyes, C. R., Am. Naturalist, vol. 23, p. 420, 1889, pl. 20. Also Acad. Nat. Sci. Philadelphia Proc., p. 303, 1889.

[2] Am. Naturalist, vol. 23, p. 423, 1889.

The other imputed difference Keyes did not discuss and I am myself uncertain to what it refers. Meek and Worthen do not describe the columella of Macrocheilus as not being straight, though they do say,[1] "inner lip thin or wanting above the middle of the aperture, more or less thickened, and generally twisted into an obtuse fold below." But this latter structure appears to be homologous with that which in Soleniscus is described as a sharply elevated plate or fold on the columella. The callus on the inner lip, which, as in the quotation above, is said to be a feature of Macrocheilus but in the description of Soleniscus is said to be missing, Keyes reports as varying so greatly according to the state of preservation and the locality that only in a general way can it be relied upon as of generic importance.[2]

Keyes is probably correct in stating that although seldom noticed on account of the apertural part of the shell being filled with matrix, a more or less well defined columellar fold is observable in most of the shells hitherto called Macrocheilea. It also seems to be true, as noted by him and previously also by White, that the fold is scarcely discernible in the perfect shell until the outer lip is broken away when it is seen to become more and more pronounced as it passes inward from the aperture.

Keyes's description and remarks on the genus Sphærodoma are as follows:[3]

> The shells of the second section are subglobose, with the spire relatively very small, short; the whorls convex, very rapidly expanding, the last ventricose, and forming, by far, the greater part of the shell; aperture oval; columella thickened, sometimes exhibiting obsolete traces of an obtuse angularity; test comparatively much thinner than in Soleniscus. Typified by *Macrocheilus ponderosum* Swallow and *M. texanum* Shumard.
>
> The enormous size of the body-whorl compared with the spire and the undeveloped columellar fold readily distinguish this form from that of Soleniscus.

It seems to me that Keyes's statements as to the distinction between Sphærodoma and Soleniscus, as the latter genus is interpreted by him, are not fully warranted by the facts. It is true that the enormous size of the body whorl and the undeveloped columellar fold readily distinguish Sphærodoma from Soleniscus if only extreme examples like the typical species *Sphærodoma primigenia* and *Soleniscus typicus* are compared, but so many intermediate forms are already known that a practically complete gradation may confidently be looked for. To show how closely the two series approach each other, I would cite *Sphærodoma intercalaris*, which Keyes regards as a synonym of *S. medialis* and includes under Sphærodoma, and *Soleniscus altonensis*, which he includes under Soleniscus, two forms so nearly similar, as represented by Meek and Worthen's figures, that I am much disposed

[1] Illinois Geol. Survey, vol. 2, p. 367, 1866.
[2] Am. Naturalist, vol. 23, p. 423, 1889.
[3] Keyes C. R., Acad. Nat. Sci. Philadelphia Proc., p. 305, 1889.

to include them not only in the same genus but in the same species. As for the claim that the undeveloped columellar fold readily distinguishes Sphærodoma from Soleniscus, Keyes himself states that in Soleniscus this feature is hardly perceptible at the aperture; he also states that in 1881 White referred to Soleniscus two, and in 1884 five other species, which had originally been placed under Macrocheilus.[1] These include *Soleniscus? ponderosus, Soleniscus? primigenius, Soleniscus? texanus,* and *Soleniscus? medialis,* all cited by Keyes in his genus Sphærodoma and all placed by White in Soleniscus, because they do show the columellar fold which Keyes says is undeveloped in Sphærodoma. Then, too, *Soleniscus altonensis*, which shows no trace of a fold, is referred by Keyes to Soleniscus, and *Sphærodoma medialis* (or *S. intercalaris*) is placed by him in Sphærodoma, although the description states and the figures show the presence of an obtuse fold on the columella at the aperture itself. Furthermore, I do not believe that any such diversity of habitat as claimed by Keyes really exists; witness the varied form in the present fauna, all from the same formation, all apparently marine, yet some belonging to "Soleniscus" and some to "Sphærodoma." Indeed, my own general experience of these types fails to support Keyes's contention. Equally unsubstantiated by such observations as I have been able to make is his statement that the test of Sphærodoma is apparently much thinner than that of Soleniscus. In fact, the test of Sphærodoma is apt to be unusually massive. It would also be difficult to find any constant differences in the thickening of the columella (callus?) mentioned by Keyes as a character of Sphærodoma but not of Soleniscus.

In the shape and the relative height of the spire there appears to be gradation in these shells from one extreme to the other, if not complete at least without any strong interruption. It hardly needs to be stated that such a difference does not afford a practicable or valid basis for generic separation. In a large group it is often convenient to establish subgenera even if the fundamentals of division are not very important in themselves, so they be practicable, but the division suggested by Keyes under Soleniscus and Sphærodoma does not seem to me to be practicable, both because there is too much common ground, and because there is, in a manner of speaking, too much ground that is proper to neither. That is, the variations not only more or less bridge the gap between the type species of the two genera, but go off into collateral branches which can not with propriety be referred to either, if strictly interpreted.

Now, regarding the inclusion of any of these forms under Soleniscus, as based on *S. typicus*, it appears to me that the evidence, though not entirely convincing the other way, quite fails to justify Keyes's course. As pointed out by Meek, the diagnostic feature of Soleniscus, aside

[1] Am. Naturalist, vol. 23, p. 420, 1889.

from its elongate fusiform shape, must be regarded as the possession of a distinct canal at the produced anterior end of the aperture, and I believe that Meek was too familiar with fossil shells and their occurrence to be easily misled by a broken specimen and too accomplished a conchologist to give a false value to a character thus observed. I shall for the present, therefore, accept his dictum in both particulars. In a careful consideration of the species which Keyes has assigned to Soleniscus, I fail to find any which has the produced canaliculate anterior extremity of Soleniscus. Some species appear to be conspicuously the other way, such as *S. altonensis*, *S. gracilis*, and *S. humilis*. Some have never been figured, and their characters are imperfectly known on that account. Still others, and perhaps the greater number, were figured from imperfect specimens, which did not show the character in point. It is, however, not without significance that these imperfect specimens are as a rule not broken along the outer lip so as to suggest the false appearance of being produced in front, as Keyes implied was the case with the typical material of Soleniscus, but are broken along the anterior extremity, so as to give them a broadly rounded outline and conceal their true character altogether. Some of these may, consequently, prove to be true Solenisci.

In the end, therefore, I find myself about where Meek left the discussion in 1866, with a large, varied, but in the main indiscriminate group of species (Meek's Macrocheilus), and another type, to which at present only a single species can perhaps be safely referred, his Soleniscus.

I can not, however, agree with Meek in the matter of nomenclature. Many generic names have been employed for these shells and in a brief review of the most important of them I may begin with the best known, that used by Meek and Worthen.

Macrocheilus Phillips 1841. Phillips proposed Macrocheilus in 1841[1] tentatively and without description for some shells generally referred to Buccinum. He mentioned a number of species as belonging more or less possibly to the genus, but designated none as the type. As a consequence the name was left very much in the air, some of the species so mentioned really belonging to Naticopsis and others to Loxonema. It is rather fortunate, therefore, that the name had been preoccupied in 1838, for a genus of Coleopterous insects. This was noticed by Meek,[2] who, however, continued to use Macrocheilus for the molluscan type. In 1879 Bayle[3] proposed Duncania as a substitute for Macrocheilus (type *D. arculata*), but finding that that name also was preoccupied, he substituted Macrocheilina in 1880.[4] Therefore Macrocheilus with its uncertainties is swept away and we have Macrocheilina covering to some extent the same ground, fixed by a definite genotype. Schlotheims's figures of *Buccinites arculatus* show a turreted shell of the general appearance of some of the Solenisci rather than the Sphærodomæ (to continue the use of these terms in their Keyesian application). A conspicuous

[1] Pal. Foss. Cornwall, 1841, p. 103.
[2] Illinois Geol. Survey, vol. 2, p. 369, 1866.
[3] Jour. de Conchyliologie, vol. 19, p. 35, 1879.
[4] Idem, vol. 20, p. 241, 1880.

feature of the configuration is a narrow shelf-like platform, nearly horizontal in direction, extending outward from the suture and joining in an angular, more or less nodulose shoulder, the ample lateral portion of the volution. Other illustrations of *M. arculata* represent this character much less distinctly, however, and so far as it is concerned the difference between Macrocheilina and Sphærodoma may be trivial. Correlated with this the figure contains suggestions of a notch at the posterior end of the aperture. The anterior end is somewhat effuse but not canaliculate. No callus is represented in the drawing and no fold on the columella, except possibly a faint suggestion. With one exception, *M. angulifera* White, all the American Macrocheilea are without any trace of this peculiar angle near the suture, but that one species possesses it in a striking degree. Provisionally this species can be referred to Macrocheilina. Several species of other groups, however, share this peculiarity of form, one of which, *M. danvillensis* n. sp., a form incorrectly identified by Meek and Worthen with Stevens's *Loxonema minutum*, I am provisionally referring to Macrocheilina. *Bulimorpha canaliculata* is another species of similar conformation, not to go farther afield and mention *Pleurotomaria inornata* and *P. perhumerosa*.

Duncania Bayle 1879. Preoccupied. See discussion under Macrocheilus.

Macrocheilina Bayle 1880. Substituted for Duncania. See discussion under Macrocheilus.

Plectostylus Conrad 1842.[1] As pointed out by Meek, this genus was founded upon internal molds of one or two species of "Macrocheilus," but Plectostylus was preoccupied by Beck in 1837 for another group of mollusks.

Soleniscus Meek and Worthen 1860. As already noted, Keyes, though I believe unwisely, expanded Meek and Worthen's term Soleniscus to include a number of species of "Macrocheilus" which I find necessary to remove from that genus and restore to their original grouping, thus restricting Soleniscus nearly to its original content, the single species, *S. typicus*. With it may be provisionally associated *Soleniscus glaber* Cumings and *Soleniscus* [*Loxonema*] *halli* Norwood and Pratten. The latter species would be incongruous with any group of American Carboniferous shells, and will probably find place in a new genus.

Sphærodoma Keyes 1889. Proposed for the more globose type of "Macrocheilus." The separation, however, proved to be artificial, and as the union of the more slender species with Soleniscus does not seem desirable, Sphærodoma is here expanded to cover the entire group of fusiform as well as globose species. It seems necessary to adopt Keyes's term for the group; however, should his interpretation of Soleniscus, which is here rejected, prove correct, that name would supplant Sphærodoma, unless, indeed, it should itself be supplanted by some name not here reckoned with, or by Macrocheilina.

In the present use of the term, therefore, Sphærodoma includes Soleniscus as interpreted by Keyes, exclusive of typical Soleniscus, together with his new group Sphærodoma; or, in other words, it includes the Macrocheilea of Meek and Worthen and other authors. In his bibliography Weller has adopted and carried out Keyes's determination of genera and species in this group and he recognizes 20 species of Soleniscus and 10 species of Sphærodoma.

Of the 10 species cited by Weller under Sphærodoma, I am excluding in this revision only three—*S. cooperensis*, *S. littonana* var. *genevievensis*, and *S. subcorpulenta*.

[1] Acad. Nat. Sci. Philadelphia Jour., 1st ser., vol. 8 (1839-1842), p. 275, 1842.

Sphærodoma cooperensis Swallow. This species was originally described as a Macrocheilus but was subsequently placed by Keyes under Sphærodoma and later under Soleniscus. No figures have ever been given and the description affords a most inadequate basis for referring it to its proper genus. Partly from the convexity of the whorls and partly from the apparent rarity of Sphærodoma in this country in the earlier horizons of the Carboniferous, it seems more probable to me that this is a representative of the group to which I am provisionally referring it, namely, Holopea.

Sphærodoma littonana var. *genevievensis* Meek and Worthen. This variety was originally described as *Naticopsis littonana* var. *genevievensis*. *Natica littonana* Hall seems to be a true Sphærodoma and this variety was included by Keyes in the synonymy of that species but was written separately by Weller in his bibliography. It seems to me, however, that Meek and Worthen were in fact dealing with a Naticopsis and were misled by wrongly identified specimens of *Natica littonana* which at that time had never been figured. They probably had *Natica carleyana*, which was described at the same time from the same locality. It is true they say that their species resembles authentic specimens of *Natica littonana* from the original locality, but, on the other hand, they state that it is a true Naticopsis, a mistake they would hardly have made if they had been referring to a Sphærodoma. They mention the callus of the inner lip, a feature prominently shown in Whitfield's figure of *Naticopsis carleyana* but absent from his figure of *Sphærodoma littonana*, and their entire description reads like that of a Naticopsis rather than a Sphærodoma.

Sphærodoma subcorpulenta Whitfield. This species first described as a Macrocheilus was later removed by Keyes to Sphærodoma. As figured by Whitfield, however, the shape and the configuration of the aperture are not those of Sphærodoma, but agree much more closely with the group of species which I am tentatively including under Holopea.

Of the 20 species cited by Weller under Soleniscus, I am retaining only one, *S. typicus*, under that generic title, but I am not referring all the others to Sphærodoma, *S. angulifer*, *S. blairi*, and *S. terranovicus* being placed under other genera.

Soleniscus? angulifer White. Described as a Macrocheilus. The shape with an angular shoulder a little below the suture, if the shape is generically characteristic, is that of Macrocheilina, and in that genus I am provisionally placing it. Certain Pleurotomarias, however, have a similar configuration.

Soleniscus? blairi Miller. Described as a Macrocheilina but apparently having neither the configuration of typical Macrocheilina nor the apertural structures of Macrocheilus (Sphærodoma). It is transferred to Holopea, to which group it apparently belongs so far as its characters are known.

Soleniscus? terranovicus Dawson. Referred by Dawson to Macrocheilus and by Weller to Soleniscus. This species has never been illustrated, but the description states that it is conical in form with five strongly shouldered volutions, of which the lower ones are each marked with 12 or 13 vertical ribs, more strongly developed at the suture and fading out below. This clearly does not describe a shell related to any known form of Sphærodoma, suggesting rather Zygopleura among the genera of our Pennsylvanian faunas.

These references to Sphærodoma and Soleniscus are mostly secondary. The content of this group as here constituted has been drawn from several original sources. I am recognizing 30 species of

Sphærodoma, of which Bulimorpha has furnished 1, Loxonema 5, Macrocheilina 2, Macrocheilus 16, Natica 1, Plectostylus 1, Polyphemopsis 1, Soleniscus 2, and Stylifer 1.

The species of Loxonema were described mostly (but not figured) by Stevens. A few have been figured by later writers and recognized as belonging to the present group, and I have added several others. Stevens's descriptions make it fairly clear that most of the forms in question could not have belonged to Loxonema but must have had the configuration of Soleniscus, Sphærodoma, Bulimorpha, or Meekospira. As between these genera the determination has been difficult, but most doubtful species have been assigned to the two genera Bulimorpha and Sphærodoma. Fortunately, in several of his descriptions Stevens noted that the columella bore a fold and in others that it was smooth. The inference would be that specimens of the former sort belong in Sphærodoma and of the latter in Bulimorpha, but the twisting of the columella may not have been observed, for in many specimens it is imperfectly developed at the aperture. A similar uncertainty exists in a number of species other than Stevens's, but the characteristic structure has been observed in many of the forms referred here. Doubtless a mutual transfer of species between this and some of the genera mentioned above will be made as the characters of the species become better known.

The following is an annotated list of species from the Carboniferous of North America which can provisionally be cited under the genus Sphærodoma. I shall here deal practically with original descriptions only, but it should be noted that many subsequent citations have been so lax that the synonymy of each species will probably need to be critically examined:

Sphærodoma alvensis Beede. Described as a Bulimorpha, but with a suggestion pointing to Macrocheilus (Sphærodoma). So imperfectly known as to be unidentifiable.

Sphærodoma brevis White. Described under Soleniscus. I do not agree that this is the same as *S. ventricosa* and am retaining both species.

Sphærodoma carinata Stevens. Described but never figured, and originally referred to Loxonema. It clearly belongs to the present group as was recognized by Keyes. The angulation near the suture would give a configuration like that of Macrocheilina, but it is said to have a distinct fold on the columella. The minute form incorrectly identified by Meek and Worthen with *Loxonema minutum*, another of Stevens's species, seems to be shaped much as *S. carinata* is described. Hall, however, who had the opportunity to examine the types of both species, regarded *S. carinata* and *S. newberryi* as the same.

Sphærodoma danvillensis Stevens. Described as a Loxonema, but clearly not a representative of that genus. The pillar lip is described as having a slight fold and the relations are probably with Sphærodoma.

Sphærodoma fusiformis Hall. Described as a Macrocheilus on rather poor material. Some much better specimens figured by White, very similar to Hall's type and probably closely identified, show an extensive callus on the inner lip and the distinctive fold on the columella.

Sphærodoma glacilis Cox. Originally referred to Macrocheilus. The figure does not show a fold on the columella, but indicates a callus on the inner lip.

Sphærodoma hallana Geinitz. Described under Macrocheilus and closely related to *S. fusiformis*.

Sphærodoma hildrethi Conrad. Originally described as a Plectostylus but probably belonging in this group, as suggested by Weller, though not represented with a fold on the columella. This is probably the same species as *S. medialis* Meek and Worthen and *S. inhabilis* Morton, which was described from about the same horizon and from a locality not very remote.

Sphærodoma humilis Keyes. Described under Macrocheilus and later referred to Soleniscus.

Sphærodoma intercalaris Meek and Worthen. Originally described as *Macrocheilus intercalare*. The columellar fold in this species seems to be very feebly developed, but the callus is large. I am including Worthen's *Soleniscus altonensis* in the synonymy of this species.

Sphærodoma kansasensis Swallow. First described as a Macrocheilus and referred by Keyes, probably correctly, to this group. It has never been figured, but appears to belong to the group of *S. intercalaris*. The columellar fold is not mentioned in the description.

Sphærodoma keyesi Rowley. Originally referred to Macrocheilina, and probably belonging in the present group.

Sphærodoma klipparti Meek. Described as a Macrocheilus and referred by Keyes to Soleniscus.

Sphærodoma littonana Hall. Described as a Natica, but later removed to Macrocheilus and then to Sphærodoma, where it seems properly to belong. The species described by Meek and Worthen as *Naticopsis littonana* var. *genevievensis*, however, is almost surely a true Naticopsis.

Sphærodoma medialis Meek and Worthen. Described as a Macrocheilus, but later referred by White to Soleniscus and then by Keyes to Sphærodoma. It is distinguished by its well-developed callosity and obsolete columellar fold. I am provisionally regarding *S.* (*Fusus*) *inhabilis* of Morton as a synonym of this species, and *S.* (*Plectostylus*) *hildrethi* may also belong here. Both names were introduced long before *Macrocheilus mediale*, the oldest being *inhabilis*, but as the specific identity of these forms is still somewhat questionable, I am retaining Meek and Worthen's name, which was furnished with so much better description and illustration.

Sphærodoma melanoides Whitfield. Originally described as a Polyphemopsis and so a priori transferable to Bulimorpha (or Meekospira) with the other American species of Polyphemopsis. This transfer has in fact been made by Weller, but as the species is described as effuse below, and so far as could be observed with a twisted columella, it seems more likely that it is a Sphærodoma.

Sphærodoma missouriensis Swallow. Described but never figured. The original reference was to Macrocheilus, but Keyes transferred it to Soleniscus. The type specimen seems to have been an internal mold and the description is so poor that the species hardly deserves recognition.

Sphærodoma newberryi Stevens. Described as a Loxonema by Stevens and not figured by him, a deficiency later supplied by Hall and by White. Their figures represent apparently the same species, but it is somewhat doubtful whether this is the same as Stevens's *S. newberryi*, which seems to be a more slender form than their figures show, one more like *S. fusiformis*. Hall, however, after examining the type specimens of *S. newberryi* and *S. carinata*, was unable to find any specific distinction either between these two species or the specimen which he figured as the former. Stevens's and Hall's descriptions mention and White's figures show the characteristic folded columella of Sphærodoma.

Sphærodoma paludiniformis Hall. Described under Macrocheilus and later referred to Soleniscus. A specimen smaller than Hall's but probably conspecific with it, was figured by White with the characteristic columellar folds of the genus. Hall remarks: "The genus Plectostylus of Conrad was founded upon a cast which very much resembles the cast of this species, and should it prove identical the name *Macrocheilus hildrethi* will supersede the present one." Conrad's figure, however, differs very markedly from that of Hall.

Sphærodoma pinguis Winchell. First called a Macrocheilus and subsequently referred by Keyes to Sphærodoma, the type of which it much resembles.

Sphærodoma planus White. This species was described as a Soleniscus and has always been cited under that genus. It is related to *S. newberryi* and *S. fusiformis*.

Sphærodoma polita Stevens. Described but never figured, the original reference being to the genus Loxonema. The possession of a slight fold on the labium seems to warrant a reference to Sphærodoma, of which it appears to be a small fusiform type related to the foregoing.

Sphærodoma ponderosa Swallow. This species was not figured by Swallow and is best known from figures given by White. White, however, seems to have had a distinct and more ventricose form, one probably identical with *S. primigenia* Conrad. True *ponderosa* seems to be more similar to *S. intercalaris;* though misinterpreted, it belongs without much question to the present genus.

Sphærodoma primigenia Conrad. The original reference was to Stylifer, but Hall later referred it to Macrocheilus, whence its transfer to the present group was easy and correct. The synonymy of this species, which is quite complicated, is given in another place. It comprises citations of *S. ponderosa*, *S. texana*, and other species. It is on specimens of this species, incorrectly identified with *S. ponderosa*, that the genus Sphærodoma is based.

Sphærodoma regularis Cox. This is the most slender and high-spired member of the genus. Owing to the excessive height of the spire, it might readily pass for a Meekospira, to which reference Cox's figure and description, neither of which indicates the presence of a fold on the columella, would lend some color. Whitfield, however, has illustrated a specimen, probably belonging to Cox's species, though showing some differences from his figure, in which this character is well developed.

Sphærodoma stinesvillensis Cumings. Described under Macrocheilus, but probably belonging in this group.

Sphærodoma tantilla Rowley. Originally referred to Macrocheilina, but probably a Sphærodoma.

Sphærodoma texana Shumard. As in the case of *S. ponderosa*, this species was not figured by its author and subsequent identifications have been, there is scarcely room for doubt, incorrect. They probably are based merely on young specimens of *S. primigenia*. The original reference was to Macrocheilus and the removal to Sphærodoma appears to be safe.

Sphærodoma ventricosa Hall. By later writers this species has been regarded as identical with *S. brevis* of White, but, I believe, erroneously, and I am retaining both names. *S. ventricosa* (originally Macrocheilus) is described as having a callosity on the inner lip, but mention is not made of a columellar fold.

Sphærodoma worthenana Miller. This species was described by Worthen as *Macrocheilus altonensis* and was later renamed *Macrocheilina worthenana* by Miller because of *Macrocheilus* (*Macrocheilina*) *altonensis* previously described by the same author. As the latter species is probably the same as *S. intercalaris*, it may be desirable to return to the original appellation for the present form. In fact, it is not certain that it really belongs in Sphærodoma.

Grouped according to geologic age, 23 of these species (including one Permian form) belong in the Pennsylvanian, leaving only 7 in the Mississippian. Grouped according to shape, species having the gibbous subspherical outline typical of the genus are much in the minority. This type appears, however, to occur in both the Mississippian and Pennsylvanian, being represented in the early Mississippian by *S. pinguis,* in the late Mississippian by *S. littonana,* and in the Pennsylvanian by *S. primigenia,* etc.

For convenience the species of Sphærodoma may be assembled into groups, though many of the assignments must be largely a matter of personal judgment. I have distinguished a number of groups based on the proportional height of the spire and body whorl, the degree of inflation of the body whorl, and such characters.

Group of *Sphærodoma primigenia* (subspherical shells with low spire and inflated body whorl): *S. brevis, S. hildrethi, S. littonana, S. medialis, S. pinguis, S. primigenia,* and *S. texana.*

Group of *Sphærodoma intercalaris* (fusiform species with rather low spire and moderately gibbous body whorl): *S. alvensis, S. hallana, S. humilis, S. intercalaris, S. kansasensis, S. ponderosa,* and *S. stinesvillensis.*

Group of *Sphærodoma fusiformis* (elongated species with high spire and relatively short body whorl): *S. fusiformis, S. melanoides,* and *S. worthenana.*

Group of *Sphærodoma klipparti* (fusiform shells with many deeply embracing, gently convex whorls, forming a high spire but at the same time a rather long body whorl): *S. danvillensis, S. klipparti, S. missouriensis, S. newberryi, S. paludiniformis, S. plana,* and *S. polita.*

Group of *Sphærodoma regularis* (form very elongated, consisting of numerous gently convex, deeply embracing volutions, forming a very high spire and fairly long body whorl): A single representative, *S. regularis,* might be considered an extreme example of the *fusiformis* group, or, on the other hand, an aberrant representative of the *klipparti* group. In either, however, it appears considerably out of place.

Group of *Sphærodoma gracilis* (species with a rather short gibbous body whorl and moderately long, slender, many-whorled spire): *S. gracilis, S. keyesi, S. tantilla,* and *S. ventricosa.*

Group of *Sphærodoma carinata* (elongated species with a carina near the spire, apparently with the peculiar configuration of Macrocheilina):[1] *S. carinata.*

Sphærodoma brevis White.

Plate XXIV, figures 8–12a.

1881. *Soleniscus brevis.* White, U. S. Geog. Surveys W. 100 Mer. Rept., vol. 3, Supp., Appendix, p. xxviii, pl. 4, figs. 5a–c.

Carboniferous: Coyote Creek; north of Black Lake; and near Taos, N. Mex.

[1] Stevens's description seems to indicate something of the sort. At the same time, Hall, who saw the type specimen, regarded *S. carinata* as of the same species as *S. newberryi,* which, of course, does not have the Macrocheilina shape. According to Hall's statement, *S. carinata* would be, if not a synonym of *S. newberryi,* at least a member of the same group.

1884. *Soleniscus (Macrocheilus) ventricosus.* White, U. S. Nat. Mus. Proc., vol. 6 p. 187, pl. 8, figs. 11, 12.
Carboniferous: Illinois.
1884. *Soleniscus (Macrocheilus) ventricosus.* White, Indiana Dept. Geology and Nat., Hist. Thirteenth Ann. Rept., pt. 2, p. 155, pl. 34, figs. 11, 12.
Coal Measures: Illinois, Iowa, and New Mexico.
1889. *Soleniscus brevis.* Keyes, Am. Naturalist, vol. 23, p. 423, pl. 20, figs. 12, 14. (Date of imprint, 1890.)
1889. *Soleniscus brevis.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 307.
1895. *Soleniscus brevis.* Keyes, Missouri Geol. Survey, vol. 5, p. 212. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City and Clinton, Mo.

Sphærodoma brevis was described by White under the genus Soleniscus from fossils obtained at Coyote Creek and near Taos, N. Mex. He compared it with *Macrocheilus ventricosum* Hall, but concluded that it belonged to a different genus because it possessed a strong fold on the columella. On discovering later that this feature was present also in Hall's species he placed it in synonymy. White has perhaps included more than a single species in this group, but none of these, or at all events not the typical one, has the characters of true *ventricosa*, as represented by Hall's figure. The peculiarity distinctive of *Sphærodoma brevis* to which White refers is the unequal increase which makes the sides of the spire concave and the final volution exceedingly ventricose. Therefore I would say that *S. brevis* was distinguished from *S. ventricosa* by having the body whorl more inflated, and the spire lower, composed of fewer volutions, and with concave sides instead of tapering regularly.

The specimens figured by White, which are five in number, three from New Mexico and two from Illinois, present certain differences among themselves. Figure 5b of the western type clearly is more nearly spherical than 5a and has a somewhat lower spire, and the Indiana specimen (Pl. XXIV, fig. 11) is still more gibbous than 5b and the spire is a trifle less concave in outline. Provisionally all three forms may be retained under *S. brevis*, but in case of a subdivision I propose to restrict the name to the specimen represented by 5b from New Mexico.

The specimens from the Wewoka formation are rather numerous and range in length to 22 millimeters, distinctly larger than the largest specimen figured by White. The average, however, is much smaller and in general this may be called a small species. The shape also varies; the majority of specimens are strongly globose; few are as slender as the most fusiform of White's specimens and the identification of these is provisional. In nearly all the specimens there is shown on the axis below the middle of the aperture a rather strong fold with a groove above it. Above the aperture as many as seven volutions can be counted. The volutions, at least the final volution, have the most prominent portion well up toward the suture so that the final one appears more or less flat on top.

S. brevis does not present great differences from *primigenia* and, on the other hand, graduates more or less completely into the elongated form, distinguished below as a variety which, in turn, is not sharply separated from *S. intercalaris*. Possibly the variety would better be regarded as a modification of the latter species, to which it stands in somewhat the same relation that *S. brevis* itself does to *primigenia*.

This form greatly resembles *Natica ventrica* Norwood and Pratten, and I should with considerable confidence refer my specimens to that species but for the fact that Norwood and Pratten describe a certain system of sculpture on the upper part of the volutions which is entirely lacking in the fossils under discussion. In addition it may be noted that those authors place *Macrocheilus inhabile* and *Natica ventrica*, which they describe and figure on the same page and plate, in different genera, whereas the identification of my shells with the latter species would show them to be congeneric.

In passing, I may again direct attention to the remarkable uncertainty which surrounds this species (*N. ventrica*). In the first place the name was originally written *Natica ventrica*, as above, and not *ventricosa*, as currently cited. Under the title *Naticopsis ventricosa* Meek and Worthen figure a shell having altogether different characters from those shown by Norwood and Pratten's figures, stating that their specimen was borrowed from Prof. Cox, who had also lent it to Norwood and Pratten, by whom it was used as the type of *Natica ventrica*. Meek and Worthen's figures are so unlike Norwood and Pratten's however, that it is inconceivable that they were drawn from the same specimen. There is evidently a mistake which at the present time it is impossible to explain, and it seems best to cite Meek and Worthen's form as *N. pricei*, with which they felt sure that it was identical, and to regard *N. ventrica* as an altogether different species based upon Norwood and Pratten's descriptions and figures. Keyes figures a still different form as *Natica ventricosa*, but this is through an inadvertence, the figure of *N. ventrica* copied from Meek and Worthen being cited as *Naticopsis* (*Isonema*) *humilis*, and the figure of the latter being cited as *Natica ventricosa*. I may also add that Meek and Worthen include in the synonymy of *N. ventrica* the species *N. pricei*, to which Weller in his bibliography gives separate entry; and that Weller cites *N. magister* Stevens as a synonym under *N. ventricosa*, this also being an inadvertence, I suspect, *magister* having been written instead of *pricei*. From Stevens's description *N. magister* seems to have different characters, as it is also a very much larger species and one which occurs associated with a Mississippian instead of a Pennsylvanian fauna.

On the whole I am inclined to believe that *N. ventrica* of Norwood and Pratten is distinct from the form figured by Meek and Worthen, which may provisionally be cited under *N. pricei*, a species, however, that is likely to prove a synonym of *N. altonensis*, as suggested by Keyes. It seems probable that *N. magister* is a still different species. While noting the very close resemblance of my shells to *N. ventrica*, I am forced to conclude that the latter is not a Sphærodoma, to which group mine without question belongs.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001 and 2004).

SPHÆRODOMA BREVIS var.

Plate XXIV, figures 7, 7a.

A few specimens there are which resemble *Sphærodoma brevis* in having a slender and more or less concave-sided spire but differ from it in being distinctly less globose. Such as have thus far come to hand are rather imperfect but in so far as their characters are shown they resemble the slender specimen [1] which was included under *S. brevis* when the species was first described. They may be provisionally referred to the same species and a varietal separation, also provisional, may be established for them. The present material is too imperfect to serve as basis for a new name.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (station 2004).

SPHÆRODOMA GRACILIS Cox.

Plate XXIV, figures 3, 3a.

1857. *Macrocheilus gracilis.* Cox, Kentucky Geol. Survey Rept., vol. 3, p. 570, pl. 8, figs. 11, 11a.
Coal Measures: Bonharbour, Daviess County, Ky.

1888. *Macrocheilus gracilis.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 239. (Date of imprint, 1889.)
Lower Coal Measures: Des Moines, Iowa.

?1888. *Macrocheilus paludinæformis.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 4, p. 122, pl. 11, fig. 10.
Coal Measures: Fultonbow, Ohio.

?1889. *Soleniscus gracilis.* Keyes, Am. Naturalist, vol. 23, p. 423, pl. 20, fig. 6.

1889. *Soleniscus gracilis.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 307. (Date of imprint, 1890.)

1891. *Soleniscus gracilis.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 262. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Soleniscus gracilis.* Keyes, Missouri Geol. Survey, vol. 5, p. 211. (Date of imprint, 1894.)
Lower Coal Measures: Clinton, Mo.

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[1] U. S. Geog. Surveys W. 100th Mer. Rept., vol. 3, Supp., Appendix, p. xxviii, fig. 5a.

The single specimen concerned in this identification shows the following characters: The size is small; the height, when complete, must have been about 7½ millimeters and the greatest diameter is about 4½ millimeters. The height of the aperture is 4 millimeters or a little less, and the height of the spire above the last volution almost 3 millimeters. The volutions are rather strongly convex and the sutures correspondingly deep. The volutions number 7 or possibly 8.

I am not sure that *S. gracilis* is not a variety or an immature condition of *S. ventricosa.* It seems to differ, however, aside from shape, in having a somewhat higher spire and volutions shorter in proportion to their breadth and more strongly ventricose. Similar differences exist between the Wewoka specimen and others from the same beds referred to *S. ventricosa.* Cox's figure represents the inner lip as covered the entire length by a callosity, but without a columellar fold. The Wewoka specimen does not exhibit any distinct callosity, but there may have been a fold, now obscured by the breaking away of the lower portion of the aperture. Cox's figure shows a callosity comparable to that of *S. medialis* and at present I know of no reason why this species should not be included in the Soleniscus-Sphærodoma group, as has been done by Keyes.

Of the numerous citations by Keyes, only one is accompanied by a figure, and that is so different from the figure given by Cox as to leave much doubt as to the correct identification of Keyes's form. On the other hand, Herrick's figure of a shell from Fultonham, Ohio, is so unlike *S. paludiniformis,* to which he referred it, and so similar to the present species, that I am provisionally citing it in this synonymy.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

SPHÆRODOMA INTERCALARIS Meek and Worthen.

Plate XXIV, figures 1–2a.

1860. *Macrocheilus intercalaris.* Meek and Worthen, Acad. Nat. Sci. Philadelphia Proc., p. 467. (Date of imprint, 1861.)
Upper Coal Measures: Springfield, Ill.

1860. *Macrocheilus pulchellus.* Meek and Worthen, idem, p. 467.
Upper Coal Measures: Springfield, Ill.

1866. *Macrocheilus intercalaris.* Meek and Worthen, Illinois Geol. Survey, vol. 2, p. 371, pl. 31, fig. 6a, 6b.
Upper Coal Measures: Springfield, Ill.; Pittsburgh, Pa.

1872. *Macrocheilus intercalaris* var. *pulchellus.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 228, pl. 6, fig. 8.
Upper Coal Measures: Near Nebraska City, Nebr.; Springfield, Ill.
Coal Measures: Pittsburgh, Pa.
Lower Coal Measures: West Virginia.

1873. *Macrocheilus Altonensis.* Worthen, Illinois Geol. Survey, vol. 5, p. 593, pl. 28, fig. 8.
Lower Coal Measures: Alton, Ill.

?1884. Macrocheilus sp.? Walcott, U. S. Geol. Survey Mon. 8, p. 260, pl. 24, fig. 8.
Lower Carboniferous limestone: Eureka district, Nev.
1889. *Soleniscus altonensis*. Keyes, Am. Naturalist, vol. 23, p. 423.
1889. *Soleniscus altonensis*. Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 307. (Date of imprint, 1890.)
1889. *Sphærodoma medialis*. Keyes, idem, p. 306 (pars).
1891. *Sphærodoma medialis* (pars). Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 262. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.
1895. *Sphærodoma medialis* (pars). Keyes, Missouri Geol. Survey, vol. 5, p. 215. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City and Clinton, Mo.
?1909. *Soleniscus* aff. *altonensis*. Girty, U. S. Geol. Survey Bull. 389, p. 108, pl. 11, fig. 6.
Manzano group (Abo sandstone): Abo Canyon, N. Mex.
1911. *Soleniscus* aff. *altonensis*. Girty, U. S. Geol. Survey Bull. 436, p. 51, pl. 6, fig. 7. (Date of imprint, 1910.)
Phosphate beds of the Park City formation: Thomas Fork, Wyo.

Meek and Worthen give two figures representing this species, which have distinctly though not very different shapes. They show opposite sides of the same individual. One would be disposed to regard that which has more gibbous whorls, especially a more gibbous body whorl, as being somewhat tilted and therefore foreshortened. The height in that case would obviously be somewhat less than in the other figure, whereas just the opposite is true. The measurements given by Meek and Worthen indicate that the proportions of the larger and more gibbous drawing are perhaps more nearly correct.

In the synonymy of this species I am placing *Macrocheilus altonense* of Worthen. Worthen did not institute comparisons of *M. altonense* with other species, but his figures are in exceedingly close agreement with those given by himself collaborating with Meek to illustrate *Macrocheilus intercalare*. This is especially evident in the view representing the side opposite the aperture. The only difference which one can detect here is that the shape of *M. altonense* is very slightly more slender and the spire very slightly higher. These differences are, however, scarcely appreciable. In the apertural view the differences are more marked; indeed quite obvious. The inner lip of *M. altonense* is also broader (perhaps the specimen is not quite so much turned away to the right). In neither species is a spiral ridge shown on the columella. Two other species closely similar to these are *S. hallana* and *S. humilis*. Both, however, have the columella distinctly folded. *S. hallana* has also an appreciably higher spire, while *S. humilis* is a minute form. It may perhaps prove to be a dwarfed variety or a young example of the other. I am not sure that it will be practicable to retain all three as distinct species.

The intergradation of the forms which Keyes has attempted to discriminate under different genera as Soleniscus and Sphærodoma is shown by the fact that of the two species which are so similar that I am regarding them as the same, and which at least are closely related and congeneric, Keyes has placed one with one genus and the other with the other.[1] They are indeed in point of configuration about on the border line which separates the two groups.

The shells referred to *S. intercalaris* from the Wewoka formation are nine in number, and the identification is more or less doubtful. The most obvious difference is that none of them shows a callosity on the inner lip such as is represented in the figures of both *S. intercalaris* and *S. altonensis*, and that all which expose the columella at all possess a more or less well-developed revolving ridge. Slight variations are shown in shape, also in the height of the spire, in the spiral angle, in the proportions of length and breadth, and in the gibbosity of the whorls and the correlated depression of the suture. Any further subdivisions if carried out consistently would almost result in placing each specimen in a distinct species. In length they range from 25 to 13 millimeters. The majority are smaller than the type specimen and are perhaps on the average a very little more slender. In size and proportions they especially resemble *S. altonensis*. As before noted, however, they have no callosity, and they do have the columellar fold.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2006 and 2010); Coalgate quadrangle, Okla. (station 2001).

SPHÆRODOMA PALUDINIFORMIS Hall.

Plate XXIV, figures 5–6a.

1858. *Macrocheilus paludinæformis*. Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 719, pl. 29, fig. 10.
Lower Coal Measures: Des Moines Valley, Iowa.

1884. *Soleniscus (Macrocheilus) paludinæformis*. White, U. S. Nat. Mus. Proc., vol. 6, p. 187, pl. 8, fig. 17.
Carboniferous: Indiana.

1884. *Soleniscus (Macrocheilus) paludinæformis*. White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 154, pl. 34, fig. 17.
Coal measures: Vermilion County, Ind.

1889. *Soleniscus paludinæformis*. Keyes, Am. Naturalist, vol. 23, p. 423, pl. 20, fig. 16.

1889. *Soleniscus paludinæformis*. Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 308. (Date of imprint, 1890.)

1891. *Soleniscus paludinæformis*. Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 262. (Date of imprint, 1892.)
Lower Coal Measures: Des Moines, Iowa.

1895. *Soleniscus paludinæformis*. Keyes, Missouri Geol. Survey, vol. 5, p. 211. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.

1903. *Soleniscus* cf. *paludiniformis*. Girty, U. S. Geol. Survey Prof. Paper 16, p. 466.
Carboniferous: Glenwood Springs, Colo.

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[1] He considered *Macrocheilus intercalare* a synonym of *M. mediale* and included the latter under Sphærodoma.

The original specimen of *S. paludiniformis* was a rather large one, while those in the present collection are all of small size. Thus it is difficult to make comparisons. White, it is true, figures a smaller specimen than the type, but I am not sure that it is correctly identified, and here again comparisons are difficult, since Hall's figure and that of White show opposite sides. Apparently White's specimen has a longer body whorl.

As nearly as can be determined, the Wewoka fossils, though for the most part much smaller, have about the same proportions as the larger shell. They resemble those referred to *S. intercalaris* but differ in having a greater number of volutions with higher spire and shorter body whorl.

Herrick's identification of *S. paludiniformis* in 1888 is almost certainly incorrect. His figure shows a shell with a shape very like *S. gracilis* though much larger, and I am provisionally including his citation in the synonymy of that species.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (station 2004).

SPHÆRODOMA PRIMIGENIA Conrad.

Plate XXIV, figures 13–17a.

1835. *Stylifer primogenia.* Conrad, Geol. Soc. Pennsylvania Trans., vol. 1, pt. 2, p. 267, pl. 12, fig. 2.

1855. *Macrocheilus inhabilis.* Norwood and Pratten, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 3, p. 76, pl. 9, figs. 9a, 9b.
Coal Measures: Grayville and Galatia, Ill.; Posey County, Ind.

1858. *Macrocheilus primogenia.* Hall, Rept. Geol. Survey Iowa, vol. 1, pt. 2, p. 720, pl. 29, fig. 11a, 11b.
Coal Measures: Ohio, Indiana, Illinois, and Iowa.

1884. *Soleniscus? (Macrocheilus) primigenius?* White, U. S. Nat. Mus. Proc., vol. 6, p. 187, pl. 8, fig. 3.
Carboniferous: Illinois.

1884. *Soleniscus? (Macrocheilus) ponderosus?* White, idem, p. 187, pl. 8, figs. 1, 2.
Carboniferous: Southern Iowa.

1884. *Soleniscus (Macrocheilus) texanus.* White, idem, p. 187, pl. 8, figs. 13, 14.
Coal Measures: Indiana.

1884. *Soleniscus? (Macrocheilus) primigenius.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 157, pl. 34, fig. 3.
Coal Measures: Ohio, Indiana, Illinois, and Iowa.

1884. *Soleniscus? (Macrocheilus) ponderosus.* White, idem, p. 156, pl. 34, figs. 1, 2.
Upper Coal Measures: Iowa.

1884. *Soleniscus (Macrocheilus) Texanus.* White, idem, p. 155, pl. 34, figs. 13, 14.
Coal Measures: Danville, Ill.

1886. *Macrocheilus primigenius.* Heilprin, Pennsylvania [Second] Geol. Survey Ann. Rept. for 1885, p. 446, fig. 16; p. 457, fig. 16a.
Mill Creek limestone, Upper Coal Measures: Wilkes-Barre, Pa.

1886. *Macrocheilus primigenius.* Heilprin, Wyoming Hist. and Geol. Soc. Proc. and Coll., vol. 2, pt. 2, p. 274, fig. 16; p. 276, fig. 16a.
Mill Creek limestone, Upper Coal Measures: Wilkes-Barre, Pa.

1888. *Macrocheilus ponderosus.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 4, p. 122, pl. 11, fig. 6.
Coal Measures: Fultonham, Ohio.
1889. *Sphærodoma primogenia.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 306.
1889. *Sphærodoma ponderosa.* Keyes, idem, p. 306.
1889. *Sphærodoma texana.* Keyes, idem, p. 306.
1895. *Sphærodoma primogenia.* Keyes, Missouri Geol. Survey, vol. 5, p. 215. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.
1895. *Sphærodoma ponderosa.* Keyes, idem, p. 213.
Coal Measures: Kansas City, Mo.
1896. *Macrocheilus (Soleniscus) primigenius.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 251.
Lower Coal Measures: Conway County, Ark.
1897. *Macrocheilus (Soleniscus) primigenius.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 41.
Lower Coal Measures: Conway County, Ark.

Macrocheilus ponderosum was not figured by its author, Swallow, and the current conception of the species may safely be said to be based on the figures of a fine large specimen from Iowa, given by White. I am almost certain, however, that the Iowa specimen belongs to another species from *Sphærodoma* [*Macrocheilus*] *ponderosa*, which in reality seems to have more the shape of *Sphærodoma intercalaris* Meek and Worthen. White's specimen is over twice as large as that of Swallow, which had a length of but 1.25 inches, and it has considerably different proportions. Its length is 2.65 inches and its greatest diameter 2.1 inches, with a ratio of 1.26, while Swallow's shell is 1.25 inches long and 0.85 inch wide, with a ratio of 1.47. Swallow gives the entire height as 1.25 inches and the spire as 0.45 inch, so that the spire should constitute 0.36 of the entire length. In White's figure the spire seems to measure 0.38 inch, so that it constitutes about 0.14 of the height.[1] Furthermore, Swallow gives the spiral angle as 72° and that of White's specimen is distinctly over 90°. Therefore I believe that *S. ponderosa* of White is a larger species, having a shape less elongate, rather spherical than elliptical, with a lower spire and a broader spiral angle.

I feel satisfied from the facts given above that *S. ponderosa* of White is not the original *S. ponderosa*, but some other species, and it seems probable that it really is the same as *S. primigenia* of Conrad. White remarks of *S. ponderosa*:[2]

This shell, like the last described, is not known to possess a sharply raised fold within the aperture, but it has the deeply sinuous inner lip and a broad obtuse thickening

[1] I am using the word "spire" to include the portion of the coiled shell lying above the last complete volution. If Swallow's measurement was made on the same basis, his form evidently had a spire more than twice as high as White's. In White's specimen the shell above the top of the aperture is 0.9 inch, or 0.34 of the whole, or if measured on the view opposite to the apertural side, the part above the suture of the final volution is 0.6 inch, constituting, therefore, 0.23 of the whole.

[2] Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., for 1883, p. 156, 1884.

of the columella below it; in short, it has all the general characteristics of the more globose of the forms that have been referred to Macrocheilus, except, perhaps, a sharply raised columellar fold.

Referring to *S. primigenia*:[1]

This shell is a somewhat common one in the Coal Measure rocks of Ohio, Indiana, Illinois, and Iowa. In form it resembles the *M. ponderosus* of Swallow, as it has just been identified, but it is regarded as specifically distinct. It differs still more widely from the *Soleniscus* type than either of the two forms that have just been noticed under the respective specific names *medialis* and *ponderosus*. There seems to be nothing upon the columella that is suggestive of a fold, although just behind the place at which such a fold should appear there is a distinct concavity which passes around the columella within the aperture. The test is thick, and there is a considerable accumulation of callus upon the inner lip, and the general characteristics of the shell are like those of the species that have already been noticed.

Keyes remarks of *S. primigenia* that it is similar to *S. ponderosa*, but smaller, with higher spire, more rounded volutions, and more deeply impressed suture. If we take Conrad's original figure of *S. primigenia* and compare it with White's figure of *S. ponderosa*, these differences do not appear. In fact *S. primigenia* has a lower spire in proportion to its size. Much the same is true if Hall's figures be taken, or White's. Slight differences in shape appear, but not constant ones, nor such as I conceive to be adequate for the discrimination of two valid species. As to the fold on the columella which White's remarks seem to suggest as being less strongly developed in *S. primigenia*, here also the differences are slight and hardly persistent. Conrad's original figure shows no such structure at all, but it is probably inaccurate. White's own figure shows it as perhaps a little less well developed than in *S. ponderosa*, and Hall's figure represents it as of about the same development as *S. ponderosa* of White. As based on a comparison of the figures, therefore, the identifications of *S. primigenia* and *S. ponderosa* show only inconsiderable and inconstant differences, so that they can provisionally at least be regarded as the same species.

Keyes also suggests that *S. texana* is based on a young stage of *S. ponderosa*, explaining the more prominent columellar fold of *S. texana* as a youthful character, shown also in young specimens of *S. ponderosa*, and in old ones when the body whorl is removed. In this statement he no doubt has reference to White's identification of *S. texana* based on specimens from Illinois. The faunal association of typical *S. texana* is so different as to make it probable that it is not the same species as *S. texana* of White. Indeed, the original description indicates a decidedly different form, since the body volution occupies three-fourths of the length and the spiral angle is given as but 69°. Shumard, in comparing his species to *S. ponderosa*, doubtless had in mind Swallow's description instead of wrongly identified specimens

[1] Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., for 1883, p. 157, 1884.

of a type similar to that of *S. ponderosa* White. Of course, White's work, on which our current conception of these species is based, was not extant at the time, *ponderosa* having been published in 1858, *texana* in 1859, and White's work not until 1884. I am forced to conclude, therefore, that *S. texana* of White and *S. ponderosa* of White are wrongly identified, and after a careful consideration of all the evidence I am inclined to believe that they are the same as his *S. primigenia,* which is the true *primigenia* of Conrad and of Hall.

For the convenience of the reader I reproduce Conrad's original description and figures; the other works are probably accessible to all. Conrad says:

> Shell ventricose, volutions rounded; suture well defined; aperture more than half the length of the shell; margin of the labium arcuated.
>
> It is with some doubt that I refer this shell to the genus Stylifer of Sowerby, which has been founded on recent species alone; but it strongly resembles *S. astericola,* Sow., except that [it] is much larger; it has, however, some of the characters of Paludina, and may possibly have been a fresh-water shell. It varies much in outline, as the figures will show. Occurs in slate, and the shell replaced by crystallized carbonate of lime.

Only about a score of specimens from the Wewoka collections have been referred to *S. primigenia.* They show some variation in shape and much in size, the largest apparently having had a length of about 40 millimeters, much less than that of the large specimen figured by White as *ponderosa.* Not many have the apical angle quite so wide and the final whorl quite so ventricose as shown in White's figure and in some of the other figures of *ponderosa* and *primigenia.* On the other hand, none has the elongate shape and narrow angle of *S. medialis,* nor does any show the striated callosity extending the full length of the aperture as in that species. Most of them have a rather strong fold on the columella.

A comparison with figures, however, is not satisfactory, because a slight inclination from the vertical will of course cause the length to appear too short relative to the breadth, the spiral angle too wide, and the spire too short. Being turned more or less to one side, even on a vertical axis, also affects the apparent height of the spire, though not the width of its angle. On the whole it has seemed impracticable to attempt to subdivide the series of specimens included in this group, and they can be most satisfactorily disposed of by referring them to *S. primigenia.* The differences now known are too slight to justify the introduction of a new name. On the other hand, the specimens clearly can not be identified as *S. medialis,* the only other species comparable with them, unless we except a few forms described without figures, and these are too imperfectly defined for practical purposes.

Some additional points in the synonymy of this species are deserving of comment. It has been the practice to place *Fusus? inhabilis*

Morton in the synonymy of *Sphærodoma primigenia,* apparently more on the strength of Norwood and Pratten's identification than of Morton's own figure. It is extremely doubtful whether, if Morton's figure is at all accurate, it is really the same as *S. primigenia.*[1] On the other hand, though certain differences are obvious between *Macrocheilus inhabile* Norwood and Pratten (non Morton) and *S. primigenia,* it is probable that they belong to the same specific group. Another doubtful citation is *Macrocheilus primigenium* of Heilprin, his two citations in 1886 being identical as to matter. Heilprin gives two figures of this species, one a copy from Hall but unacknowledged; the other representing an imperfect specimen, doubtfully the same form, from the Mill Creek limestone of the Second Geological Survey of Pennsylvania. Herrick's citation in 1888 is also doubtful. Keyes in 1889 and 1895 cites both *Sphærodoma primigenia* and *S. ponderosa* but without illustrations. Not only may it be fairly inferred that his interpretation of both species, especially *ponderosa,* is largely, if not wholly, derived from White, but his remarks appear to indicate a conception of *ponderosa* just the reverse of the fact. Thus, he says that *S. primigenia* has the higher spire and his conception is further illustrated by the fact that he considers *S. texana* an immature condition of the larger species. Here, too, his interpretation is doubtless based on *S. texana* of White, which may provisionally be considered distinct from typical *texana.* Keyes is probably correct in including White's citation of *texana* in the synonymy of *ponderosa* and I am following him in so doing. Mention has already been made of the fact that Heilprin's paper on the fossils from the Mill Creek limestone was reprinted. The same is true also of White's paper and of that of J. P. Smith, as shown in the synonymy.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001?, 2004, and 7193).

SPHÆRODOMA aff. S. REGULARIS Cox?

I am here considering a fragment of a large gastropod which is laterally compressed and has both the apex and the basal portion broken away. The length is 35 millimeters and the width at present 24 millimeters. Parts of 7 volutions remain and at least 3 others are needed to complete the spire. The volutions are rather flat and the suture slightly depressed.

This form in a general way suggests *S. regularis.* The spiral angle is considerably greater, but this difference is clearly much enhanced by the compression which the specimen has suffered. It also suggests

[1] The shape is closely comparable to *S. medialis* Meek and Worthen, and if the figure can be relied on (which is probably not the case) they would doubtless be the same species. Morton's name would then replace *S. medialis,* if, indeed, it be regarded as adequately established.

S. paludiniformis, but even in its present crushed condition the spiral angle is considerably less. The shape of the final volution is not known, but I infer rather doubtfully that it was relatively short and broad. It does not seem probable to me that this can be a specimen of *Meekospira peracuta*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

SPHÆRODOMA VENTRICOSA Hall.

Plate XXIV, figures 4, 4a.

1858. *Macrocheilus ventricosus*. Hall, Rept. Iowa Geol. Survey, vol. 1, pt. 2, p. 718, pl. 29, fig. 8 (not *Phasianella ventricosa* Goldfuss, 1841).
Lower Coal Measures: Des Moines Valley, Iowa.

This identification is primarily based on one specimen from station 2006, which agrees very closely with Hall's description and figure. The shape is ovoid with an acute, somewhat attenuate, many-whorled spire. The entire height is 14 millimeters. The height of the aperture is 7 millimeters and the height of the spire above the last volution $3\frac{1}{2}$ millimeters. The last volution is gibbous and the spire has slightly concave sides. The volutions number 8 and the columella has a relatively strong fold. With this specimen, which agrees closely with typical *S. ventricosa*, I have assembled others in which the agreement is not quite so close, but which it seems inadvisable to distinguish specifically from the first. All are small specimens, some only half the size of that selected for illustration. One or two may possibly be identifiable with *S. gracilis*.

As noted elsewhere (p. 202) *S. ventricosa* of Hall has generally passed under the name subsequently introduced by White, *S. brevis*. White at first regarded *S. brevis* (based on specimens from New Mexico) as distinct from *S. ventricosa* but later, concluding that it was the same species, he employed Hall's name to the exclusion of his own. Keyes, however, adopted the latter name because of *Macrocheilus* or *Buccinum ventricosum* of Goldfuss, but until it is shown that the American species and the German one are congeneric I prefer to regard *Soleniscus ventricosus* or *Sphærodoma ventricosa* as not preoccupied and am therefore employing *ventricosa* for the species name.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (station 2001).

Genus MEEKOSPIRA Ulrich.

The relationship between Meekospira, Bulimorpha, and Polyphemopsis, not to mention Subulites and other genera, is difficult to determine and define. All comprise elongate, fusiform shells with narrow, flat-sided spires and elongated, deeply embracing whorls. Polyphemopsis, the oldest to be described, apparently based on the Silurian species, *P. elongata*, is, so far, at least, as represented in Portlock's description and figures,[1] without a canal at the anterior end of the aperture, without a callus on the inner lip, and without a fold on the columella. The first to apply the name Polyphemopsis to American shells was Meek,[2] who included in it three Pennsylvanian species, *P. inornata*, *P. nitidula*, and *P. peracuta*. He states, however, that *P. peracuta* may not properly belong to this genus because of the presence of a callus on the inner lip, a feature not present in the other species. He also notes that *P. bulimiformis*, *P. canaliculata*, and *P. elongata*, the three Mississippian shells on which Hall proposed to found the genus Bulimella, a name preoccupied by Pfeiffer, agree exactly in all their generic characters with Polyphemopsis. Whitfield subsequently included these species in a new genus, Bulimorpha, which he substituted for Bulimella and of which *B. bulimiformis* is the type. The columella is described as bent and truncated at the base, where it is separated from the outer lip by a notch, as in the recent genus *Achatina*. The outer lip is very slightly notched near the upper end. This character of a notch at the anterior end of the aperture is a feature not indicated by the original description and figures of Polyphemopsis, though it is noted in Meek and Worthen's definition of that genus, which is apparently based on the three Pennsylvanian species mentioned above. On the statements of Meek and of Whitfield one would feel disposed to hold Polyphemopsis and Bulimorpha as distinct and to refer to Bulimorpha the six American species already mentioned.

Keyes adopted this course in 1889[3] when he substituted Bulimorpha as a generic name for all American species previously referred to Polyphemopsis. He remarks that Polyphemopsis was founded on very imperfect material and that its structural characters have never been sufficiently understood to limit the group. This appears to me to be true only in part, and in that part to be applicable to a number of other genera. Portlock gives two figures of what appears to be an unusually perfect specimen of *P. elongata*, and while the generic description perhaps implies more than it actually states, together with the figures, if they are to be relied on, it gives a fairly complete conception of the genus. Keyes goes on to say that Polyphemopsis is regarded as a synonym of Macrocheilus by the majority of European writers, whereas Macrocheilus "has recently been shown to be identical with Soleniscus." As Soleniscus, even as used by Keyes, is clearly distinct from Bulimorpha, the inference is that the name Polyphemopsis can not be applied to that group of shells. It does not appear to me, however, that Polyphemopsis is synonymous with Macrocheilus nor that Macrocheilus is the same as Soleniscus.

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[1] Geology of Londonderry, p. 415, pl. 31, fig. 2, 1843.
[2] Illinois Geol. Survey, vol. 2, p. 372, 1866.
[3] Acad. Nat. Sci. Philadelphia Proc., p. 299, 1889.

In 1897 Ulrich introduced the name Meekospira with *M. peracuta* as the type, the genus probably to include also *M. inornata* and *M. nitidula.* In his description of Meekospira, he says, "inner lip slightly reflected, simple, without folds winding about the columella so as to pass out of sight opposite the middle of the aperture, lines of growth nearly or quite straight and vertical."[1] As it stands this phraseology is scarcely intelligible, but if a semicolon or period be substituted for the comma before "lines of growth" and a comma be inserted after the words "without folds," the meaning becomes more clear and evidently refers to the feature of *Meekospira peracuta* to which Meek already called attention in these words: "Inner lip somewhat reflexed below, and winding around the columella so as to pass out of sight opposite the middle of the aperture."[2] It is this feature which led Meek to express a doubt as to whether *Polyphemopsis peracuta* were really congeneric with the two other species referred with confidence to that genus. Ulrich therefore makes Meekospira include just half of Meek's Polyphemopsis, since he evidently refers the three Mississippian species to Bulimorpha. He neglects to state how Meekospira differs from either that genus or from Polyphemopsis, from which, if any, the distinguishing characters should have been named. He mentions that he conceives it to occupy an intermediate position between Loxonema and Soleniscus, which he follows Keyes in regarding as covering the same ground as Macrocheilus Phillips.

Apparently Meekospira must depend for its separation from related genera largely on the reflexed lip, which is well shown by some of the Wewoka specimens and which alone would seem to distinguish it from Polyphemopsis (as already noted by Meek), so that *P. nitidula* and *P. inornata* can not be reckoned veritable species of Meekospira. The reflexed lip and the absence of a notch at the anterior end of the aperture distinguish it from Bulimorpha, and the absence of the fold on the columella distinguishes it from Sphærodoma (*Macrocheilus auctorum*).

The validity of these differentiating characters is perhaps open to question. The notch at the anterior end of the aperture is so liable to be caused by breakage in shells which have it not, and obscured by the same cause in shells which originally possessed it, as to make it a character at least difficult of application. It is pretty clearly lacking in *M. peracuta.* On the other hand, it may be asked, since Sphærodoma often has a callus on the inner lip and the fold on the columella obsolescent or even obsolete, whether there is any real distinction between Meekospira and Sphærodoma. Keyes seems to think that the callus is an unreliable character in Sphærodoma,

[1] Minnesota Geol. and Nat. Hist. Survey Final Rept., vol. 3, pt. 2, p. 1079, 1897.
[2] Illinois Geol. Survey, vol. 2, p. 376, 1866.

sporadic and even more or less local in its development. Most specimens fail to show it. It is perhaps noteworthy that in Sphærodoma the callus either does not occur at all or else it completely covers the inner lip. However, it seems doubtful whether this structure can be compared in Sphærodoma and Meekospira since in the latter it passes well out on to the broad, rounded, anterior portion of the outer lip, whereas in Sphærodoma it seems to be a deposit on the columella alone. Still less is its occurrence in Meekospira to be confused with the fold on the columella of Sphærodoma, though making an irregularity in much the same position. The fact that the columellar fold is best developed on the inner portion of the shell and is often obscured at the aperture shows that it is developed subsequent to the advance of the shell growth, whereas the reflexure in Meekospira, since it is a feature of the lip, must be external and its development must proceed abreast of the advance. Consequently I conclude that Meekospira should be regarded as distinct from Sphærodoma and also, though more provisionally, from Bulimorpha.

To Meekospira can be referred *M. peracuta*, the type species, but not the two other Pennsylvanian species of Polyphemopsis described by Meek and Worthen. By inference from their descriptions, these species do possess a notch at the anterior end of the aperture and do not show the reflexed and thickened lip passing around on to the lower half of the columella. With *M. peracuta* I am provisionally including a species described by Walcott under the genus Loxonema, *L. bellum*. As the type specimen is an internal mold the critical characters are not shown, but from the flattened and elongated volutions I judge that the form is not a Loxonema, even of the smooth type which I am tentatively citing under Holopea. The height of the spire is unfavorable to a reference to either Sphærodoma or Bulimorpha, the general appearance in fact seeming more like that of typical Meekospira, to which genus it seems best to transfer it, in spite of the lack of conclusive confirmatory evidence.

MEEKOSPIRA PERACUTA var. CHOCTAWENSIS Girty.

Plate XXV, figures 5–8a.

1911. *Meekospira peracuta* var. *choctawensis*. Girty, New York Acad. Sci. Annals, vol. 21, p. 139.

Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

This fossil is very abundant in the Wewoka formation and shows certain variations, some of which are probably adventitious. It has an acutely conical form with a very elongate spire and a narrow spiral angle. The sides of the spire are usually flat and the suture is only slightly depressed, but in some specimens the sides are more undulating and the suture is deeper, perhaps because of variation in curve of the outer surface of the whorl. In the more usual form the convexity is more regular; in the other form the upper surface of the volution is flattened and the greatest convexity is well below the middle, where it is overlain by the succeeding whorl. The rate of increase in growth seems to have been accelerated somewhat toward maturity, so that the sides of the spire are slightly concave. As a result, if the apex of a specimen is broken away, as it very commonly is, the frustum remaining shows a wider spiral angle than that which would be shown by the complete shell. In comparing these broken shells with more perfect specimens one is somewhat surprised to find that they may belong to the typical variety, as well as to find what a large number of volutions are present when the apex is complete, the number being proportionally much greater toward the top. On the side of a specimen 14 millimeters long parts of 9 volutions appear and as the apex is broken there must have been one or two more. A full-sized specimen about 30 millimeters long shows parts of 10 volutions with an apical break which may possibly account for two more. The number of complete volutions in a mature specimen is probably 11 and possibly 12.

The callus is very distinct in well-preserved specimens, extending halfway or a little less than halfway up the inner lip. It is formed by a slight backward flexure of the outer lip on itself as it passes up the axis and is there gradually lost in the aperture.

In its specific characters this species is intermediate between *Meekospira peracuta* and *Bulimorpha nitidula* and does not exactly agree with either species. According to Meek and Worthen, *B. nitidula* has a lower spire with fewer volutions and broader spiral angle than *M. peracuta;* it is smaller, the volutions are more rounded, and the sutures are more deeply depressed.

The present form seems almost invariably to have a slightly broader spiral angle than *M. peracuta,* though it shows a certain amount of variation. The agreement in this respect is then distinctly with *B. nitidula.* As for the convexity of the volutions, some specimens resemble *peracuta* and others *nitidula;* but few, perhaps none, are quite so strongly convex as Meek and Worthen's figures of the latter species. In fact, one of their figures shows this character more strongly than the other, though both are drawn from the same specimen. The number of volutions is more like *peracuta,* which is said to have 13, than *nitidula,* which is said to have 8 or 8½. The size is that of *nitidula,* none of the specimens attaining the length of *M. peracuta.* In the most essential respect, the callus and reflexed lip, the Wewoka form agrees with *M. peracuta* and differs from *B. nitidula,* and if this character is regarded as of generic importance there can be no question about associating it with any species but *M. peracuta.* Ulrich seems inclined to include *B. nitidula* and *B. inornata* with *M.*

peracuta in his genus Meekospira, but it seems to me that the callus which is such a marked feature of *M. peracuta* must be a generic character, or its absence from the two other species accidental—an assumption that seems unwarranted—and I am referring those two species to another genus than Meekospira in which, of course, the present form must be included. Though closely related to *M. peracuta* I can hardly place it in the same species because of its broader spiral angle and smaller size.

Most of the specimens referred to this species are almost absolutely smooth, having but very obscure growth lines, but those from one or two localities (for example, station 2001) are regularly marked by more or less strong incremental lines, some of which are prominent and give an irregularly and intermittently corrugated appearance where most strongly developed. Some of these shells, furthermore, show slight modifications of curvature in the outer surface of the volution which gives the spire a slightly different outline from the normal. In others, however, the shape of the whorl section is entirely normal, so that no persistent difference can be pointed out save in the increased development of the striæ of growth. It is possible that these sculptured specimens should be separated as a distinct variety, but the differences observed hardly seem to justify the distinction.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2006, and 2010); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

MEEKOSPIRA BELLA Walcott?

Plate XXV, figure 9.

1884. *Loxonema bella.* Walcott, U. S. Geol. Survey Mon. 8, p. 258, pl. 24, figs. 1a, 1b. Lower Carboniferous: Eureka district, Nev.

This form is distinguished from *M. peracuta* var. *choctawensis*, occurring in the same beds, by its more rapidly tapering spire and shorter body whorl. The sides of the volutions are flat and the suture indistinct. Owing to this configuration there is a strong and rather abrupt curve by which the outward direction of the upper part of the volution is changed to an inward direction in the lower part. The volutions appear to number 8 or 9.

The single specimen included under this title has much the same spiral angle as that referred to *Bulimorpha inornata?*, but it is distinguished by the different shape of the body whorl and by the straight, less undulating outline of the spire, in which the suture is scarcely depressed below the regularly conical surface. The same characters as well as the larger size distinguish this from typical *B. inornata*. A similar peculiarity of shape appears to exist in *M. bella*, but that species has a more gradually tapering spire. It is far from certain that *M. bella* belongs to the genus Meekospira, nor have all the distinguishing characters of Meekospira been observed in the present specimen.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus BULIMORPHA.

In first applying Portlock's genus Polyphemopsis to American shells in 1866, Meek and Worthen [1] included under it six species, three of Pennsylvanian and three of Mississippian age. One of the Pennsylvanian species, *P. peracuta,* regarding which these authors were in some doubt, was subsequently made by Ulrich the type of a new genus, Meekospira, which was erroneously, I believe, made to include the two other Pennsylvanian species, *P. inornata* and *P. nitidula.*

The three Mississippian species had even at that time been made the content of a new generic group, Bulimella Hall, but as that name was preoccupied by Pfeiffer, Whitfield later substituted for it the appellation Bulimorpha.

Provisionally, I am recognizing as valid all three of the genera named, retaining in the main the assemblage of Meek and Worthen. That is, Meekospira Ulrich I recognize as including only the typical species *M. peracuta,* which is distinguished by having the anterior portion of the outer lip reflexed and thickened and extended on to the columella as a sort of callus halfway up the length of the aperture.

The five remaining species cited by Meek and Worthen I am retaining as a natural group, but employing for it the name introduced by Whitfield—Bulimorpha. It is perhaps doubtful whether this is really distinct from the Silurian genus Polyphemopsis, but Meek and Worthen mention for Polyphemopsis (as based on American Carboniferous species) and Whitfield mentions for Bulimorpha a character certainly not intimated either by the original description of Portlock or by his figures of the typical species, *P. elongata*—that is, the possession of a notch or sinus separating the outer from the inner lip. If anything develops to show that this difference is not constant and important, it would appear necessary to return to Polyphemopsis as the generic name for the American shells.

In the possession of this notch or sinus Bulimorpha resembles Soleniscus, from which it is distinguished by the absence of a fold on the columella. A similar difference exists between Bulimorpha and Sphærodoma, which has in addition a callus on the inner lip and an effuse but not distinctly canaliculate anterior margin to the outer lip. The callus, however, is not a constant character and in fact seems to be rarely shown. The columellar fold is developed in varying degrees and is usually obscure at the aperture, and perhaps the conformation

[1] Illinois Geol. Survey, vol. 2, 1866, p. 372.

of the anterior end does not really differ greatly in many cases. It would appear, therefore, that in practice it might be difficult to distinguish between Bulimorpha and certain slender species of Sphærodoma.

Besides the species discussed by Meek, as named above, a number of other species have from time to time been placed under Bulimorpha. Of these the following appear to be incorrectly referred:

Bulimorpha alvensis Beede. This form is too imperfectly known to merit description as a new species. The general shape suggests Bulimorpha or an elongated Sphærodoma. As the preservation is that of an internal mold the presence of a fold on the columella might easily escape detection, and though this structure is not known to be present it seems better to place *B. alvensis* under Sphærodoma provisionally and to reserve Bulimorpha for types in which the absence of a columellar fold is, or is stated to be, absent.

Bulimorpha? Keokuk Worthen. Of somewhat similar status is this species of Worthen's which Keyes justly remarks is too imperfect to deserve recognition. In its broken condition the shape of the aperture shown by the figure is probably not intrinsic, while the strongly rounded whorls suggest a reference to Holopea. The true relationship, however, may be with Loxonema s. s. or with Polyphemopsis (=Bulimorpha) as originally written.

Polyphemopsis melanoides Whitfield. Probably owing to Whitfield's original reference to Polyphemopsis this species has been carried over by Weller into the genus Bulimorpha. Since Worthen states that the aperture is effuse below and that so far as can be observed the columella is twisted, it seems preferable to refer the species to Sphærodoma until more is known of it.

Polyphemopsis minuta Stevens. Stevens gave a brief and unsatisfactory description without figures of this species in 1858, referring it to the genus Loxonema. Fifteen years later Meek and Worthen published two figures of it as *Actæonina minuta* [1] without description. A cursory comparison of these figures with Stevens's diagnosis is enough to show that the shells can not possibly belong to the same species, if both figures and description are at all accurate. The figure represents an angulation just below the suture, such that the upper part of the volution is nearly horizontal and approximately perpendicular to the lateral portion. This feature is not noted by Stevens, though he seems to record it in *Loxonema carinatum*, a much larger form from the same locality. Furthermore, Stevens gives the length as 0.2 inch, or four times the width of the body whorl, which is 0.05 inch. Meek's figure, however, shows the length as scarcely two and one-half times the width of the body whorl. The name *danvillensis* is accordingly proposed for the form shown by Meek and Worthen's figures. The generic position of *danvillensis* is uncertain. Meek and Worthen's figures show a callosity covering the whole of the inner lip and apparently extending on to the anterior portion of the outer lip. Keyes, who subsequently referred the species to Bulimorpha,[2] states that the callus extends only half the length of the aperture and is separated from the outer lip by a distinct notch. In neither citation is a columellar fold indicated. The absence of this character would seem to debar the species from Sphærodoma. The callus extending halfway up the inner lip is suggestive of Meekospira, but in *danvillensis* the structure appears to be a true callus and not a reflexure of the lip, at least if Keyes is to be relied upon; further, the relatively low spire and angulated whorls and the notch at the anterior end of the aperture, described by Keyes, are quite alien to Meekospira. Bulimorpha is not supposed to have a callus and the typical species is without the angulation of

[1] Illinois Geol. Survey, vol. 5, pl. 29, fig. 2, 1873.
[2] Acad. Nat. Sci. Philadelphia Proc., p. 301, 1889.

danvillensis, though *B. canaliculata* possesses it. The presence of an angulation suggests the genus Macrocheilina, and if this be regarded as an important character, a reference to Macrocheilina would be in order. At the same time Macrocheilina is not known to possess a callus any more than Bulimorpha. Tentatively I would refer the species to Macrocheilina. Typical *Loxonema minutum* may provisionally be retained under Bulimorpha. No callus is mentioned and the columella is said to be smooth—that is, without a fold.

In the genus Bulimorpha I am including the following species:

Bulimorpha bulimiformis Hall.

Bulimorpha? canaliculata Hall. This may prove to belong to a distinct genus. It apparently does not show the characteristic notch at the anterior end of the aperture, but it does show a notch at the posterior end, probably also indicated by the angulation in the contour just below the suture. This gives it the shape which is a peculiarity of Macrocheilina and which is not found in the other species of Bulimorpha.

Bulimorpha chrysalis Meek and Worthen.

Bulimorpha chrysalis var. *delawarensis* Girty. Not very completely known and possibly belonging to some other genus.

Bulimorpha? elongata Hall. Imperfectly known; evidently, however, the spire is very much longer than the body whorl, suggesting some other genus, such as Meekospira.

Bulimorpha inornata Meek and Worthen.

Bulimorpha minuta Stevens. Never figured, poorly defined, and doubtfully referred. Described as a Loxonema and referred by Keyes to Bulimorpha, apparently on the strength of specimens which do not belong to the species. The columella is described as being without a fold and the presence of a notch is not mentioned.

Bulimorpha? nodosa Stevens. Referred by Stevens to Loxonema, a genus to which it pretty certainly does not belong. The description is inadequate and unaccompanied by figures. The rudimentary nodes suggest Trachydomia, but the elongated shape, two and one-half times as long as the width, is more like Meekospira, Bulimorpha, or certain narrow types of Sphærodoma. The columella is said to be smooth. Besides being very brief the description appears to be self-contradictory, since the mouth and the body whorl are stated to be equal, which is a physical impossibility in such types as these. The reference to Bulimorpha is very doubtful, but it is at least possible, whereas the reference to Loxonema appears to be out of the question.

Bulimorpha? tenuicarinata Stevens. Another of Stevens's species, of which the fore going remarks are true in nearly every respect. The length is said to be 0.5 inch and the width 0.02 inch. This would make the length 25 times the width, a most abnormal relation. If the decimal is misplaced the species would be more natural, one might almost say more possible, but the description remains most inadequate. The hair-line carina at the suture suggests the form which Meek and Worthen erroneously identified with another of Stevens's species, *Loxonema minutum* and which, as above, I have called by a new name. The *danvillensis* is much smaller than *tenuicarinata*, only 0.2 inch instead of 0.5 inch long. If the minute carina of Stevens is the same as the angulation shown by Meek and Worthen's figures, I should tentatively place it in the same genus Macrocheilina, in spite of the fact that no callus is recorded in the description of the present form, a circumstance which, however, is much more favorable to Macrocheilina than against it. As the columella is said to be smooth (without a fold) this form apparently can not be placed with Sphærodoma, while the general configuration and the absence (?) of a reflexure of the lip indicate a reference to Bulimorpha rather than to Meekospira, between which the probabilities otherwise seem to lie.

BULIMORPHA INORNATA Meek and Worthen.

Plate XXV, figures 10, 10a.

1860. *Loxonema inornata.* Meek and Worthen, Acad. Nat. Sci. Philadelphia Proc., p. 465. (Date of imprint, 1861.)
Upper Coal Measures: Springfield, Ill.
1866. *Polyphemopsis inornata.* Meek and Worthen, Illinois Geol. Survey, vol. 2, p. 374, pl. 31, figs. 8a–c.
Upper Coal Measures: Springfield, Ill.
1887. *Polyphemopsis inornata.* Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 20, pl. 2, fig. 15.
Coal Measures: Flint Ridge, Ohio.
1889. *Bulimorpha inornata.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 301. (Date of imprint, 1890.)
1895. *Bulimorpha inornata.* Keyes, Missouri Geol. Survey, vol. 5, p. 205, pl. 55, fig. 6. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.
1896. *Polyphemopsis inornata.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 251.
Upper Coal Measures: Crawford County, Ark.
1897. *Polyphemopsis inornata.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 41.
Upper Coal Measures: Crawford County, Ark.
1897. *Meekospira inornata.* Ulrich, Minnesota Geol. and Nat. Hist. Survey Final Rept., vol. 3, pt. 2, p. 1079.

Since this type is represented by only a single specimen, found in association with *Meekospira peracuta* var. *choctawensis*, it might perhaps more safely be considered only an abnormal example of the same species. It is, however, considerably less elongated and has a larger spiral angle. The volutions are probably broader and shorter, notably the final volution. In size and in the greatly rounded whorls the specimen resembles *Bulimorpha nitidula*, but it has a more abruptly tapering spire. In shape it very closely resembles *B. inornata* but it is much larger, and the volutions are a little more gibbous, rather as in *B. nitidula*. The present example is incomplete, consisting of but 4 volutions, perhaps as many more having been broken away from the apical portion.

Meek states that *B. inornata* is without the callosity of the inner lip found in *Meekospira peracuta*, and if this feature is persistent I question whether the form should be included under Meekospira. The single example from the Wewoka formation also appears to be without a callosity, but this feature may have been obscured.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (station 2004).

Family IANTHINIDÆ??

Genus IANTHINOPSIS Meek and Worthen.

IANTHINOPSIS GOULDIANA Girty.

Plate XXIII, figures 1, 1a.

1911. *Ianthinopsis gouldiana.* Girty, New York Acad. Sci. Annals, vol. 21, p. 141. Wewoka formation: Wewoka quadrangle, Okla.

Shell rather large, subovate; length a little less than one and one-half times the greatest width. Aperture about three-fourths and spire about one-eighth of the entire height. Volutions, 4 or 5, rather inflated, especially above, so that the upper surface of the volution appears flattened and not strongly oblique to the horizontal. Aperture fusiform, more than twice as long as wide.

Surface smooth, but marked on the more gibbous portion with a few (4 or 5) rather coarse but faint revolving striæ. Axis solid.

The affinities of this type, represented as it is by only one specimen, are much in doubt. If it were not for the sculpture and for the shape with the most prominent part of the volutions so high up, this shell might be placed under Sphærodoma in the same series with *S. intercalaris* and *S. primigenia.* The striation, though faint, is unmistakably visible in a good light, but it can only be seen in the region of the aperture. The shape has doubtless been somewhat modified by compression, but not sufficiently to have produced the present result from a shell originally having the proportions of either of the two species named.

On the assumption that the peculiarities presented by this form are inherent, it may be compared with the singular species described by Meek and Worthen under the name *Pleurotomaria? tumida.* While clearly distinct from *P.? tumida* the general resemblance is so striking that it would be overcautious not to conclude that it is a generically related species. The most important fundamental difference is stated by Meek—the columella of the Illinois form is perforated (?), whereas that of the Wewoka shell is certainly solid.

Meek had not observed the presence of a slit band in *P. ? tumida* and justly remarked that that species differs materially in outline from the usual form of Pleurotomaria. Suspecting that it was a representative of a new genus, he provisionally proposed the name Ianthinopsis. I am ready, without having determined the absence of a slit band, to accept *I. tumida* as representing a new generic type, and I am employing that name for the type specimen and for the Oklahoma shell also.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

CEPHALOPODA.

NAUTILOIDEA.

Family ORTHOCERATIDÆ.

Genus ORTHOCERAS Breyn.

ORTHOCERAS TUBA Girty.

Plate XXVI, figures 1-4.

1911. *Orthoceras tuba.* Girty, New York Acad. Sci. Annals, vol. 21, p. 142.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Orthoceratoid shells are abundant in the Wewoka formation and many of them possess the singular feature of accelerated expansion, so that they flare conspicuously at the larger end and if the tendency were carried out to a high degree the complete shell would be trumpet-shaped, a configuration which many of them even now suggest. This peculiarity, however, is manifested in shells of very different sizes and presumably of ages corresponding to the sizes, and it is found in both the chamber of habitation and in the septate portion.

It might be supposed (1) that the flaring is a feature of maturity, which is the natural supposition, or (2) that it is normal at all stages, the expanded portion being resorbed so that the shell is regularly conical except toward the aperture; but both suppositions are repugnant to the fact that in some specimens the flaring portion is septate. On the former supposition, furthermore, the mature stage must in some specimens be enormously accelerated or retarded.

Correlated with the peculiarity above described is a relatively abrupt expansion which gives the regular portion of the cone a rather strong taper. The siphuncle is conspicuously excentric, though this character has been seen in only a few individuals that at the same time have the trumpet shape in a conspicuous degree. The septation is rather closely spaced, about 4½ to 5 chambers occurring within the distance of a diameter.

None of the shells having the characters enumerated possesses the peculiar secondary deposits of Pseudorthoceras. Indeed, they have the chambers filled with ocherous clay and it is difficult to understand how this condition came about when the partitions are still retained. Possibly the fine mud permeated the chambers through the siphuncle, which is preserved in but few of the specimens examined. Most of the specimens are internal molds, though some retain a substantial outer investment.

With typical *O. tuba* I am provisionally including a group of specimens which do not show the expanded aperture but have a similarly excentric siphuncle and similarly closely spaced partitions. They differ greatly in size and some of them are much larger than some of those which show the accelerated expansion, but in view of the extreme variation in size of the specimens having the latter character it seems that this fact alone can hardly be regarded as forbidding their grouping under a single species. This grouping, of course, can be made only on the hypothesis either that the trumpet shape was not an important character, or that these specimens, all of which naturally are now imperfect, possessed it or would have possessed it in their complete and mature condition.

I am inclined to believe that this peculiarity of configuration is not so much a specific character as that it is either generic or is of no fixed value at all, but I feel that its significance is too little understood to warrant establishing a new genus on the evidence in hand.

Few shells of this group are complete, all those examined being imperfect at one or both ends. Some were evidently broken before fossilization, for they bear on their septa small Roemerellas, apparently in their original places of attachment, places which of course they could not possibly have reached if the Orthoceras shells had not been fragments at the time of attachment.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2004 and 7193).

ORTHOCERAS sp. A.

Plate XXVII, figure 13.

The single specimen representing this type looks at first sight much like an ordinary Orthoceras, but a careful examination leaves some doubt whether it is even a cephalopod. Its shape is that of a gently expanding cone showing no septa, but its smaller end is rounded as if by a septum. The fragment tapers rather abruptly for the genus Orthoceras, having a diameter of 14.5 millimeters at the larger end and of 9 millimeters at the smaller end, and a length of 33 millimeters.

The sculpture consists of abruptly elevated, fine, threadlike liræ, 13 to 15 in a distance of 5 millimeters, separated by intervals of from once to twice their own thickness. The liræ have a slightly sinuous course, but are almost directly transverse. It is in the character of these markings that the doubt as to the cephalopod relationship of this form finds its chief support. In the first place, no substantial shell seems to be present, whereas the other Orthocerata have a rather thick though smooth test. The markings which have just been described consist of a thin film overlying the cone of rock forming the inside of the shell. The elevated lines are white; the depressed lines between them black and membranaceous. Furthermore, these markings pass over the rounded end of the shell, not regularly but as if plastered on, the fine costæ being bent and separated in the process.

Only one hypothesis occurs to me on which this shell can be included with the Orthocerata. We know that the fossils from the Wewoka formation have suffered chemical replacement and it is conceivable that in this process the substantial portion of the test was removed without destroying a thin outer coating which may have had a different chemical composition or a different physical structure from the rest and that this thin integument produced the phenomenon under consideration. The fact that a Cyrtoceras-like form (Cyrtoceras?? sp. of the present report) seems to show a similar type of preservation somewhat strengthens this hypothesis.

If this is not an Orthoceras its zoologic relations are extremely doubtful. The shape and tenuity suggest some sort of a worm tube and a relationship to Conularia is suggested by the straightness of the shell and the regularly costate sculpture. If an Orthoceras, the form is probably distinct from anything else in the collection. Otherwise, it is almost necessary to regard it as representing an undescribed genus.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

ORTHOCERAS sp. B.

Plate XXVII, figures 12, 12a.

A few specimens are characterized by having a well-marked constriction which is, as usual, due more to a thickening of the test than to an annular inflection. These are all rather large shells and all chambers of habitation, the constriction occurring close to the larger end. The section of these specimens is elliptical and the constriction, which is not straight, has its sinuosities oriented with reference to this shape, retral curves or lobes occurring on the ends and broader saddles on the sides. In one specimen the base of the living chamber formed by the first septum is preserved, showing a siphuncle which appears to be centrally located.

The type most difficult to distinguish from this form is *Orthoceras tuba*, the swelling above the constriction in the form here described looking in some specimens very much like the abrupt expansion in *O. tuba*—an expansion not connected with a constriction. In some specimens it is impossible to ascertain the distinguishing characters.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005); Coalgate quadrangle, Okla. (stations 2004 and 7193).

ORTHOCERAS sp. C.

Plate XXVI, figures 8, 8a.

The specimen especially discriminated under this title is large, has rather high chambers, which occur about three to a diameter, and a siphuncle apparently central in position. The other specimens, three in number, are much smaller, but so far as can be determined show similar characters. All the specimens and especially the smaller ones, which might otherwise be united with *P. knoxense,* appear to lack the secondary deposits of Pseudorthoceras. Clearly this form can not be referred to *Orthoceras tuba,* but it might comprise septate portions of shells which in the chamber of habitation possessed the constriction characterizing Orthoceras sp. B. The smaller examples, however, seem to be circular in shape, not elliptical.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus PSEUDORTHOCERAS Girty.

1911. Pseudorthoceras. Girty, New York Acad. Sci. Annals, vol. 21, p. 143.

Shells small(?), straight, gradually tapering. Siphuncle nearly central, small, but considerably expanded between the septa, without, however, becoming nummuloidal. Septa simple. Funnels apparently very short and thick. Chambers partly occupied by secondary deposits which accumulated, not about the funnels and siphuncle, but about the walls. In the type species the deposits fill about half of each chamber, thinnest toward the aperture, thickest toward the apex, and diminishing irregularly, so that the outline is shaped like an incomplete letter S. The deposit appears to be more or less vesicular, perhaps as the result of weathering. Shells which are not broken at the apex do not taper to a point but are obliquely truncated.

This type is rather clearly not a representative of true Orthoceras, nor have I been able to find a genus with which it can be assembled. Indeed, it is not certain that it can be included among the Orthoceratidæ, though to that family it is for the present referred. The most diagnostic features are probably the enlarged siphuncle and more especially the secondary deposits accumulated not axially but circumferentially. In this item lies the main difference from Orthoceras, for in that genus, and indeed in that family, the secondary deposits are rather sparingly developed and they are accumulated about the funnels, not about the outer wall.

Type species.—*Pseudorthoceras knoxense.*

PSEUDORTHOCERAS KNOXENSE McChesney.

Plate XXVII, figures 1–6.

1860. *Orthoceras knoxensis.* McChesney, Desc. New Spec. Foss., p. 69. (Date of imprint, 1859.)
Coal Measures: Danville, Springfield, Peoria, and Dr. E. Hall's mill, Knox County, Ill.

1866. *Orthoceras cribrosum.* Geinitz, Carb. und Dyas in Nebraska, p. 4, tab. 1, fig. 5.
Dyas: Nebraska City, Nebr.

1872. *Orthoceras cribrosum.* Meek, U. S. Geol. Survey Nebraska Final Rept., p. 234, pl. 11, figs. 18a, 18b.
Upper Coal Measures: Nebraska City, Nebr.; Illinois.
Lower Coal Measures: Illinois, West Virginia.
1873. *Orthoceras Rushensis*? Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 612, pl. 30, fig. 4.
Upper Coal Measures: Springfield, Ill.
1884. *Orthoceras Rushensis.* White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 164, pl. 36, fig. 5.
Coal Measures: Eugene, Newport, Lodi, Merom, Graysville, New Harmony, Rush Creek, and Newberg, Ind.
1887. *Orthoceras cribrosum*? Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 17, pl. 5, fig. 2.
Coal Measures: Flint Ridge, Ohio.
1888. *Orthoceras rushensis.* Keyes, Acad. Nat. Sci. Philadelphia Proc., p. 242.
Lower Coal Measures: Des Moines, Iowa.
1891. *Orthoceras rushensis*? White, U. S. Geol. Survey Bull. 77, p. 22, pl. 2, figs. 14–16.
Permian: Military Crossing, Baylor County, Tex.
1892. *Orthoceras cribrosum.* Miller, Indiana Dept. Geology and Nat. Hist. Eighteenth Ann. Rept., Advance Sheets, p. 65.
Upper Coal Measures: Turner station, near Kansas City, Mo.
1894. *Orthoceras cribrosum.* Miller, Indiana Dept. Geology and Nat. Hist. Eighteenth Ann. Rept., p. 319.
Upper Coal Measures: Turner Station, near Kansas City, Mo.
1895. *Orthoceras rushense.* Keyes, Missouri Geol. Survey, vol. 5, p. 226, pl. 56, fig. 6. (Date of imprint, 1894.)
Upper Coal Measures: Kansas City, Mo.
1896. *Orthoceras cribrosum.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 253.
Upper Coal Measures: Poteau Mountain, Okla.
1896. *Orthoceras* cf. *rushensis.* Smith, idem, p. 253.
Upper Coal Measures: Scott County, Ark.
1897. *Orthoceras cribrosum.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 43.
Upper Coal Measures: Poteau Mountain, Okla.
1897. *Orthoceras* cf. *rushense.* Smith, idem, p. 43.
Upper Coal Measures: Scott County, Ark.

This is an abundant species in the Wewoka formation. All the fossils subsumed here are rather small, gradually but conspicuously tapering, with a circular or nearly circular cross section, and a central or nearly central siphuncle. The septa are moderately concave and are separated by intervals such that, as a rule, three chambers occur in the diameter at the point of measurement. The septa are essentially straight and transverse.

My specimens rarely, perhaps never, show the original surface. The best appear to be smooth, bearing hardly a trace of even incremental markings. Many show little round pits such as Geinitz described as a feature of *O. cribrosum.* These are sporadic in occurrence and irregular in arrangement. In some shells they project as tiny prominences instead of being depressed as tiny excavations. I have observed such markings on many kinds of cephalopods and am strongly disposed to believe, therefore, that, as suggested by Meek, this is not a characteristic feature of *O. cribrosum* or of any other species, but is an extrinsic feature.

Owing perhaps to the large number of specimens examined, for this species is common in the Wewoka formation, a considerable degree of variation has been observed. The cross section is in most specimens oval, though in some it is essentially circular. This difference is not generally ascribable to compression. The upper part of many specimens is flattened, particularly in the chamber of habitation, which is not strengthened by partitions, but the lower part of only a very few has been compressed. The siphuncle seems to be nearly central, though in many shells it is very slightly off the center and in a few it is distinctly so. If displaced it is usually to one side of the long axis. Probably in no feature do the specimens show greater variation than in the number of the chambers that occur in a given distance. Usually the number is three (four septa) in the diameter at any point, but not uncommonly it is a little more or a little less, the extreme limits being two and four. Almost all specimens with two to a diameter are small, though others of the same size have three. On the other hand, most specimens with four chambers are larger, but others of the same dimensions have the normal number, three. In a few the chambers are irregular in height.

Theoretically, one might regard those specimens with two chambers to a diameter as one species, those with three as another species, and those with four as still another. But in attempting to apply such a basis of discrimination one would find not only the intermediate conditions shown by different specimens, but also variations in the same specimen at different stages—variations that in some shells are considerable.

The suture has been described as in the main straight and direct, but this is especially true of the specimens which have a circular section. Those that are compressed tend to have shallow lobes on the broad side and low saddles on the narrow sides. In some shells, furthermore, the lobe on one of the broad sides is better developed than that on the other, so that the suture is slightly oblique.

A number of specimens have been found which seem to show the initial stages. These indicate that the shell does not taper directly to a point, but that at a diameter of 1 millimeter or less the slender cone is obliquely truncated, so that the apex occurs on one of the sides instead of at the center. The edges of the truncation and the apex itself are more or less rounded. The structures of this truncated end are not well shown, but at a diameter of 1 millimeter, or about 1 millimeter, the structure seems to be normal, the shell septate, and the siphuncle central.

The internal structures show modifications which make it impossible to regard this form as a representative of true Orthoceras. The siphuncle is rather slender at its passage through the septa, but just beyond them it abruptly expands on either side, about doubling in size; within the chambers it is fusiform in shape, for it is a little larger at the distal than at the proximal end. The funnels are short and thick(?). The chambers themselves are about half filled by a testaceous deposit which accumulated about the walls instead of about the funnels, as is the case in Orthoceras when there is any deposit at all. The deposit has a somewhat annular form but is much thinner distally than proximally. The thickness does not decrease regularly; it diminishes gradually at first, then abruptly, and then gradually again, so that in longitudinal sections of the shell the outline within each chamber is sigmoidal or even somewhat anglar or steplike. On the inner surface the deposit is more or less corrugated longitudinally, and in a few weathered specimens it appears to consist of elongated cysts, although in sections it seems to be solid. In some specimens the deposit is bounded by layers of a substance darker than the rest, which is variously distributed; it may be very thick where the deposit is thickest and abruptly thinned where the deposit is thinnest. Since in Orthoceras such deposits accumulated about the funnels and siphuncle, it may be asked whether, after all, what I have called the deposit is not a chemical infiltrate and what I regard as a chemical infiltrate is not the deposit. That this is not the case is indicated by the fact that the deposit in the peripheral region is uniform in character and distinctly lamellose in structure, whereas that in the axial region is variegated and more or less distinctly crystalline. Furthermore, the matrix, where it had access to the interior of the shell, is found filling not the marginal but the axial portion.

Owing to the regularly accumulated secondary deposits, specimens of this species paradoxically appear to possess a rather heavy outer shell and at the same time show the septa as if in an internal mold. Furthermore, specimens of Serpulopsis and in one instance of Stropholosia were observed in contact with and apparently attached to these secondary deposits which simulate the true shell. It would almost appear that the true outer shell is entirely missing. In a few specimens a film partly covers the shell and conceals the septa, but it is doubtful whether this is the real outer shell. The irregularly distributed pits already mentioned can hardly have anything to do directly with the sculpture or structure of the true outer shell. They may be indirectly connected with it, but their nature and function are unknown.

Two hypotheses especially invite attention in connection with these phenomena. One is that the outer shell was originally extremely thin; the other that it was originally of substantial thickness but has subsequently been lost through solution. The former hypothesis, which would also give a reason for the heavy secondary deposition, at first appears more probable, but it involves certain difficulties hard to explain. The chamber of habitation of most Orthoceras-like shells is relatively long—at least several times as long as one of the chambers—but one can hardly imagine a chamber of habitation as long as this and yet with a wall as extremely tenuous as the outer shell must have had if the indications are reliable. On the other hand, as the septa pass through the secondary deposits, the latter must be regarded as separate bodies confined in each case to a single chamber, so that the chamber of habitation, if strengthened by secondary deposits, must have been restricted in length to the chamber unit—another supposition scarcely admissible.

The second hypothesis, on the other hand, grows rather more probable as it is further considered. It is common, indeed, to find the shells of cephalopods dissolved away while the shells of brachiopods and other organisms are preserved in their original composition and structure. It is quite conceivable, therefore, that the shell of Pseudorthoceras might have been gradually dissolved out without the Serpulopsis or the Stropholosia or even the secondary deposits (which might readily have possessed a different molecular structure from the true shell) being affected; and that, as the shell was gradually dissolved, the parasitic organisms might have been brought into contact with the likewise resistant secondary shell, the inclosing shaly matrix having, under pressure, the action of a thoroughly plastic medium.

Some specimens possess an additional structure of very puzzling nature which suggests a second siphuncle more than anything else. It is marginal, lying in the peripheral surface of the secondary deposit and it looks like a narrow rod or band, usually preserved as limonite, having definite boundaries and being very distinct in every way. In some specimens this structure has weathered out, leaving an elongated cavity or, since it is especially developed in the lower part of each chamber near the apical partition, a linear series of cavities. This structure seems to have been observed by Herrick[1] in the species that he cites as *cribrosum?* and one resembling it seems to be figured by Miller in *O. colletti.* One specimen appeared to have a second structure of similar character on the opposite side. It hardly seems that these features can be adventitious, but nevertheless they appear on only a small proportion of the specimens examined.

In so far as McChesney's description of *O. knoxense* is complete and accurate and the characters of the present shell have been ascertained, it seems almost necessary to conclude that the shell belongs to

[1] Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 17, 1887.

McChesney's species. For ready comparison his original description is here quoted in full.

Shell very small, elongate conical, increasing but slightly in diameter in proportion to its length; septa circular, convex, distant from each other about one-third of their diameter; siphuncle minute, round and situated centrally.

Surface destitute of ornament, sometimes polished.

The only perfect specimen of this species in my possession is a very small one, and probably a young individual; but I have fragments from various localities of much larger specimens, apparently of the same species, which have the septa varying in distance from each other from one-sixth to one-fourth their diameter; from which it is probable that the chambers increase more in diameter than in length with their age.

This species differs from *O. moniliformis* of Swallow, in having a small siphuncle instead of a large one, and still more distinctly in being destitute of the annulations which, according to the description, constitute such a distinct feature in that species.

It will be seen that about the only characters which McChesney names are the smooth surface, small size, gradual enlargement, circular section, central (and small) siphuncle, and the fact that there are three chambers to a diameter. Other and larger specimens referred by him to the same species have four and even six chambers to a diameter. Some of the Wewoka shells seem to agree exactly in the characters named, although I have associated with them in the same species others which display certain differences, such as having less than three chambers to a diameter, having the section more or less compressed instead of circular, and having the siphuncle slightly eccentric instead of central.

In the synonymy of this species I have placed with some confidence the current identifications of *O. rushense*. The latter species was described in a rare work and was never figured by its author. Meek and Worthen, however, gave a figure of a doubtfully identified specimen, and it is probably from this figure that many of the recent identifications of *O. rushense* start. Meek and Worthen do not discuss this species, else some valuable data might have been expected as well as an explanation of an identification which seems almost certainly at fault. That the identification is wrong appears from the fact that McChesney describes *rushense* as being marked by shallow annulations spaced about equally with the septa and separated by shallow rounded depressions—a character entirely absent in the specimen figured by Meek and Worthen, which is represented as having smooth, gradually tapering sides without annulations. In discussing in 1872 the pitted surface which Geinitz described as characterizing *O. cribrosum*, Meek states that the same species occurs in Illinois, and that it is probably identical with *O. knoxense*. I can hardly doubt that it is this species which he figured in 1873 (with the same sculpture) but for some reason identified as *O. rushense*.

It seems probable that *O. cribrosum* is likewise a synonym of *P. knoxense*, though based on somewhat larger specimens, for the type has a diameter of 5 millimeters at the smaller end. As *O. cribrosum* is described as having four to five septa in 5 millimeters, this would seem to mean that three or four chambers occur in a diameter. The cross section is said to be elliptical, but is probably compressed. The position of the siphuncle was not known to Geinitz, who thought that it might be marginal. In that event, of course, *O. cribrosum* is not the same species as *knoxense.* It is this species to which Geinitz ascribed the pitted sculpture which Meek justly thought might be accidental. As already noted, this is a conspicuous feature of many specimens from the Wewoka formation. In some shells these markings are not pits but stand up from the surface as little spherules, apparently of ferruginous nature, for they are of a dark, rusty color. When these spherules are removed by weathering the pitted appearance results. In arrangement these markings are sporadic and in size variable. Some are large, others small. They are absent on some specimens and thickly cover others. On some they are scatteringly arranged or are concentrated on one side or on opposite sides. Personally I have not the least doubt that this character is adventitious in the specimens which I have examined. At the same time it seems to be connected with some intrinsic peculiarity not of any species but of the cephalopod shell structure generally. I have observed it often not only in the Orthoceras group but in the Nautiloid as well, and it is found in specimens from widely different localities and geologic horizons. I have not seen a similar phenomenon in other Mollusca—not even in specimens associated with the cephalopods. Miller[1] discusses this character in *O. cribrosum*, but comes to a conclusion different from that here expressed.

Meek's figure of *O. rushense*, which I am placing in synonymy, shows a surface pitted like the Wewoka form. The cross section, as represented by his figures, is strongly elliptical or compressed at the small end but is more nearly circular above, and the siphuncle is central. The number of chambers in a diameter at the small end seems to be three, but toward the large end it appears to be four, as in the Wewoka shell.

White's description and figure of *O. rushense*, given in 1884, leave much to be desired. The species is clearly not *rushense*, but it is not certain that it is *knoxense.* The chief difference that can be noted is that, according to the description, the surface is finely and distinctly striated in specimens from which the epidermis is not removed.

Herrick's identification in 1888, reprinted in 1895, is based on a Waverly form, much larger than the specimens here considered as representing *P. knoxense.* Like these, it has three chambers to a diameter, but as I have observed a decided tendency to a diminution

[1] Indiana Dept. Geology and Nat. Hist. Eighteenth Ann. Rept., p. 319, 1894.

in the proportional height of the chambers as growth progresses I infer that here also there is probably no agreement. Herrick's citation can with safety be eliminated from the synonymy.

Keyes's citation the same year (1888) is noncommittal. As he cites White (1884) in the synonymy and as he later (1895) again cites the species, giving a figure copied from White (without acknowledgment), it may be presumed that his shells are of the type of White's original rather than of Meek's, if there is any difference.

White's citation in 1891, from specimens obtained at a much higher horizon than either typical *knoxense* or the species here identified as such, is in doubt. The data which he furnishes are incomplete. His form is large and shows five or six chambers to a diameter. Whether this is excessive or not depends on the degree to which the characters of the smaller shells are conceived to be modified by growth. The form from Texas would hardly on this account, however, fall beyond the limits recognized originally by McChesney.

Smith cites this species, together with *O. cribrosum* from Arkansas, in 1897, but he does not give data by which his citation can be tested. His discrimination of *cribrosum* is apparently based on the pitted surface, which is probably an accidental character.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

PSEUDORTHOCERAS SEMINOLENSE Girty.

Plate XXVII, figures 7–8a.

1911. *Pseudorthoceras seminolense.* Girty, New York Acad. Sci. Annals, vol. 21, p. 143.
Wewoka formation: Wewoka quadrangle, Okla.

Three specimens in the collection appear to belong to Pseudorthoceras by reason of their central siphuncle and chambers partly filled by secondary deposits and at the same time to differ from *P. knoxense* by being very much larger. These large specimens have about 3½ chambers to a diameter and so do not differ essentially from the smaller species. One of the figured specimens is compressed and seems to show on one side a structure that suggests a marginal siphuncle. On the opposite side there is a slender strand of limonitic material, such as, in describing *P. knoxense,* I have called a "false siphuncle."

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

Family CYCLOCERATIDÆ.

Genus PROTOCYCLOCERAS Hyatt.

PROTOCYCLOCERAS ? RUSHENSE McChesney?

Plate XXVII, figures 9–10b.

1860. *Orthoceras rushensis.* McChesney, Desc. New Spec. Foss., p. 68. (Date of imprint, 1859.)

Coal Measures: Rush Creek, 5 miles below New Harmony, Ind.; Illinois.

Shell small, straight, conical, gradually enlarging. Cross section slightly elongate, so that the shape is elliptical. Position of siphuncle, height of chambers, and other features not shown. The surface is marked by strong, abruptly elevated annulations, which occur at varying but fairly regular intervals and are separated by relatively broad, flattened constrictions. The annulations, which are directly transverse, show fairly strong retral deflections or lobes on the narrow sides of the shell and are nearly straight or only obscurely concave over the broad sides.

Two specimens from station 2005 agree with the foregoing description and a third from station 2006 is tentatively referred to the same species, although it differs in having a circular instead of an elliptical section. A fourth specimen, also from station 2006, presents such differences that it probably must be regarded as a distinct variety.

I have elsewhere called attention to the fact that apparently through a clerical error, by which the name of one of McChesney's Carboniferous species was substituted for the other, Meek and Worthen gave currency to a wrong interpretation of *Orthoceras rushense*, causing it to appear in their work as a simple conical type, whereas McChesney distinctly described it as annulated. This and all subsequent citations of *O. rushense* based upon it may probably be transferred in a body to *O. knoxense*, leaving the synonymy reduced to the original citation. From this the following description is quoted literally and in full:

Shell small, elongo-conical, tapering gradually, slightly sometimes almost imperceptibly flattened on one side; septa subelliptical or nearly circular, convex, distant from each other from one-sixth to one-third their diameter; siphuncle cylindrical, central or nearly so; shell marked by shallow annulations about equally distant with the septa, and separated by shallow rounded depressions.

This species differs from both *O. aculeatum* and *O. occidentale* of Swallow in the siphuncle being nearly central, and from the former in the siphuncle not being formed of a succession of hollow spheres; but no surface character of those species being given, it is difficult to make any further comparisons.

I have a specimen from Coal Measure slate in Kentucky, which I take to be the same with the above; and if so, the siphuncle is irregularly cylindrical through the chambers and strongly constricted in the septa.

It is impossible to be certain, partly owing to incompleteness of information about the present form, partly owing to incompleteness in McChesney's description (unaccompanied as it is by figures), that the two forms are really the same; but, on the other hand, it is impossible to point out any very important points of disagreement. Perhaps the most tangible are (1) that McChesney describes *O. rushense* as slightly flattened on one side, whereas my specimens, except one which is circular, are flattened on opposite sides; (2) that the annulations on my specimens are apparently not quite so closely arranged, although this is not certain; and (3) that McChesney fails to mention the two slight sinuations or lobes occurring in the annulations on the narrow sides of the shell. I feel hardly justified, however, in proposing a new name until better distinctions are available.

Protocycloceras is described as including annulated orthoceratocones and cyrtoceratocones without longitudinal ridges, by the absence of which it is distinguished from Cycloceras. The siphuncle is large. Protocycloceras has previously been known only from the Ordovician, but Cycloceras is recorded from the Ordovician to the Permian. Partly influenced by the matter of range, I described under Cycloceras a species from the Caney shale of Oklahoma which was without longitudinal costæ. But other Carboniferous species besides that from the Caney and those here noted from the Wewoka formation show annulations without longitudinal plications, so that it seems better to place these shells under Protocycloceras, whose range would thus be extended into the Carboniferous and be practically coextensive with that of Cycloceras. Though these shells are probably to be regarded as distinct from Cycloceras, they are as yet imperfectly known and when all the evidence is in they may prove to be distinct from Protocycloceras also.

To Protocycloceras, in addition to the two types recognized in the present paper, may also be referred *Orthoceras lasallense*, distinguished from the present form by its more closely arranged annulations—*Cycloceras ballianum*, previously referred to, and *O. randolphense*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

PROTOCYCLOCERAS? RUSHENSE var. CREBRICINCTUM Girty.

Plate XXVII, figures 11-11b.

1911. *Protocycloceras? rushense* var. *crebricinctum*. Girty, New York Acad. Sci. Annals, vol. 21, p. 144.
Wewoka formation: Wewoka quadrangle, Okla.

Two specimens, though resembling *P.? rushense?*, are distinguished by having the annulations more closely arranged and somewhat alternating. The cross section is elliptical, as in that species, but an acceleration of expansion produces a flaring shape toward the aperture.

The recurrence of this latter character, which is found to a marked degree in one of the species of Orthoceras, is noteworthy and seems to bring its importance somewhat in doubt. Its significance is entirely unknown.

One of the specimens shows the surface to be marked by fine, subequal, somewhat wavy, threadlike, transverse liræ.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Family TRIBOLOCERATIDÆ.

Genus COLOCERAS Hyatt.

It would be difficult to name the type species of Coloceras and to this extent the genus is not well founded. Hyatt says: "The types of the genus are the specimens described above from Visé, De Koninck Coll. Mus. Comp. Zool., supposed to belong to *C. globatum*, sp. De Kon." [1] The *C. globatum* referred to is probably the form figured by De Koninck in the work which Hyatt had already mentioned,[2] but the species there described and figured is not De Koninck's but *Nautilus globatus* Sowerby. At least De Koninck regarded it as Sowerby's species, but Hyatt apparently places typical *Nautilus globatus* in the genus Planetoceras.[3] He makes this disposition of *Nautilus globatus* Sowerby as figured by Foord, whose identification, so far as the literature has come before me, is unquestioned.

But not all of De Koninck's *N. globatus* is referred by Hyatt to Coloceras, for apparently he regards figures 1a and 1b of Plate XXXI as belonging to *Coloceras coyanum* De Koninck.[4] Therefore Coloceras seems to rest on some specimens in the Museum of Comparative Zoology which are presumably conspecific with *Nautilus globatus* De Koninck (non Sowerby) pars (Pl. X, figs. 1, 2, 3, and Pl. XXXI, figs. 1c–1e, not 1a, 1b), which De Koninck thought, but Hyatt does not think, to be the same as *Nautilus globatus* of Sowerby.

COLOCERAS LIRATUM Girty.

Plate XXVIII, figures 2–6a.

1911. *Coloceras liratum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 144.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell small, the largest specimen seen measuring 34 millimeters in the plane of revolution. Shape subglobose. Cross section sublunate, somewhat gibbous at the sides. Ventral surface rather regularly curved, abruptly rounded inward at the umbilicus, forming two not very well defined umbilical zones, the direction of which is nearly hori-

1 Texas Geol. Survey Fourth Ann. Rept. (for 1892), [pt. 2], p. 451, 1893.
2 Faune du calcaire carbonifère, vol. 1, 1878, p. 95, Pl. X, figs. 2, 3, 4; Pl. XXXI, fig. 1.
3 Op. cit., p. 421.
4 Idem, p. 452.

zontal. At maturity the section is about twice as wide as high and the median line of the venter is broadly and faintly impressed. The rate of increase is rapid and the depressed zone is narrow, considerably less than half the width of the preceding whorl. The umbilicus is rather small and deep.

The surface is marked at the side by fine revolving liræ, separated by wide, flat interspaces. These extend from the umbilical zone over the subangular shoulder onto the extreme sides of the venter. In some shells the revolving liræ are crossed by much more closely arranged transverse liræ, producing fine crenulations. This cancellation seems to cover the entire surface in immature stages, but appears only in a band on the sides in the mature shell, and on the oldest specimens and some others the transverse markings can not be seen at all. The ventral surface is crossed by fine, incremental striæ, which indicate a deep subangular V-shaped sinus, whose sides are nearly straight over the median portion but curve gracefully outward with increasing rapidity toward the sides. In one specimen the striæ are so arranged that every seventh or eighth is stronger than the others which cross the slightly elevated spaces between in crowded though regular order.

The septa are rather far apart, about 6 millimeters along a median line in a mature specimen. They are nearly straight, except for slight sinuosity across the venter caused by the shallow ventral lobe and a pair of obscure saddles. The siphuncle appears to be situated below the center (dorsad) but is not well shown.

This species is related to *C. globulare*. It appears to be more slender (though specimens vary somewhat) and to have more widely spaced septa, which show a slight lobe instead of a slight saddle on the ventral surface. The sculpture of *C. globulare* is not known, so that additional differences may be discovered.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

COLOCERAS LIRATUM var. OBSOLETUM Girty.

Plate XXIX, figures 1–3a.

1911. *Coloceras liratum* var. *obsoletum*. Girty, New York Acad. Sci. Annals, vol. 21, p. 145.

Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Generally associated with *C. liratum* are specimens which show certain minor differences from that species, the most constant, perhaps, being the absence of liræ on the umbilical zone. Correlated with this is a more regular curvature at the sides, making the umbilical zones less well defined. The incremental markings are perhaps stronger, or are at least more regularly preserved. Some but not all of the specimens are rather narrow. As the sculpture on the typical *liratum* might easily be obscured, it is possible that some specimens of the latter may have been referred to the variety *obsoletum*. The siphuncle of the variety seems to be ventrad or at least central, whereas that of *liratum* is or appears to be dorsad. This feature, however, is shown by few specimens and is not well shown by any of my specimens of *liratum*.

There seems here to be a varietal or even a specific difference from *C. liratum*, but my material is not sufficiently good to show the degree of difference or the constancy of it, or whether possibly the shells assembled under this title are really conspecific.

Horizon and locality.—Wewoka formation: Wewoka quadrangle (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2004? and 2001).

Family TAINOCERATIDÆ.

Genus METACOCERAS Hyatt.

Temnocheilus and Metacoceras are closely related groups. Aside from differences more or less embryonic, which it is seldom possible to observe, the chief distinction between them seems to lie in the whorl section, which in Temnocheilus is triangular and in Metacoceras quadrate. In Temnocheilus the base of the imperfect triangle is the ventral surface, so that the shape contracts dorsally or toward the center. I have not seen it stated whether the two angles are the umbilical shoulders or the ventrilateral shoulders. From their position they would appear to be the latter, the lateral and dorsal zones not being differentiated, but it is possible to conceive of these angles as being the umbilical shoulders, the ventral and lateral zones merging and the umbilical zone being exceptionally broad. In Metacoceras, however, more distinct umbilical shoulders are developed. In Temnocheilus, therefore, the venter is broadest and the shell contracts to the impressed zone without umbilical shoulders. In Metacoceras, on the other hand, the umbilical shoulders are developed and the shell contracts from them to the ventral surface. An additional pair of saddles are developed on the umbilical shoulders.

Six American species of Metacoceras are recognized in the Carboniferous: *M. cavatiforme*, *M. dubium*, *M. hayi*, *M. inconspicuum*, *M. sangamonense*, and *M. walcotti*, and I am also provisionally removing *Temnocheilus crassum* to this genus. To these are added 6 forms from the Wewoka formation described below, making 13 in all. These species are divisible into four groups, as follows:

The first group, represented by *M. cavatiforme*, has the height and width of the chambers more or less equal, and consists of *M. cavatiforme*, *M. dubium*, and *M. inconspicuum*, and *M. cornutum* and its three varieties, *carinatum*, *multituberculatum*, and *sinuosum*, described in the present report. These species are also characterized by having a more or less distinct ventrilateral shoulder, furnished with spoutlike nodes, and a rounded or obscure umbilical shoulder.

A second group can probably be formed of *M. crassum* Hyatt and *M. perelegans* n. sp. In this the whorl section is similarly proportioned but is distinguished by having the sides marked by pilæ extending downward from more or less distinct nodes on the ventrilateral shoulder. *M. perelegans* has, in addition, a subangular umbilical shoulder at which the pilæ terminate in a second series of nodes less prominent than the ventral series.

M. sangamonense may perhaps be regarded as representing a third group distinguished from the first group by its concave sides and angular umbilical shoulders, and from the second by its lack of pilæ along the sides.

In a fourth group may be assembled *M. hayi* Hyatt, *M. sculptile* n. sp., and *M. walcotti* Hyatt. These forms have the height of the whorls much in excess of the width. In addition, the nodes along the ventrilateral shoulders are large and not very distinct in *M. hayi,* small and indistinct in *M. sculptile,* and almost completely obsolete in *M. walcotti.* This order coincidentally corresponds with their stratigraphic occurrence, *M. walcotti* being the oldest and *M. hayi* the youngest species.

METACOCERAS CORNUTUM Girty.

Plate XXIX, figures 4–5b.

1911. *Metacoceras cornutum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 145.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

This species is founded on a fragment which must have had a diameter of 70 millimeters exclusive of the chamber of habitation, no portion of which is retained. The whorl section is subquadrate, distinctly wider than high. The height is 23 millimeters and the width 29 millimeters. The ventral surface is gently convex, more nearly flat on the shell itself than on the internal mold. The sides, exclusive of the prominent tubercles, are nearly flat and parallel. The lower portion of the whorl is tripartite, consisting of an impressed zone about 12 millimeters wide and two umbilical zones, each about 8 millimeters wide. The umbilical shoulder is abrupt and angular, the angle being somewhat greater than a right angle. The ventrilateral shoulder is also angular and is furnished with large, prominent, compressed nodes, which project outward and slightly upward and are flattened on the upper surface and more convex on the lower. Those on one side alternate with those on the other and those in the same row occur on about every other chamber.

The septa are about 6½ millimeters apart, measured along the median line of the venter, and the sutures are rather strongly bent. There is a broad, deep ventral lobe, almost angular at the middle in some sutures; a broad, moderate deep lateral lobe, the point of greatest convexity being below or interior to the middle; and a gently curved internal or dorsal lobe across the impressed zone. Abruptly rounded saddles occupy the ventrilateral angles and a broad saddle, flattened across the middle, occupies each of the umbilical zones. Each of the saddles last named, however, may be regarded as composed of two obscure saddles, one on the umbilical shoulder and one on the angle of the impressed zone, a scarcely perceptible lobe lying between.

The sculpture is not well shown. On the ventrilateral angles and tubercles it consists of regular, strong, sharp, transverse liræ, which are deeply curved, suggesting a broad, deep hyponomic sinus.

The test appears to be considerably thickened at the ventrilateral angles, so that the internal mold differs appreciably from the perfect shell, the shell being flatter across the ventral surface, with the sides more convergent toward the umbilicus, and with the tubercles very much more produced. Indeed, on the internal mold the tubercles are not at all prominent.

In the prominence of the tubercles this form suggests *Nautilus latus* and *N. winslowi* of the "Coal Measures" of Illinois, the latter rather more than the former, but owing to the very different shape of the cross section (to judge by the description, no figures being given which illustrate this point) the present form must be regarded as belonging to a different genus, to Metacoceras rather than Temnocheilus. From the species of Metacoceras this would appear to be distinguished at once by the very prominent tubercles, but as most of those species have been described from internal molds and as the tubercles are much less conspicuous on the internal mold than on the shell itself, this difference must be discounted. The two most closely related species are evidently *M. dubium* and *M. inconspicuum*, the former more than the latter. The present species differs from *inconspicuum* in having a relatively broader section and in having the nodes farther apart, on alternating chambers instead of consecutive ones. *M. dubium* is described as having on the venter a depressed central zone with low, broad, longitudinal swellings on each side, features which, of course, are not found on the present species. The sutures appear to be less strongly flexed on the sides (the only place where they are shown) and they are differently shaped, having the greatest curvature toward the ventral rather than toward the dorsal side.

A second specimen has been included in this species, much smaller but more complete than the other. It answers to the foregoing description very closely, showing in addition the position of the siphuncle, which is almost exactly central. The sutures are naturally less strongly flexed. The growth lines are fine and regular, becoming stronger and coarser as they pass between the horns of the ventrilateral shoulder and sweeping backward to form a deep sinus across the ventral surface. When the development is traced backward to the immature stages, the cross section is seen to become more transverse and more regularly elliptical with obscure umbilical and ventrilateral shoulders. The horns on the ventrilateral shoulder become less and less prominent and extend farther down the sides of the shell, so that they are transformed into lateral plications without suggestion of especial prominence along the shoulder. The growth lines are also stronger and coarser.

This smaller specimen somewhat resembles *M. perelegans*, but is easily distinguished by the absence of nodes along the ventrilateral shoulder and of sharp pilæ across the sides. It is also very similar to *M. sangamonense* but presents a number of minor differences such as a section less spreading on the dorsal side, more prominent nodes or horns along the ventrilateral shoulder, less closely arranged septa, and a more nearly central siphuncle.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2001); Wewoka quadrangle, Okla. (station 2005?).

METACOCERAS CORNUTUM var. SINUOSUM Girty.

Plate XXX, figures 1–1b.

1911. *Metacoceras cornutum* var. *sinuosum*. Girty, New York Acad. Sci. Annals, vol. 21, p. 146.
Wewoka formation: Wewoka quadrangle, Okla.

A single fragmentary specimen which retains the shell is all that represents this variety. It is smaller than the original species and with a less transverse cross section. The nodes are rounded instead of compressed and extend part way down the sides as low, broad, obscure plications which fall far short of the umbilical shoulder. The latter is regularly rounded and although strongly turned is not angulated. The ventral surface is marked by two obscure sulci with a gentle convexity between. The tubercles appear to be nearly opposite.

The surface is almost smooth, the incremental lines being very obscure except on the tubercles, where they develop into regular, fine, though sharp liræ. They make a deep sinus on the ventral surface, are nearly straight and gently sloped backward at the sides, and gradually change direction at the umbilical shoulder, beyond which on the umbilical zone they are gently concave.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

METACOCERAS CORNUTUM var. CARINATUM Girty.

Plate XXX, figures 3–4c.

1911. *Metacoceras cornutum* var. *carinatum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 146.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

This variety is represented by two fragments which apparently show the chamber of habitation but do not retain the septa. They are partly testiferous and partly exfoliated.

The variety *carinatum* is distinguished from both *Metacoceras cornutum* and the variety *sinuosum* by its more abrupt expansion and more transverse shape, in which it exceeds even the original species itself. The sides are in consequence relatively very narrow. The tubercles are rounded, as in the variety *sinuosum,* but owing to the shortness of the sides they make more prominent plications. The ventral surface is rather strongly rounded and without sulci. The umbilical shoulder is very angular and is extended into a crest or carina, in which respect it shows a marked difference from the variety *sinuosum* though possibly not from *M. cornutum* itself. The growth lines indicate the presence of a deep hyponomic sinus.

It may be that these shells represent a young stage of *M. cornutum* (though hardly of the variety *sinuosum*), but they present certain differences (the abrupt expansion, greater breadth, and differently shaped tubercles) that are too important to make it safe to assume this relationship without more evidence.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (station 2004).

METACOCERAS CORNUTUM var. MULTITUBERCULATUM Girty.

Plate XXX, figures 2, 2a.

1911. *Metacoceras cornutum* var. *multituberculatum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 147.
Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

This variety is founded on a crushed specimen which differs from all the others in that the tubercles are smaller and more closely arranged. They appear to be somewhat compressed rather than rounded. The umbilical shoulder is subangular, without the crest of *carinatum,* but more rounded than *sinuosum.* The height between the ventrilateral and umbilical angles is about 10 millimeters; the width across the venter (tubercles included) about 15 millimeters.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

METACOCERAS PERELEGANS Girty.

Plate XXX, figures 5–6.

1911. *Metacoceras perelegans.* Girty, New York Acad. Sci. Annals, vol. 21, p. 147. Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell rather small, so far as known not exceeding 31 millimeters in diameter. Cross section of mature whorls hexagonal, transverse; width about 20 millimeters; height about 12 millimeters; width of lateral zone 7 millimeters; of umbilical zone 6 millimeters; of impressed zone 8 millimeters; of ventral zone, including tubercles, 17 millimeters. Ventral surface gently convex, flattened or slightly depressed along the center, gently upturned at the edges, owing to the tubercles. Lateral zone nearly flat except for the tubercles, the projection of which gives it a gently concave shape. Umbilical zone nearly flat. The lateral zone slopes gently outward from above and the umbilical zone strongly inward. When the shell is traced from the mature to the immature condition the transverse diameter of the cross section gradually equals then exceeds the longitudinal, so that the shape is more nearly elliptical, with an angular periphery a little above the middle and the usual recurved dorsal zone. Still considered with the actual order of development reversed, this change of shape results from an increasing inward slope of the umbilical zone and a corresponding loss of the umbilical shoulder. Both the ventrilateral and the umbilical shoulders, however, are more or less distinguished by an angulation.

The sculpture of the youthful stages is incompletely known, but the sides of the youngest example seen are marked by fine, even, transverse, rounded striæ, separated by narrow, sharp liræ. Later the flattened sides are marked by strong, regular plications, the folds being angular and the furrows between relatively broad and rounded. On these are superposed strong, incremental striæ, much less distinct in the furrows than on the crests between them. The pilæ thus gradually formed tend to become more prominent at the ends, developing little nodes in which they terminate, the nodes appearing at an earlier stage and more strongly at the outer than the inner ends. At maturity the connecting ridges gradually fail of development, leaving two rows of nodes, the larger and more prominent along the ventrilateral shoulder, the smaller and less prominent on the umbilical shoulder. Both these loci are well defined and more or less strongly angular during the periods of adolescence and maturity.

The sculpture at maturity consists of very obscure incremental lines which tend to become sharp liræ on the tubercles, and which show a deep sinus over the ventral surface.

The septa are not well exhibited by my specimens, though the fossil is fairly common in the Wewoka fauna. In a mature specimen they are 3½ millimeters apart along the middle of the venter; and the suture is very nearly straight, though depressed into a shallow ventral lobe with very obscure saddles on the ventrilateral shoulders. In the ventrilateral region the suture is likely to be more or less deflected by the pilæ, which are not developed exactly with regard to the septa. Some of the nodes occur on the septa; others occur between them, there being about three nodes to four septa. A young specimen which probably belongs to this species shows a suggestion of a very small, pointed dorsal lobe, somewhat like that of the genus Endolobus. The siphuncle appears to be central or somewhat below the center.

I know of no American nautiloid which this species so much resembles as that which Hyatt described as *Temnocheilus crassum*. The whorl section of *perelegans* is more transverse and somewhat differently shaped, with distinct umbilical shoulders. The pilæ have nodes at both ends instead of near the ventral surface only, and at maturity they disappear, leaving only the two rows of nodes.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

METACOCERAS SCULPTILE Girty.

Plate XXXI, figures 1–2a.

1911. *Metacoceras sculptile.* Girty, New York Acad. Sci. Annals, vol. 21, p. 148. Wewoka formation: Wewoka quadrangle, Okla.

Shell rather large, attaining a diameter of 67 millimeters, discoidal, with large umbilicus, 31 millimeters across at the diameter named.

Whorl section irregularly hexagonal, consisting of a relatively narrow ventral surface, two broad lateral surfaces, two umbilical zones, and an impressed zone, all narrow. The ventrilateral and umbilical angles are distinct and only slightly rounded. The ventral surface is marked by two shallow sulci situated close to the margins, on either side of which the shell rises slightly into a gently convex median portion and gently elevated ventrilateral angles. The sides are flattened and slope distinctly outward from above to the umbilical shoulder. There, with an abrupt subangular change of direction, they are withdrawn inward and somewhat downward to a rather deeply concave impressed zone. Greatest height of the final volution, 31 millimeters; greatest width (at the umbilical shoulder), 25 millimeters; width of ventral surface, 15 millimeters; width of lateral surface, 24 millimeters; width of umbilical zone, 8½ millimeters; width of impressed zone, 9½ millimeters.

The sculpture seems to consist of fine, even striæ, which follow the lines of growth, leaving between them sharp, strong, angular liræ. This sculpture, however, is more or less concealed in my specimens by a thin, even, superficial deposit, whether intrinsic or extrinsic I am unable to determine. This makes the surface look either smooth or, as the sculpture shows through, as though marked by obscure lines of increase. The liræ, which seem to strengthen and coarsen as they cross the ventrilateral shoulders, form a deep sinus on the venter. On the sides the direction is sigmoidal, convex above and concave below; similarly on the umbilical zone, save that the concave portion, which is below, is very slightly developed. When mature the ventrilateral shoulders are marked by small, rather indistinct nodes.

This species is of the type of *M. walcotti* and *M. hayi*. From both species it seems to differ in having the height proportionally less in comparison with the width; in having the sides contract toward the venter; in having the umbilical zones more nearly horizontal and the umbilical shoulders perhaps a little more angular. The nodes along the ventrilateral angles appear to be smaller and less distinct than in *M. hayi*, and the sculptured surface of *M. sculptilis* is not recorded for either species.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

Family OOCERATIDÆ.

Genus CYRTOCERAS Goldfuss.

CYRTOCERAS PECULIARE Girty.

Plate XXVIII, figures 1–1b.

1911. *Cyrtoceras peculiare.* Girty, New York Acad. Sci. Annals, vol. 21, p. 149. Wewoka formation: Wewoka quadrangle, Okla.

Shell rather small, expanding very rapidly. Apical angle about 60°. Axis nearly, if not quite, straight. The rate of expansion is so great that unless the animal grew to a very large size, the curvature of the axis would hardly be perceptible. The sides, therefore, appear to be nearly straight, but that on which the expansion is least strong may probably be regarded as the dorsal and the other as the ventral side. The siphuncle then is strongly dorsad. The cross section is broadly oval, contracting toward the dorsal side, which is somewhat flattened. Only five chambers are preserved, the oldest being about three times as high as the others. The prolongation of the chambers is so great on the ventral side that in the internal mold they make steplike projections. The sutures are nearly direct, but are more or less distinctly sinuated, with gentle lobes on the dorsal, ventral, and lateral surfaces and equally faint saddles between.

The extremely abrupt expansion distinguishes this species from the few other Carboniferous representatives of the genus known in North America. It is, however, extremely doubtful whether *C. peculiare* is a true representative of Cyrtoceras, a question which can be raised with equal propriety regarding the other American Carboniferous species referred to the genus.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

CYRTOCERAS ? ? sp.

Plate XXXII, figures 4–5a.

I am including under this title two specimens of extremely doubtful affinities. The general shape is conical with a rapid rate of enlargement. The larger specimen appears to be straight, but the smaller is so unequally developed that it appears to be curved; in both the apical portion is imperfect. The test of the smaller is moderately thick; that of the larger is much macerated. Both are marked by thin, strongly and sharply elevated lamellæ, rather closely and regularly arranged. The lamellæ are not straight, but have a gently sinuous course. They tend to be regularly unequal, every seventh or eighth being more prominent.

I have seen Orthoceratites with sculpture very similar to this, but these shells are not chambered, so far as is shown in their present condition. If they are really Nautiloids, their shape is, of course, much more like Cyrtoceras than Orthoceras. In its shape and sculpture the smaller specimen suggests Lingulidiscina, a genus to which the associated and kindred specimen could, of course, hardly belong, but the test is not phosphatic and the form probably does not belong in that group.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

AMMONOIDEA.

Family PRONORITIDÆ.

Genus PRONORITES Mojsisovics.

PRONORITES ? ? sp.

Plate XXXIV, figures 5–5c.

A small imperfect specimen of discoidal shape, having a diameter of about 15 millimeters and a thickness of 6 millimeters. The whorls are evolute and rapidly enlarging, leaving a wide umbilicus. The shape of the section is subelliptical, with a broad, gently concave, impressed zone. The sides are gently convex and the ventral surface more strongly rounded. The width is slightly greater toward the venter than below and the sides round in gradually to the impressed zone, so that there are no distinct ventral, lateral, or umbilical areas.

The suture is not shown over the venter, but, beginning with the margin of the impressed zone, there are six saddles and five lobes on each side, with probably a ventral saddle and two ventral lobes obscured. The first four saddles, beginning from the side, are small, but show a gradual and regular increase in size. They are rounded, more or less flattened on top, and progressively tend to be inequilaterally enlarged and to overhang on the inner side. The lobes are narrower and rather more pointed. The fourth one conspicuously bends outward under the projecting portion of the fourth saddle, which is developed in an opposite direction. The next two saddles and included lobe are considerably larger than the four lateral ones, the lobe being larger than the saddle. They are broad and almost symmetrically rounded.

The generic position of this form is uncertain, as the suture seems to agree with none of the genera with which I have compared it. The small size of the fragment suggests that its characters are not mature, and only because of this suggestion can it be even questioningly referred to Pronorites. It may prove to belong to an undescribed genus, but even if I were sure of this I would hesitate to base a new genus on this single small and imperfect example.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Family GASTRIOCERATIDÆ.

Genus GASTRIOCERAS Hyatt.

The relation between Hyatt's Gastrioceras and Glyphioceras (Goniatites s. s.) has always given trouble. According to the original author Gastrioceras includes species with open umbilici and whorls that are semilunar or trapezoidal in section. The abdomen is wider than the dorsum and the sides are often costated. As examples are given *G. listeri*, *G. marianum*, and *G. jossæ* of Europe, and *G. kingi* and *G. globulosum* of America. *G. listeri*, which is the first mentioned and possesses the essential characters ascribed to the genus, must be regarded as the genotype.

The typical group as based on *G. listeri* should include subglobose shells with trapezoidal section, broad, gently convex ventral surface, distinct subangular umbilical shoulders, inward-sloping umbilical zone, broad, open umbilici, and costated sides.

The suture Hyatt describes as having deep, straight-sided ventral lobes, and siphonal saddles which are often more or less prominent and angular. The first pair or primitive saddles are on the venter and often spatulate. Typically there are in the external suture two rounded saddles on either side of a small bifid siphonal saddle and two pointed lobes.

To a certain extent Hyatt confused Gastrioceras with Paralegoceras, since he referred to the latter genus *Gastrioceras russense*, because it had an additional pair of lobes in the external suture. Subsequent examination of *G. russense* showed, however, that there were the same number of lobes and saddles in that species as in typical Gastrioceras and one pair less than in Paralegoceras. Gastrioceras therefore agrees with Goniatites s. s. in having nine lobes and nine saddles and *G. russense* merely differs from the typical species in having parts of the suture external and visible which in the other are internal and invisible. In thus distinguishing *G. russense*, however, Hyatt was inconsistent, because this same peculiarity is shown by *Gastrioceras globulosum*, one of the original Gastriocerata, and, indeed, it appears in a considerable number of species which have subsequently been placed with Gastrioceras.

The distinction thus made between Gastrioceras and Goniatites s. s. is not an essential one, nor one always easy to apply. Hyatt described Gastrioceras as being subglobose with wide umbilici and trapezoidal or semilunar whorl section, the venter being wider than the dorsum.

When critically considered this last distinction loses much of its significance, if not much of its meaning. The venter in these species is not differentiated from the sides; in some species, however, a more or less angular change of direction accompanies the descent of the sides to the umbilicus. From its position, as well as from other considerations, it seems appropriate to consider this angle as the umbilical shoulder rather than as the shoulder which is sometimes developed at the junction of the sides with the ventral surface. This umbilical shoulder is almost invariably the widest part of the shell and it can probably be considered as dividing the ventrilateral area from the dorsal surface, whether it is angulated, or rounded and indistinct. Since, then, only two lines are distinguished, those which separate the ventral and lateral surfaces from the dorsal, and since these lines almost invariably project the most, it of necessity follows that the venter, by which term Hyatt doubtless designates all of the surface above the umbilical shoulders, is wider than the dorsum. Still more properly the dorsum and venter may be said to have the same width. Probably the point which Hyatt had in mind amounts to no more than that the umbilical shoulder is distinct and angulated.

A large proportion, at least, of the American species of Gastrioceras lack the costæ which mark the sides of the typical group. They are as a rule distinguished by being more or less evolute and by having a correspondingly wide umbilicus. Some, however, though evolute, are discoidal rather than globose. Thus no really persistent differences distinguish Gastrioceras from Goniatites, though the extremes of the series are reasonably far apart.

In studying some Goniatites of this group from the Caney shale I found that *G. choctawensis* (a typical Goniatites s. s.) was subglobose and had the umbilicus nearly closed throughout its development, whereas *P. richardsonianum* (a species related to *G. kingi*, which Hyatt included among the typical Gastriocerata), was in its early stages discoidal and composed of many slowly enlarging, highly evolute whorls. It was provisionally assumed that this difference in the development characterized the two groups Goniatites s. s. and Gastrioceras. Whether any of the species here included under Gastrioceras manifest this character in the early stages is not definitely known. It seems rather doubtful in the case of *G. wewokanum*, at least in a degree comparable with *G. richardsonianum*.

When Hyatt described the genus Glyphioceras [1] he did not name a genotype, but cited a number of species, among which he discriminated two groups. The name Glyphioceras would naturally attach itself to the first of these groups, of which *G. crenistria*, the species first named, would ordinarily be taken as the type species. If this course is followed, however, Glyphioceras becomes a synonym of Goniatites s. s., of which *G. sphæricus* is the type. Haug, however, has proposed to retain the name and associate it with the second group distinguished by Hyatt under Glyphioceras. Smith also, who in 1913 revised the American species of this group, assigns to Goniatites s. s. the first or typical division of the original Glyphioceras, and, following Haug, uses Glyphioceras for the second or less typical group. Under Glyphioceras thus redefined he includes four American species: *G. calyx*, *G. hathawayanum*, *G. læviculum*, and *G. pygmæum*. Now, it seems doubtful to me whether it is permissible thus to divert Glyphioceras from its original meaning, and, furthermore, whatever may be said of the European species of Glyphioceras so defined, it is not clear just how the American shells referred to that genus are distinguished from other genera. If Gastrioceras be restricted to shells closely similar to *G. listeri*, then the major portion of the American Gastriocerata would be removed from Gastrioceras, some of them possibly to Glyphioceras of Haug. I have elsewhere suggested that *Glyphioceras calyx*, as identified by Smith, may be a youthful stage of *Gastrioceras richardsonianum, mihi*. *G. hathawayanum* and *G. læviculum* are probably referable to the genus Gonioloboceras. After examining the type specimen of *G. pygmæum* I am inclined to believe that its proper position is with Goniatites s. s.

There are now assembled under Gastrioceras forms of so great variety that it would probably be more convenient to unite the two

[1] The derivation of this name being *γλυφίς, ἴδος* (not *γλῦφις* as given by Hyatt), the proper form is evidently Glyphidoceras.

groups (Gastrioceras and Goniatites) into one assemblage, since there is no real line of demarcation between them and since greater differences can be found between selected specimens of Gastrioceras than between selected specimens of Gastrioceras and Goniatites. The variation which exists among forms included under Gastrioceras is well shown by the American species. Fourteen out of nineteen species at present referred to the genus lack the lateral costæ of the typical Gastrioceras. Many have on the visible portion of the suture the additional saddles not shown in the typical section. Some have a much more discoidal shape than is typical and others lack the umbilical shoulder. The only point on which there is much agreement is in the relative size of the umbilicus, and even in this considerable diversity is shown. This character, on which in practice the differentiation of Gastrioceras from Goniatites seems mainly to depend, appears to me less essential than some of the others—more liable to variation in individuals of the same species. The development of an umbilical shoulder also appears to be of minor importance. Of somewhat higher significance is the development of costæ and especially the shifting of the lines which define the exterior and interior sutures so as to make visible an extra pair of lobes.

The typical Gastrioceras, in point of external or visible suture, has, besides the siphonal saddle, two lobes and two saddles on each side. There have, however, been referred to the genus a number of species in which a third lobe is exposed on the umbilical zōne. This is not an additional lobe, because the total number remains the same, there being nine lobes and the same number of saddles in all; it is only a transfer of that portion of the suture from the internal concealed area to the external exposed area.

This feature, indeed, suggests the existence of structural differences of some importance and can conveniently be utilized to divide the Gastriocerata into two sections. It can hardly be regarded as a mere narrowing and broadening of the impressed zone so that more or less of the suture is exposed to view, although that explanation may be applicable in some cases. If, for the sake of speculation, the shell be conceived as a very gradually tapering cone, which is flexible and has the sutures marked on it, a highly involute form with narrow umbilicus could be reshaped into an evolute form with broad umbilicus by a spreading out or flattening of the ventral surface, without any change in the edges of the impressed zone or, consequently, in the limits of the visible suture. Furthermore, the Gastriocerata are typically distinguished by just this configuration, the broad, gently convex venter and wide umbilicus. On the other hand, if the shell, conceived in the manner described, pass from an involute shape to an evolute one having a narrow venter, high volutions, and as a whole a discoidal instead of a globose shell, the narrowing of the venter would entail the narrowing of the impressed zone with a shifting of internal concealed to external visible sutures consequent upon it. However, as there are broad and narrow species in both Goniatites and Gastrioceras, an explanation of this sort, which would in a measure belittle the importance of the phenomenon, need not be sought even in the case of the narrow types which have the additional lobe on the visible suture. Furthermore, even in the case hypothetized, transformation of the shape from globose to discoidal, with a narrow instead of a broad impressed zone, might readily be accompanied by a rearrangement of the sutures, so that the internal sutures would be compressed within the narrowed limits of the impressed zone and the external ones expanded over the broadened visible portion of the whorl.

In our American Carboniferous fauna the typical section of the genus, which may be called the Gastriocerata celata, comprises 12 species: *G. caneyanum*, *G. carbonarium*, *G. entogonum*, *G. kansasense*, *G. kingi*, *G. nolinense*, *G. occidentale*, *G. planorbiforme*, *G. richardsonianum*, *G. serratum*, *G. subcavum*, and the species described as *G. venatum* (p. 254). These are divisible into several groups. *G. carbonarium* constitutes one group, and it is the most typical in one respect because of the costate sides. The cross section, however, is semilunar, narrowing ventrally. The suture has rounded saddles and rather narrow, pointed lobes.

Another group is distinguished by having strong, coarse, revolving striæ. This feature is possessed by *G. caneyanum* and *G. entogonum*. both of lower Carboniferous age. In section they are semilunar, The suture of *entogonum* is not known but *caneyanum* has rounded saddles and a broad, tongue-shaped, lateral lobe.

A third group comprises only *G. serratum*, characterized by its wide umbilicus, its trapezoidal section, by having its surface longitudinally striated down the venter, and by heavy plications on the sides. The suture is simple with rounded subequal lobes and saddles.

A fourth group distinguished consists of species that have rather wide umbilici and trapezoidal section with angular umbilical shoulders and distinct umbilical zones sloping strongly inward. The surface is smooth or marked by transverse lamellæ. Here belong *G. kingi*, one of the original species of Gastrioceras, *G. richardsonianum*, *G. occidentale* (with subnodose umbilical shoulders), *G. subcavum*, and *G. planorbiforme*. The sutures in these forms tend to have rounded saddles and pointed, more or less linguiform lobes; but no other general statement can be made regarding them.

There is possibly still another group much like the last, except that the umbilici are rather small and the sides round inward more gradually without a distinct umbilical shoulder. Two species are provisionally included here, *G. kansasense* and *G. nolinense*. Both may have had a distinct umbilical shoulder in the testiferous condition, and both, especially *G. kansasense,* may really belong in the preceding group. *G. nolinense* is additionally distinguished by having the saddles as well as the lobes pointed and tongue-shaped, in which it differs so far as known from all the other species here included under Gastrioceras.

Probably still another group must be established for *G. venatum,* described below. This has rather wide umbilici and subangular umbilical shoulders. The sides are plicated and the ventral surface marked by sublamellose transverse striæ. The suture appears to be rather primitive, both lobes and saddles being rounded.

In the nontypical group, or the Gastriocerata aperta, may be included, with more or less confidence, *G. branneri, G. compressum, G. excelsum, G. globulosum, G. illinoisense, G. listeri, G. montgomeryense, G. welleri,* and the two species described as *G. angulatum* (p. 256) and *G. hyattianum* (p. 254). These may be divided into two groups: (1) Species with costate sides (*G. branneri,* a slender, evolute, discoidal shell without distinct umbilical shoulders, and *G. listeri* and *G. montgomeryense,* evolute shells with broad cross section and angular umbilical shoulder), and (2) species whose sides are not costate (*G. compressum, G. excelsum, G. globulosum, G. illinoisense, G. welleri, G. wewokanum,* and *G. angulatum*).

All these species appear to have a distinct, subangular umbilical shoulder except possibly *G. illinoisense,* whose characters in this particular are not clear from the description; and it is not unlikely, as most of the species were described from internal molds, that the shoulder in all of them was more angular than it now appears to be.

All the species in group 2 have a broad, gently convex venter, except *G. compressum,* which is compressed and discoidal in general shape. *G. illinoisense, G. welleri,* and *G. wewokanum* are more or less intermediate in this respect between *G. compressum* on the one hand and *G. excelsum, G. angulatum,* and *G. globulosum,* which represent the opposite extreme, on the other. There is not much variation in the relative size of the umbilicus, but the species with plicated side are distinctly more evolute than the other. Of the nonplicated types *G. wewokanum,* though showing considerable variation, is somewhat distinguished by its narrower umbilicus.

All the species of whatever configuration agree in having the lobes pointed and the saddles rounded except *compressum,* which is unique in other particulars. That species is represented as having the saddles pointed on the outer side of the thick suture, but rounded on the inner. In *G. montgomeryense,* which is based on a small and possibly immature form, both lobes and saddles are rounded, the latter more broadly than the former, and in *G. listeri* the umbilical lobes are rounded instead of pointed. The detail of the sutures, of course, varies in different species, the lobes being more acutely pointed in some than in others, and the sides of both lobes and saddles being nearly straight in one and more sigmoidal in another.

Gastrioceras venatum Girty.

Plate XXXII, figures 1–3b.

1911. *Gastrioceras venatum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 149. Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell small, attaining a diameter of 18 millimeters, compressed globose. Umbilicus rather large. Whorl section lunate, somewhat tumid at the sides, with an ill-defined umbilical shoulder.

Sculpture consisting of angular pilæ or plications at the sides with relatively broad, rounded interspaces. The pilæ are short and divide irregularly into three or four branches of inferior size and prominence. Similar small plications are developed simultaneously in the sulci between the pilæ, all of which become crowded and finer, so that the venter is crossed by regularly arranged, moderately coarse and strong striæ which are bent into a rather broad, deep sinus as they pass to the other side.

The suture is rather simple. The siphonal saddle is small and indented on top, but the remaining lobes and saddles are rounded. The first lateral saddle is rather broad and symmetrical, the second still broader and very asymmetric, its outer side being straighter and more extended than the inner. The two lobes are symmetrical. The first is very small, narrower than the siphonal saddle. The second is fully twice as large as the first and somewhat more spreading.

This species resembles the few Carboniferous American Gastriocerata that have plicated sides, but the plications are finer and branch in a rather unusual manner. The suture is also distinctive in that the lobes are rounded instead of angular. In some respects the characters shown by this species suggest that it represents an immature stage, but some 15 specimens have been examined, all of which are of small and more or less uniform size.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006); Coalgate quadrangle, Okla. (station 2004).

Gastrioceras hyattianum Girty.

Plate XXXII, figures 6, 6a; Plate XXXIII, figures 1–4d.

1911. *Gastrioceras hyattianum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 150. Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell subspherical with relatively wide umbilicus when young; compressed globose with relatively narrow umbilicus when mature; attaining a rather large size, the largest example having a diameter in the plane of revolution of 65 millimeters and being about 37 millimeters thick at the widest part of the final volution. Umbilical shoulder angular and more or less carinated at all stages except perhaps when very immature. Cross section broadly lunate in the young and narrowly lunate in the mature condition. In the latter the curve of the venter and sides, which are not differentiated, is parabolic, gradually expanding toward the umbilicus and much more strongly curved above than at the sides. In this condition the whorls are deeply embracing. Specimens of nearly the same size seem to vary considerably in thickness, some being more discoidal, others more globose. The chamber of habitation is long, one volution or possibly more.

The surface when very young is probably cancellated with fine transverse liræ and fine revolving ones. In an early mature condition the strength of the liration seems to have diminished considerably. The transverse liræ are finer but persistent, and the revolving liræ are restricted to the umbilical surface and to the sides of the ventrilateral surface, the major portion of the venter showing only transverse markings. These have a more or less sinuous course with a gentle saddle in the center and obscure lobes toward the sides. When mature the shell seems to have had a perfectly smooth surface without liræ of either sort, except possibly a few revolving ones on the umbilical shoulder. My specimens do not show this sculpture except here and there, and the foregoing statements are based on scattered observations and not on any one specimen, still less on a series of specimens showing consecutive changes.

The suture (observed on a shell in an early mature stage) shows a high, narrow ventral saddle, indented on top, and two rounded lateral saddles, the first of which is relatively narrow and symmetrical and the other broad and asymmetric. Both are considerably higher than the ventral saddle. The two lobes are tongue shaped, the inner one being narrow and the outer broad and asymmetric. A third, broad, tongue-shaped lobe, smaller than the others, is found on the umbilical zone.

This species closely resembles *Gastrioceras occidentale*, the only positive difference of any moment suggested by the description and figures being that the umbilical shoulder of the latter is obscurely crenulated or subnodose. As neither the suture nor the sculpture are known, however, adequate grounds for comparison are wanting.

Gastrioceras globulosum also resembles the present form, but it is a much thicker shell with somewhat differently shaped sutures and slightly different sculpture, for the transverse liræ are more sinuous and no revolving liræ are developed.

Although they are, of course, intrinsically very different, *Gastrioceras hyattianum* presents many points of resemblance to *Coloceras liratum*, and it is extremely difficult to distinguish some specimens of one form from specimens of the other, especially as they occur in association. Of course, when the suture is visible the distinction can be made at a glance. Mature shells of *G. hyattianum* attain a size much larger than is yet known in the Nautiloid, and their shape is more discoidal. This difference, however, is much less conspicuous in young specimens. The shell in *C. liratum* expands more abruptly and the umbilical shoulder is somewhat less angular and lacks the carina or crest that is commonly developed in the other species. The sculpture, singularly enough, is very similar in the two types and in the main is restricted to the same areas, around the umbilici. The transverse markings in the Nautiloid, however, indicate a deep hyponomic sinus, whereas in the Goniatite they traverse the shell more directly and even bend outward into a saddle rather than form a sinus. Frequently also the presence or absence of constrictions is an assisting factor, since the constrictions appear to be invariably present in *G. hyattianum* and invariably absent in *C. liratum*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005, 2010?, and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

GASTRIOCERAS ANGULATUM Girty

Plate XXXIV, figures 1–3d.

1911. *Gastrioceras angulatum.* Girty, New York Acad. Sci. Annals, vol. 21, p. 151. Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

Shell of medium size, subglobose. The largest specimen has a diameter of 32 millimeters. Cross section trapezoidal, much wider than high. Umbilical shoulders very angular. Umbilicus wide and deep. Ventral surface broadly rounded, more or less parallel to the impressed zone. Constrictions about five to a volution, gently curved across the venter with the convex side forward. A typical specimen has a diameter of 30 millimeters with an umbilicus 16 millimeters wide. The thickness at the widest part of the final volution is 25 millimeters. The height of the final volution is 7 millimeters, the width of the impressed zone 17½ millimeters. A small specimen having a diameter of 15 millimeters is composed of 7 volutions.

The surface over the venter appears to be smooth in mature shells. The region of the umbilical shoulder, however, is marked by moderately coarse revolving liræ, crossed by about equally coarse transverse liræ. This cancellated area appears to be narrow and to extend to or just beyond the umbilical shoulder, leaving the umbilical zone smooth. Doubtless in the younger stages the whole surface was cancellated, though this fact is not shown by my specimens. In the later stages also the transverse cancellating liræ appear to be absent, leaving only a few revolving ones on the umbilical shoulder.

The suture is not well shown by my specimens. There is a narrow bifid siphonal saddle with sigmoidal sides. The first lobe is extraordinarily narrow, not so wide as the siphonal saddle and less than half as wide as the second lobe. Both the lobes are tongue-shaped. The saddles are rounded, the first a little broader than the second, and they are considerably higher than the siphonal saddle. The umbilical shoulder passes through the outer side of the second saddle and doubtless a third tongue-shaped lobe is situated on the umbilical zone. The internal sutures consist of three tongue-shaped lobes of very nearly equal size and shape, two rounded saddles also nearly equal, and half of two others, one at either margin, each being interrupted by the limit of the depressed zone.

This species resembles especially *Gastrioceras globulosum*, *G. welleri*, and *G. subcavum*. From *globulosum* it differs in having more compressed whorls and a wider umbilicus. The suture is somewhat different, notably in the shape and relative size of the saddles. Difference can also be found in the sculpture, *angulatum* having rather strong transverse and revolving lines, but only at the sides, whereas *globulosum* has only transverse lines which, moreover, seem to cross the ventral surface and to have a more sinuous course.

Smith does not compare his species *G. welleri* with *G. subcavum*, but they appear to be very closely similar, if not entirely identical. From both of these *G. angulatum* presents slight differences in shape, sculpture, and suture, of about the same character as those already pointed out for *G. globulosum*. There is not so marked a difference in the size of the umbilicus, but *angulatum* is a broader form with less convex venter.

There can hardly be a question of the specific distinction between this and *G. hyattianum*, but they appear to intergrade to some extent and it is difficult to refer some young specimens satisfactorily to one form or the other. The striking difference in shape is less obvious when immature examples of *hyattianum* are in point. The sutures are or appear to be distinctive in each species, but they are seldom shown. The sculpture appears to be similar in general character and similarly restricted to the umbilical region, but so far as seen that of *angulatum* is coarser than that of *hyattianum*.

The constrictions of *angulatum* are more regularly curved, those of *hyattianum* more sigmoidal. The constancy of these differences is more or less questionable. Young specimens, unless very typical, can hardly be distinguished by differences in shape. I am also inclined to doubt the value, without corroboration, of the shape of the constriction. The sculpture, when discernible, will probably be found a better differentiating character, and the suture the best of all.

In shape, too, *G. hyattianum* appears to be related to *G. welleri*, which is more or less intermediate in this respect between the two forms found in the Wewoka formation.

G. angulatum may possibly be based on small examples belonging to the same species as the much larger fragment identified as *G. excelsum.*

The small specimen (Pl. XXIV, fig. 3) deserves some special mention in connection with the rather similar one referred to *G. hyattianum.* In the shape, the size of the umbilicus, the curvature of the ventral surface, and so forth, there is no appreciable difference between the two specimens, although one referred to *angulatum* is rather wider. The sculpture is missing from both. In the form referred to *angulatum* the constriction is straighter and considerable differences in suture can be found, such as a narrower ventral lobe and a wider first lobe and saddle, differences which ally it with mature *angulatum* rather than with mature *hyattianum.* Further, the lateral lobe points less inward and the second lobe occurs well on the umbilical zone instead of on the angular umbilical shoulder.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2006 ? and 2005); Coalgate quadrangle, Okla. (station 2001).

GASTRIOCERAS EXCELSUM Meek.

Plate XXIV, figure 4.

1876. *Goniatites globulosus* var. *excelsus.* Meek, U. S. Geog. and Geol. Survey Terr. Bull., vol. 1, 2d ser., p. 445.
Coal Measures: Osage, Kans.

1896. *Gastrioceras excelsum.* Smith, Leland Stanford Junior Univ. Pub., Contrib. Biology Hopkins Seaside Lab. No. 9, p. 50, pl. 17, fig. 1.
Lower Coal Measures: Pope County, Ark.

1897. *Gastrioceras excelsum.* Smith, Am. Philos. Soc. Proc., vol. 35, p. 50, pl. 17, fig. 1.
Lower Coal Measures: Pope County, Ark.

1903. *Gastrioceras excelsum.* Smith, U. S. Geol. Survey Mon. 42, p. 88, pl. 16, fig. 2, pls. 28, 29.
Upper Coal Measures: Osage, Kans.
Middle Coal Measures: Pope County, Ark.

The collection contains only one specimen of this type, and it is very fragmentary, but it probably belongs to the species cited above because of its large size and its agreement with that species in such characters as it is possible to observe. However, although 62 millimeters wide, it is much smaller than the very large specimen which is possibly to be regarded as the type of *G. excelsum.*

A rather interesting question is involved in the determination of the type specimen of *G. excelsum.* In 1866 Meek and Worthen figured as *Goniatites globulosus* a specimen from an unknown locality in eastern Kansas differing in size and some other points from the Illinois material on which the species was founded. In 1876 Meek gave an account of a still larger specimen from Osage in eastern Kansas and suggested that the shell figured 10 years previously might belong to the same species. Because of the large size of this later specimen Meek introduced the varietal name *excelsus*, but he not only did not figure the shell but did not even give any character, except size, by which it could be distinguished from *globulosus*. I am rather disposed to think that without the figure given in 1866, the name, which Smith subsequently raised to the rank of a species, should be regarded as a nomen nudum, whereas with this figure the office of type would appear to revert to the specimen it represents. Smith, however, regards as the type the large specimen now in the National Museum, which was the subject of Meek's very incomplete memorandum in 1876. The Wewoka fossil is much smaller than the latter and somewhat smaller than the specimen first figured. It may be a very large example of the form described above as *G. angulatum*.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Family AGANIDIDÆ.

Genus DIMORPHOCERAS Hyatt.

DIMORPHOCERAS LENTICULARE Girty.

Plate XXXV, figures 1–1b.

1911. *Dimorphoceras lenticulare*. Girty, New York Acad. Sci. Annals, vol. 21, p. 152. Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

This species is known only from one or two fragments, but the characters shown are sufficient for a fairly complete description.

The shape is discoidal, much thicker at the umbilicus than at the venter. The size indicated is about 40 millimeters in diameter and about 13 millimeters in thickness. As only the septate portion is known, complete specimens must have been considerably larger. The umbilicus was small and the shell highly involute. The shape of the whorl section is somewhat triangular, slightly higher than broad. The sides are gently convex, strongly and regularly contracting to the ventral surface, which is narrow and sharply rounded. Probably there was a more or less distinct umbilical shoulder and a narrow umbilical zone.

There is a broad, rounded ventral saddle with a median notch. The lateral sutures consist of two parts, that toward the umbilicus having large turns and that toward the venter having small ones. The small folds, which comprise two lobes and a saddle, can be thought of as a large lobe coordinate with those toward the umbilicus, which has been divided by a median saddle. The three plications thus formed are nearly equal, but the first lobe and the saddle are rounded, whereas the second lobe is tongue-shaped. The saddle is a little narrower than the two lobes and the second lobe projects a little farther backward than the first. The remainder of the suture consists of high angular plications, a saddle and a lobe, together with the major part of another saddle, all of which probably come within the limits of the visible suture when fully exposed. These lobes and saddles are asymmetric and have more or less sigmoidal sides. They are so arranged that the point of the lateral lobe is almost in contact with the outer side of the preceding lobe somewhat less than halfway up. The final saddle is broad, rounded, and asymmetric.

The only American species of Dimorphoceras is *D. texanum,* which presents numerous differences. It is a more compressed or discoidal shell with the cross section much narrower for the height. The venter bears a median groove whereas in this species it is rounded. Smith states that the groove is a mature character, the venter of the youthful stage being rounded. However, the specimen on which *lenticulare* is based can hardly have been more than half a volution smaller than the type of *texanum.* The suture also differs in that the first lobe of the group of small lobes is rounded and relatively broader in *lenticulare* than in *texanum* and the inner sides of the large lateral saddles do not not come in contact as in the latter.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2005); Coalgate quadrangle, Okla. (station 2001).

DIMORPHOCERAS OKLAHOMÆ Girty.

Plate XXXV, figures 2–2b.

1911. *Dimorphoceras oklahomæ.* Girty, New York Acad. Sci. Annals, vol. 21, p. 152. Wewoka formation: Wewoka quadrangle, Okla.

Shell lenticular in shape, thick in the middle, thin at the edges. Diameter, 50 millimeters; thickness, 20 millimeters. Highly involute with small umbilicus, measuring about 5 millimeters. The whorl section is more or less triangular, with gently convex, converging sides and narrow, strongly rounded venter. Umbilical shoulder distinct; umbilical zone narrow.

Ventral saddle rather narrow, indented on top. The two small ventral lobes are pointed and tongue-shaped, the first one short, the second long and narrow. The saddle between them is rounded. There is not much difference between these four lobes and saddles in the matter of width. If anything the ventral saddle and the small lateral saddle are a little wider than the two lobes. The large lateral saddle and lobe are about equal, moderately narrow with somewhat sigmoidal sides. There also seems to be part of another large, rounded, asymmetric saddle. Only part of the outer limb of this is retained on the only specimen found, but probably the remainder appeared on the confines of the visible suture not exposed in the type.

This species is most closely related to *D. lenticulare,* from which it has been discriminated because of the suture. The differences manifested in this feature can hardly be ascribed to difference in age, because the two type specimens must have been nearly of a size and presumably of corresponding stages of development. The differences noted are the narrower ventral saddle, the pointed instead of rounded shape of the first small lobe, and the much-elongated shape of the second. The outer sides of the first large lobe are also more approximate. *D. oklahomæ* differs from *D. texanum* in about the same characters pointed out for *D. lenticulare*, but is rather more closely related. This is shown, for instance, in the first small lobe, which is pointed in *oklahomæ* and *texanum* but rounded in *lenticulare*.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Genus **GONIOLOBOCERAS** Hyatt.

1900. Gonioloboceras. Hyatt, Zittel's Textbook of paleontology (Am. ed.), p. 551.
1900. Milleroceras. Hyatt, idem, p. 550.
1903. Gonioloboceras. Smith, U. S. Geol. Survey Mon. 42, p. 123.
1903. Milleroceras? Smith, idem, p. 127.

This name was introduced by Hyatt in Zittel's Textbook of Paleontology. He did not describe the genus but merely cited a type, *Goniatites goniolobus*, and so far no description of the genus appears to have been given, though the characters of the type species are pretty well known. As based largely on the type species, Gonioloboceras is discoidal in shape, with deeply embracing volutions, which are narrow and sometimes canaliculate over the venter. The umbilicus is narrow or closed. The sutures consist of a large siphonal saddle indented or open on top with two lateral lobes and one ventral saddle, all large and all pointed except the lateral saddle which is incomplete and rounded. The sides are nearly straight or gently curved (not sigmoidal), so that the lobes and saddles are strongly angular, not tongue-shaped. The siphonal saddle is, however, more or less tongue-shaped with sigmoidal sides.

By this description, founded principally on the type species, the differences between Gonioloboceras and Goniatites s. s. are not striking. So far as known they consist only of the compressed and very discoidal shape of Gonioloboceras and the sutures, which are characterized by the large siphonal saddle, the nearly straight instead of sigmoidally curved sides of the lobes and saddles, and the angular shape of the ventral saddles, which are nearly like the lobes. The saddles in Goniatites are usually rounded, but in some species (for instance, *G. choctawensis*) they are rather narrow and pointed.

As a synonym of this genus I am placing Milleroceras Hyatt, as already suggested by Smith. Like Gonioloboceras, which was introduced in the same work, Milleroceras was named but not described, though a genotype (*M. parishi*) was selected. In shape and suture

Milleroceras parishi approaches *Gonioloboceras goniolobum* very closely, the only essential difference being that the siphonal saddle of *parishi* appears not to be indented on top, a feature which might easily be concealed or obscured in the small shell that forms the type of Milleroceras, and which in fact seems not to be present in all specimens of Gonioloboceras (cf. *G. welleri*).

In view of the fact that Milleroceras first appears on page 550 of the same work[1] in which Gonioloboceras was introduced on page 551, I do not know that I am justified in using the name Gonioloboceras for this group. As the type species of Milleroceras is based on a small and possibly immature specimen, it would doubtless be advantageous to have the genus referred back to the large, fine original of *Gonioloboceras goniolobum*.

In addition to the type species named by Hyatt, Smith has also referred to Gonioloboceras, *Goniatites allei* Winchell, *G. limatus* Miller and Faber, and *G. welleri* Smith. I am here adding to the genus a new variety of Smith's species together with *Milleroceras parishi* and also tentatively *Goniates hathawayanus* McChesney and *G. læviculus* Miller and Faber, which Smith places under Glyphioceras as restricted by Haug.

The species thus provisionally assembled show considerable variation, so that were they to be separated into different groups the group containing the genotype *G. goniolobum* would embrace in addition only *G. parishi* and that somewhat doubtfully. After carefully examining the type specimen of *G. allei*, which Smith refers to Gonioloboceras, I find that I can not agree that that species is a proper member of the genus. It has the shape of Gonioloboceras, compressed and discoidal with very small umbilicus, but the sutures are those of the typical Goniatites, with rounded lobes, small siphonal saddle, and strongly sigmoidal curves to the sides of the lobes and saddles. Though not globose, as is typical Goniatites, this species appears to be more strongly allied with Goniatites than with Gonioloboceras.

Another group is typified by *G. welleri* which shows certain modifications of the suture that make it more or less intermediate with Goniatites s. s. The shape is discoidal, with narrow venter and small umbilicus, but the periphery has a median channel bounded by two angular ridges or carinæ. The siphonal saddle is large. The lobes and saddles (except the lateral saddle) are pointed, though not so sharply as in typical Gonioloboceras, and their sides are sigmoidally curved. Here doubtless belongs also the variety *wewokanum*, in which the sinuous curvature of the sutures is less distinct than in typical *welleri* but the lobes and saddles more obviously rounded. *Goniatites hathawayanus* too, which Smith refers to Goniatites s. s.,

[1] Zittel's Textbook of paleontology (Am. ed.).

is highly suggestive of the present group of Gonioloboceras, since it is discoidal with a narrow venter which is traversed by a linear sulcus. The umbilicus is described as comparatively wide and shallow, but this is not clear from the only figure given. The latter shows the septa only imperfectly, but they appear to resemble those of *G. welleri* var. *wewokanum*. They have the lobes much more sharply turned than the saddles, the sides of which appear to be a simple curve not sigmoidal.

The species thus far considered are of Pennsylvanian age. Two Mississippian species may very provisionally be added—*Goniatites limatus* and *G. læviculus*—one of which Smith refers doubtfully to Gonioloboceras and the other to Glyphioceras. I do not see by what characters these two forms should be referred to different genera. In shape they are almost identical. The suture of neither species has been shown in detail, but so far as can be determined they do not differ materially. The siphonal saddle of *limatus* is not represented nor described as indented, but this fact would be adverse to receiving *limatus* rather than the other species into Gonioloboceras (*G. parishi* has the siphonal saddle similarly pointed). This character, however, may well be obscured (compare also *G. welleri*). The two lobes appear to be somewhat more angular in *limatus* than in *læviculus*, but this difference is no more marked than in *G. welleri* and the variety *wewokanum*. These differences certainly do not impress me as being generic; but, although I would treat both species in the same way, I am doubtful as to what group they should properly be referred. If they belong with Gonioloboceras, where Smith has tentatively placed one of them, they form a distinct group by reason of their relatively wide umbilici (compare, however, *G. hathawayanum*). It is possible, however, that they belong with *A. meslerianum*, the species which I made the type of the subgenus Adelphoceras.

GONIOLOBOCERAS WELLERI var. GRACILE Girty.

Plate XXXV, figures 3-5b.

1911. *Gonioloboceras welleri* var. *gracile*. Girty, New York Acad. Sci. Annals, vol. 21, p. 153.

Wewoka formation: Wewoka quadrangle, Coalgate quadrangle, Okla.

This species shows a diameter of 53 millimeters in a fragment entirely septate, but the type specimen has a diameter of 43 millimeters, and its thickness through the center is 14 millimeters. The umbilicus is small, only 3 millimeters wide, and the whorls are highly involute. The sides are gently convex, contracting to a very narrow venter marked by a revolving channel guarded by two thin, angular ridges. In the early stages the shell is less compressed and the venter less distinctly channeled. When still younger the venter was probably rounded, but the two carinæ with their inclosed groove are largely a development of the test and do not show clearly on the internal mold. The surface appears to be marked by obscure, incremental liræ, the direction of which indicates a deep, broad, hyponomic sinus.

The suture consists of two lobes and two saddles on each side, together with a high, broad siphonal saddle, which is rounded, but has a notch on the median line. The latter feature is not clear. The suture lines bend sharply backward near the middle, but in most specimens they appear to be disconnected. In one, however, they appear to connect into a small V-shaped reentrant angle. The second saddle is broad and asymmetric. The first saddle and the two adjacent lobes are very nearly equal, the second lobe being slightly broader. They are subangular but not acutely pointed. The sutures are closely arranged, the inner sides of the first saddles being almost in contact.

This form is closely related to *G. welleri* but differs in some particulars. Smith figures two mature examples of *G. welleri*, and it is perhaps desirable to distinguish between the type and the auxiliary specimen. The type specimen of the variety *gracile* is a little more compressed than the original specimens, but I am not sure that the difference would be constant. The venter also seems to be narrower than either of them and to show the channeled condition at a stage when the type was rounded. The sutures are more closely arranged than in Smith's second specimen, in which this feature is better shown and from which the detail was drawn, but not more closely than in the type. The sides of the lobes and saddles in *G. welleri* are more sigmoidal as given by Smith, and they are very nearly a constant distance apart, whereas in the variety *gracile* they are nearly in contact at one point, as described above, and the first lobe is much narrower. These differences are not so marked in the type specimen of *G. welleri*, in which the point of the second lobe is nearly in contact with the inner side of the lobe immediately preceding, an arrangement quite different from the variety *gracile*. Furthermore, Smith definitely states that the ventral saddle in his form is not notched but has a tongue-shaped forward extension, whereas the extension in my shell is as certainly backward.

These differences appear to be rather constant for the material examined and it seems unwarranted to consider the Wewoka form as quite identical with the other.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (station 2004).

CRUSTACEA.

TRILOBITA.

Family PROETIDÆ.

Genus PHILLIPSIA Portlock.

PHILLIPSIA SANGAMONENSIS Meek and Worthen.

Plate XVIII, figures 10–13a.

1865. *Phillipsia* (*Griffithides?*) *Sangamonensis*. Meek and Worthen, Acad. Nat. Sci. Philadelphia Proc., p. 271. (Date of imprint, 1866.)
Upper Coal Measures: Springfield, Ill.

1873. *Phillipsia* (*Griffithides?*) *Sangamonensis*. Meek and Worthen, Illinois Geol. Survey, vol. 5, p. 615, pl. 32, fig. 4.
Upper Coal Measures: Springfield, Ill.

1884. *Phillipsia* (*Griffithides?*) *Sangamonensis*. White, Indiana Dept. Geology and Nat. Hist. Thirteenth Ann. Rept., pt. 2, p. 174, pl. 39, figs. 4, 5.
Coal Measures: Indiana.

1886. *Phillipsia Sangamoensis*. Heilprin, Pennsylvania Second Geol. Survey Ann. Rept. 1885, p. 458, fig. 14a; p. 446, fig. 14.
Upper Coal Measures (Mill Creek limestone): Wilkes-Barre, Pa.

1886. *Phillipsia Sangamoensis*. Heilprin, Wyoming Hist. and Geol. Soc. Proc. and Coll., vol. 2, pt. 2, p. 274, fig. 14; p. 277, fig. 14a.
Upper Coal Measures (Mill Creek limestone): Wilkes-Barre, Pa.

1887. *Phillipsia sangamonensis*. Herrick, Denison Univ. Sci. Lab. Bull., vol. 2, p. 61, pl. 5, fig. 13.

1887. *Griffithides sangamonensis*. Vogdes, New York Acad. Sci. Ann., vol. 4, p. 99, pl. 3, figs. 7, 8.
Upper Coal Measures: Springfield, Ill.

General shape elliptical, nearly twice as long as broad, about equally divided into cephalon, thorax, and pygidium. The cephalon, however, is distinctly shorter than the two other parts and the pygidium is distinctly narrower than the cephalon.

The cephalon is much wider than long. The length from the front to the margin of the neck ring is about half the width, but owing to the prolongation of the cheeks at the sides into genal spines the total length is three-quarters of the width or more. The cranidium is about half as wide as the entire cephalon, slightly longer than wide, slightly narrower in front than at the eyes, and considerably narrower at the eyes than posteriorly, the outline of the suture contracting strongly before and behind the palpebral lobes. The glabella is broad, moderately elevated and defined, with subparallel sides and a subrectangular or subelliptical shape. It does not extend to the anterior margin, but is bounded in front by a moderately broad band defined by a distinct groove. A deep, somewhat curved furrow passes obliquely across each of the posterior angles, marking off two moderately large lobes and dividing the posterior margin of the glabella at the neck furrow into three nearly equal parts. In some specimens two other very obscure furrows pass part way across the glabella defining two other pairs of obscure lobes. The palpebral lobes are moderately large, prominent, and sharply defined. The neck furrow is narrow and deep; the neck ring prominent with the usual narrow, ribbon-like extensions from its sides caused by the sudden divergence of the facial sutures. The free cheeks have a generally triangular shape, prolonged posteriorly at the sides into moderately long, stout spines. Two grooves, one parallel to the outer side of the free cheek, and the other parallel to its posterior margin, divide it into two areas, each of which is again subdivided. The one area consists of a broad marginal band passing around two sides and extended posteriorly into the genal angle, while the other area is triangular in shape and has an interior position. The latter comprises the large, abruptly, strongly, and obliquely elevated ellipse of the many-faceted eye and a flatter, depressed portion adjacent. The lateral portion of the margin gradually broadens from the front to the genal spine and is really a dihedral angle, each face of which has a gradual increase in width corresponding to that of the whole. The hypostoma preserved in two specimens consists of an elongated triangular piece, which extends backward on the under side nearly the full length of the cephalon. It is strongly convex in a transverse direction and gently convex longitudinally, the convexity in both directions dying out toward the posterior end. A border begins to be developed about halfway back, broadens rapidly, and is wide and upturned at the narrow posterior end. Toward the latter the hypostoma has a pair of distinct lobes, corresponding to the large basal lobes of the glabella above.

The thorax consists of nine segments which have the usual character. The axial portion is about a third or more of the entire width and is moderately convex. The pleural portions are depressed, somewhat flattened medially, but bent downward more strongly toward the extremity. For purposes of articulation the anterior margin of each segment is abruptly depressed below the posterior; on the pleural portions the raised or posterior margin, which is there somewhat broader and less prominent, is divided by a slightly oblique furrow which does not extend to the axis.

The pygidium is subtriangular, slightly wider than long, contracting strongly to the posterior end, which is abruptly rounded, the sides being nearly straight. The convexity is high, rising rather strongly from a somewhat broad, smooth, flat, or gently concave border over the lateral lobes and then again over the very prominent axis. At the articulating margin of the pygidium the axis is about as wide as the lateral lobes, but all three narrow posteriorly to blunt points, the lateral lobes contracting much more rapidly than the axis. The border, on the other hand, is widest over the posterior margin of the pygidium and narrows anteriorly. The axis, which is sharply defined by a groove on either side and rises high above the pleural lobes, contains about 20 segments, and each of the pleural lobes has about 11. All the segments are strongly defined by narrow, deep sulci, but the annulations tend to be obsolete on the sides of the axis. The segments of the axis are naturally narrower than the lateral ones. As is usual in this group the anterior or articulating segments of the pygidium, both axial and pleural, are imperfectly subdivided by a groove; a narrow supernumerary strip or segment which has no pleural portion correlated with it is developed at the anterior end of the axis.

The surface is smooth or finely granulose and lacks regular nodose ornamentation.

The specific relations of this form are somewhat uncertain. It resembles *Phillipsia major* and *Phillipsia missouriensis* in the lack of sculpture and in the segmentation of the pygidium, from which organ alone both species are known. *P. major* has 23 axial and 12 pleural segments and *P. missouriensis* has 18 axial and 11 pleural segments on the pygidium. The two descriptions read so much alike as to suggest that they refer to the same species. *P. major* has a greater number of segments, but it is also much larger than the other and, as everyone knows who has tried to count segments on trilobite pygidia, the final ones are very small and faint and likely to be obscured by the accidents of fossilization; young specimens either do not have quite so many segments as old specimens of the same species or else the terminal segments are so small and obscure that they can not usually be observed.

Our interpretation of *P. major* is derived largely from Meek, who gave figures, whereas Shumard, the author of the species, did not. Meek, however, expresses some doubt whether the form which he figured was really *P. major*, the chief difference, as he points out, being that his *P. major* had the pygidium considerably narrower than Shumard's. To pygidia that appear to be conspecific with Meek's type and to heads associated with them and apparently belonging to the same species, the Wewoka form is very similar. The pygidia are uniformly more spreading, but other differences are less constant, being found between some specimens but not between others.

Another extremely similar species is *Phillipsia sangamonensis.* I can indicate very few points indeed in which my fossils differ from Meek and Worthen's description and figures and those are not very essential ones. The outline of the cephalon contracts a little more distinctly from the genal angles forward. The axis of the thorax appears to be slightly broader in some specimens but not in all, and the border at the end of the pygidium slightly narrower; Meek states that in *P. sangamonensis* it is one-third the length of the axial portion. Unless specimens of *P. sangamonensis* reveal more important differences than I have been able to ascertain from the description and figures, I can hardly consider the Wewoka form specifically distinct. At the same time I see no valid differences between the pygidium of my form and that of *P. missouriensis* or even that of *P. major* as described. At present it seems not improbable that the former, if not both species, will prove to be the same as *P. sangamonensis*. Both of Shumard's names have priority of publication.

After a careful consideration of the description and figures given by Meek and Worthen I am unable to see why Vogdes placed *P. sangamonensis* in the genus Griffithides unless it be that the original authors described it as *Phillipsia* (*Griffithides?*) *sangamonensis*. The generic position of the Wewoka form, and also of that described by Meek and Worthen, which it so closely resembles, appears to me to be decidedly with Phillipsia rather than with Griffithides.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006); Coalgate quadrangle, Okla. (stations 2001, 2004, and 7193).

Genus GRIFFITHIDES Portlock.

GRIFFITHIDES PARVULUS Girty.

Plate XVIII, figures 14, 15.

1911. *Griffithides parvulus*. Girty, New York Acad. Sci. Annals, vol. 21, p. 154. Wewoka formation: Wewoka quadrangle, Okla.

Carapace small, elliptical, length about two and one-half times the width, nearly equally divided between cephalon, thorax, and pygidium. The head, however, even without the genal angles, is longer than the pygidium.

Cephalon semielliptical, considerably wider than long (if the width is measured from the anterior extremity to the edge of the neck rings), and rather tumid. Genal angles prolonged into spines of undetermined length. A broad, striated border passes around the arc of the cephalic shield, terminating posteriorly in the genal spines. The border is strongly arched or subangular transversely, so that the outer surface is directed obliquely downward and outward and the inner surface obliquely downward and inward, thus causing it to be defined from the inner parts of the cephalon by a deep sulcus. The sulcus dies down to a depressed line as it passes around the front of the glabella, and at the same time the direction of the border becomes so changed that its surface is essentially vertical and the anterior outline of the glabella is terminal when the head is seen from above. The outline of the facial suture is very sinuous. The sutures almost come together at the end of the glabella, diverging strongly as their course is traced backward. At the sulcus which defines the border they assume an opposite direction, contracting gently for an equal distance. They make a strong arch around the palpebral lobes and from the neck furrow pass somewhat obliquely outward to the articulating margin. The glabella is much wider toward the front than behind, occupying nearly the whole of the cranidium so that there is little of the free cheek except the rather small palpebral lobes. The neck furrow is strong and broad, passing almost directly across the cephalon to the two sulci defining the border. The neck ring is very broad, oblique, prominent, much wider than the sort of band with which it is continuous, which is produced on either side by the neck furrow. The posterior part of the glabella is subdivided into three knoblike lobes by two oblique furrows cutting off the corners, so to speak, and a cross furrow connecting these, parallel to and a little in front of the neck furrow. These lobes are rounded and the furrows between coalesce around them into an undefined depressed area. A partial and indistinct transverse furrow, a little in front, indicates a second annulation of the glabella. The glabella is tumid, the palpebral lobes and neck ring very prominent. The large, elliptical, many-faceted eye is strongly oblique, and the free cheek just external to the eye also slopes strongly downward toward the border. A small subangular ridge passes around the outer margin of the eye.

The somatic segments number nine with a highly arched axal lobe which comprises about one-third of the entire width. The pleural lobes are much depressed and are defined from the axial portion by sharp sulci. They are nearly planate over the median portion, but bend strongly and abruptly downward about halfway to the extremity. The pleural portion of each segment is subdivided by a furrow which reaches almost to the axis.

The pygidium is semielliptical in outline, is broadly rounded posteriorly, and has a broad, smooth, oblique and depressed border which narrows somewhat anteriorly. The axis is strongly and sharply elevated and defined by well-marked grooves. It is flattened on top and nearly quadrate in section. The lateral lobes are moderately inflated, the convexity being irregular, so that an angulation is formed down the center of each, appearing on the segments on either side as a row of prominences or nodes. The segmentation of the pygidium is strong, produced by deep, sharp grooves which do not extend onto the border nor onto the sides of the pygidium. They define about 12 axial rings and about 7 lateral ones.

The surface is marked by granules or small nodes which appear on the more prominent parts of the surface, on the basal portion of the glabella, on the crest of the neck ring, along the little ridge under the eyes, and in rows across the segments of the axis of both thorax and pygidium. The pleural segments are either without these nodes or have them fewer, smaller, and less conspicuous.

Except for *Griffithides sangamonensis,* which I believe to be a Phillipsia, only two species of Griffithides are known in our American Pennsylvanian, *G. ornatus* and *G. scitulus;* and of these two, only *G. ornatus* appears to be marked with nodes like those of *G. parvulus.* In many respects *G. parvulus* is very similar to *G. ornatus,* but aside from being very much smaller, it presents important and striking differences in the configuration of the basal portion of the glabella.

Horizon and locality.—Wewoka formation: Wewoka quadrangle, Okla. (stations 2005 and 2006).

OSTRACODA.

Family CYTHERELLIDÆ.

Genus CYTHERELLA Jones.

CYTHERELLA sp.

This type is represented by a single rather imperfect specimen. The size is moderately large (length, 1.4 millimeters; width, 0.77 millimeter) and the shape elliptical with narrowly rounded ends. The convexity is relatively low and is greatest at a point rather more central than is common in the genus. The surface appears to be smooth. The larger valve does not project far beyond the smaller, the projection being greatest along the upper and lower margins.

The peculiarities of this form are its more than usual size, its somewhat pointed ends, and its more central than terminal convexity. In the latter particular comparisons can be made with *C. subreniformis* which, however, is a smaller and less elongated species. The present form is also comparable to the Pennsylvanian shell from Iowa which Jones, Kirkby, and Brady refer to *C. concinna?* The most noteworthy difference is that the convexity is highest near the middle instead of at one extremity. The same peculiarity, together with the less truncated ends and in some specimens the larger size, distinguishes this shell from other American Cytherellas.

Horizon and locality.—Wewoka formation: Coalgate quadrangle, Okla. (station 2026).

REGISTER OF LOCALITIES.

2001. Coalgate quadrangle. Seven collections, five from west of the center of sec. 24, and two from the northern part of sec. 23, T. 5 N., R. 8 E. All appear to be in the lower shale of the Wewoka formation.

2004. Coalgate quadrangle. Two collections, one from the southeast corner of the southwest quarter, the other from the southwest corner of the southeast quarter of sec. 32, T. 6 N., R. 9 E. One and probably both are in the middle shale of the Wewoka formation, 50 feet below the sandstone.

2005. Wewoka quadrangle. Four collections from sec. 2 (three of them from the southeast quarter), T. 6 N., R. 9 E. The horizon appears to be in the middle shale of the Wewoka formation.

2006. Wewoka quadrangle. Seventeen collections from the bluffs on the north side of the Canadian River valley, from the northern part of sec. 5, T. 6 N., R. 9 E., and the adjacent southern part of sec. 32, T. 7 N., R. 9 E. The horizon is in the middle shale of the Wewoka formation, from 25 to 75 feet below the sandstone.

2009. Wewoka quadrangle. Railroad cut near the center of sec. 9, T. 6 N., R. 9 E. From a sandstone, possibly the sandstone between the lower and middle shales, more probably a thin seam in the lower shale.

2010. Wewoka quadrangle. Railroad cut in sec. 10, T. 6 N., R. 9 E. Probably the lower shale of the Wewoka formation.

2021. Wewoka quadrangle. Northeast corner of the NW. ¼ sec. 31, T. 7 N., R. 9 E. Probably from the middle shale of the Wewoka formation.

2026. Coalgate quadrangle. Southwest corner of sec. 32, T. 5 N., R. 8 E. From a thin limestone locally developed near the top of the lower shale of the Wewoka formation.

7193. Coalgate quadrangle. Two collections, one from sec. 32, the other from the SW. ¼ sec. 33; both from the lower shale, 50 feet below the sandstone.

PLATES I–XXXV.

PLATE I.

FUSULINA INCONSPICUA (p. 15).

FIGURE 1. A thin section cut longitudinally through a specimen, $\times$ 15.
2. Another thin section, longitudinal, $\times$ 15.
3. A transverse section, $\times$ 15.
4–8. Side views of five different specimens, $\times$ 5.
Wewoka formation: Coalgate quadrangle, Okla. (station 2026).

SPONGE? sp. A (p. 18).

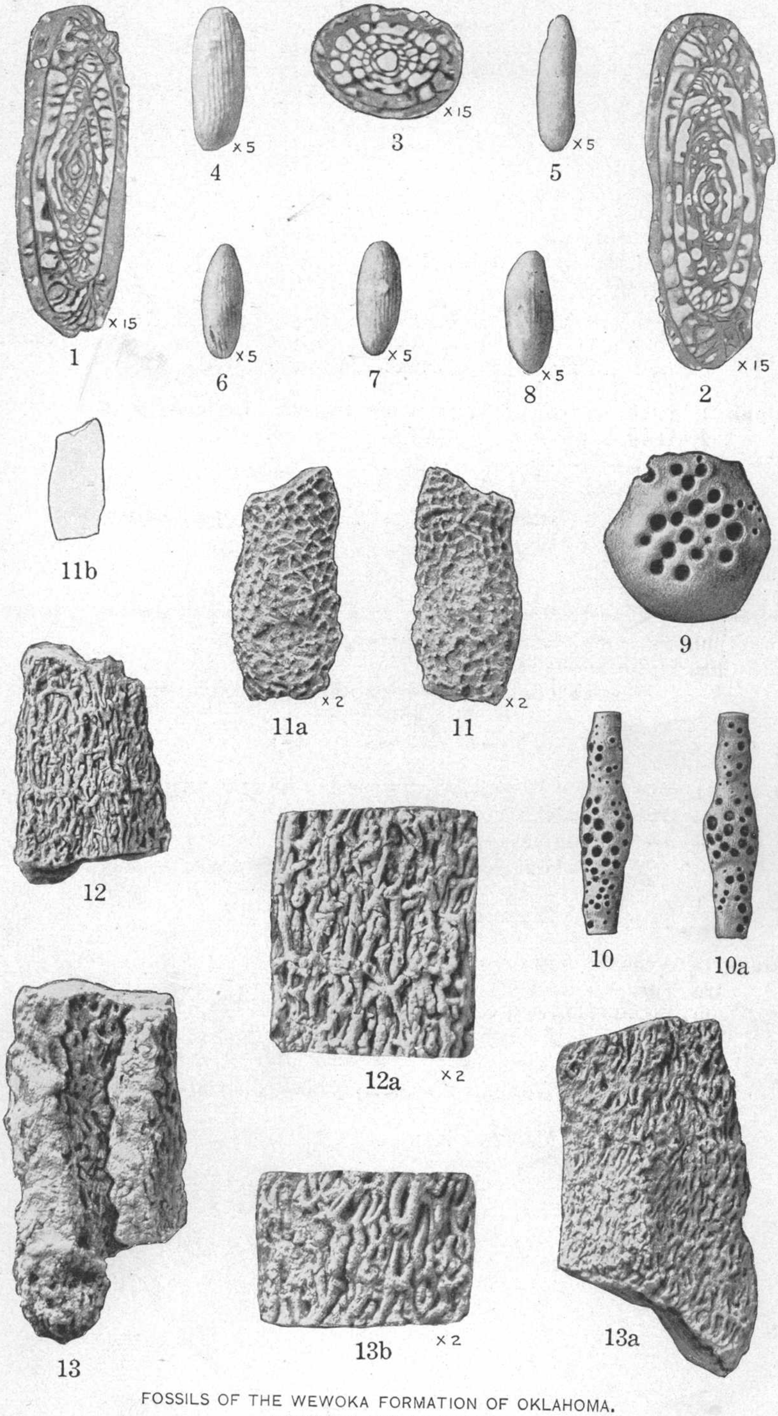
FIGURE 9. A crinoid plate deformed by some boring organism, possibly a sponge.
10. Side view of a crinoid stem similarly attacked.
10a. Opposite side of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

VIRGULA? sp. (p. 18).

FIGURE 11. Side view of an organism of somewhat doubtful affinities, $\times$ 2.
11a. Opposite side, $\times$ 2.
11b. Same in outline, natural size.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

WEWOKELLA SOLIDA (p. 17).

FIGURE 12. A fragmentary specimen; exterior side.
12a. Part of same, $\times$ 2.
13. Interior side of the typical specimen.
13a. Exterior side.
13b. Part of surface, $\times$ 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
PROTOZOA AND SPONGIÆ.

PLATE II.

Lophophyllum profundum (p. 19).

Figure 1. A somewhat distorted specimen. The walls of the calice are broken away, so that the pseudocolumella is shown. View on the side of the cardinal septum, × 1½.

1a. Same, view on the side of one of the alar septa, × 1½.

2. Thin section through the mature portion of a characteristic specimen, × 4. Many of the septa are fused by stereoplasma with the pseudocolumella, but in no instance does the primary plate extend to the axis of that structure.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

3. A broken specimen showing dissepiments. The pseudocolumella is at the right.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

4. View looking down on the broken calice of a weathered specimen.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

5. A young specimen attached to a crinoid stem.

6. Side view of a specimen showing calicinal gemmation.

6a. Same, seen from above. The ''bud'' here conceals from view the pseudocolumella of the parent corallite, which is well shown in the side view.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

For other figures of this species see Plate VI, figures 12, 14.

Lophophyllum profundum var. radicosum (p. 27).

Figure 7. Side view of a specimen with large and numerous stolons.

8. Side view of a specimen with much fewer stolons.

9. A characteristic specimen attached to a crinoid stem.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Hapsophyllum? sp. (p. 28).

Figure 10. A representative specimen of this group. It is not improbable, however, that this specimen is really a misleading example of Lophophyllum from which the pseudocolumella has been broken.

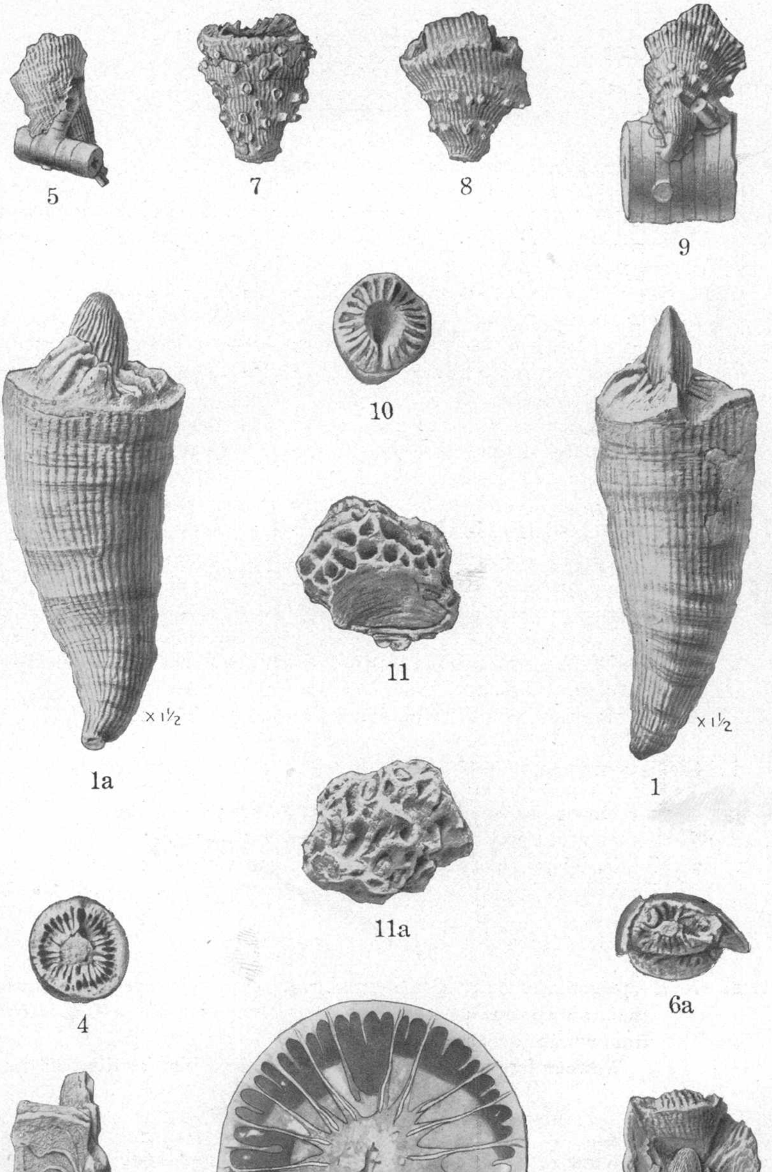
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Michelinia eugeneæ (p. 29).

Figure 11. Side view of the only specimen of the species found. The surface of attachment is shown in the lower half of the figure, at the very base the initial point.

11a. Opposite side of same.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
CŒLENTERATA.

PLATE III.

Crinoid stems, representing group A (p. 30).

FIGURE 1. Side view of a fragment of a stem with large cirri. The character of the ends is not well shown but it seems to resemble that seen in figure 3. The axial canal is smaller, however, here only about 3 millimeters in diameter.

2. Side view of a slender stem with large cirri. From its size and markings this might be the stem of *Hydreionocrinus patulus;* or it might be a cirrus of one of the larger stems.

2a. End view.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

3. A single large segment, seen from above.

3a. Side of same.

Wewoka formation: Wewoka quadrangle, Okla. (station 2021).

4. Two segments of somewhat different detail.

4a. Side view.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

5. A smaller segment somewhat different in detail.

5a. Side view.

Wewoka formation: Wewoka quadrangle, Okla. (station 2021).

6. A specimen, unique of its kind, with numerous and small cirri.

Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

Crinoid stems, representing group B (p. 32).

FIGURE 7. Side view of a stem with unusually numerous cirri, some of which are exceptionally large.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

8. A single segment showing the markings of the flat side.

8a. Side of same.

Wewoka formation: Wewoka quadrangle, Okla. (station 2021).

Delocrinus hemisphericus ? (p. 34).

FIGURE 9. Outer surface of a radial plate belonging to a species of Delocrinus, × 2.

9a. Upper surface, × 2.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Delocrinus ? sp. (p. 36).

FIGURE 10. First brachial plate; seen from above.

10a. Same; seen from below.

10b. End of same.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Eupachycrinus sp. (p. 33).

FIGURE 11. A small basal plate, characterized by its very coarse sculpture.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Eupachycrinus verrucosus ? (p. 32).

FIGURE 12. A basal plate characteristic of the Wewoka form.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Hydreionocrinus patulus (p. 36).

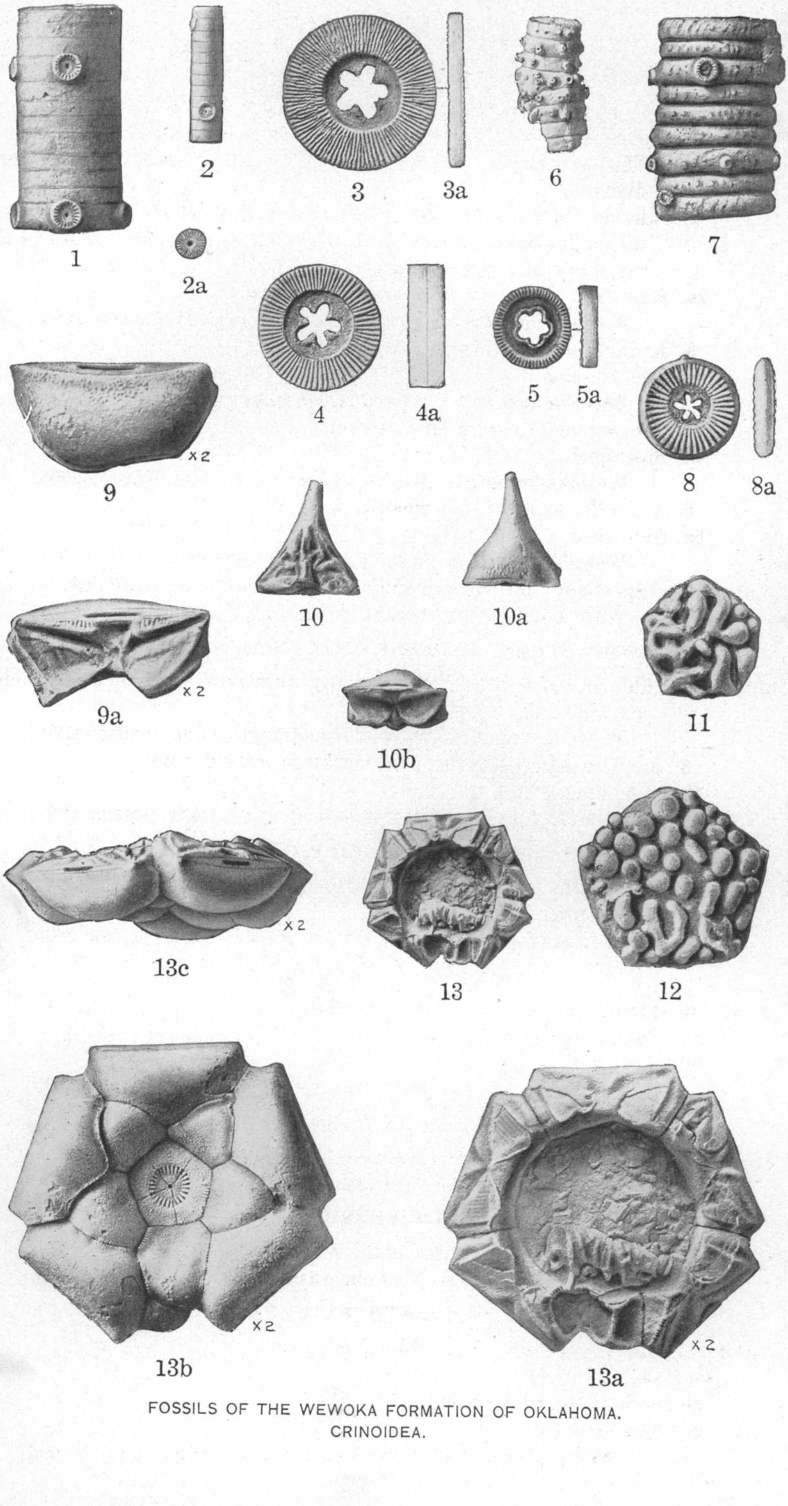
FIGURE 13. The type specimen, seen from above.

13a. Same, × 2.

13b. Same; seen from below, × 2.

13c. Side view, × 2.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



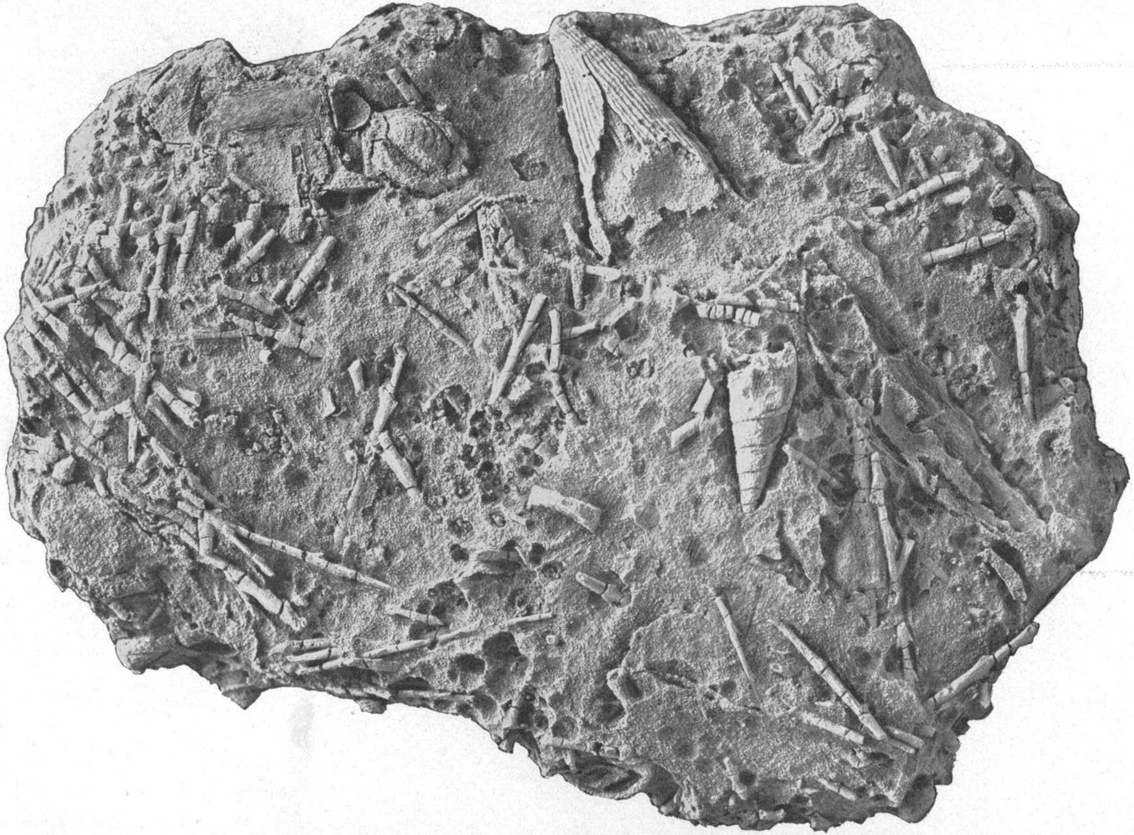
FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
CRINOIDEA.

PLATE IV.

ECHINOCRINUS aff. CRATIS (p. 37).

FIGURE 1. At station 2001 the fossils occur as small irregular concretions, through which the shells are thickly sprinkled and from the surface of which they project in bold relief. The slab which the figure represents, × 1½ is thickly crossed by spines of an echinoderm, and as this is the only specimen in which such spines occur abundantly, it appears not improbable that they may all have come from a single individual.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
ECHINOIDEA.

PLATE V.

CONULARIA CRUSTULA var. HOLDENVILLÆ (p. 44).

FIGURE 1. Side view of a large fragment, × 2.

1a. Same in outline, natural size.

Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

2. Side of a smaller, more nearly perfect specimen, × 2.

2a. Same in outline, natural size.

2b. Part of same, × 5.

3. Part of a very fragmentary specimen with well-preserved surface. The nodes on the costæ, which in this specimen are angular, are in others round, and the regularity of the wrinkles in the intercostal tissue is not a constant feature, × 15.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

CONULARIA CRUSTULA (p. 42).

FIGURE 4. Side view of the most complete specimen (but not the largest) in the collection, × 2.

4a. Same in outline, natural size.

5. Part of a squeeze made from an internal mold, showing the crenulations of the costæ, × 5.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

ENCHOSTOMA sp. (p. 39).

FIGURE 6. A fragment of the broad type showing the lateral ribs and the flexible intermediate tissue, × 2.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

SERPULOPSIS INSITA (p. 41).

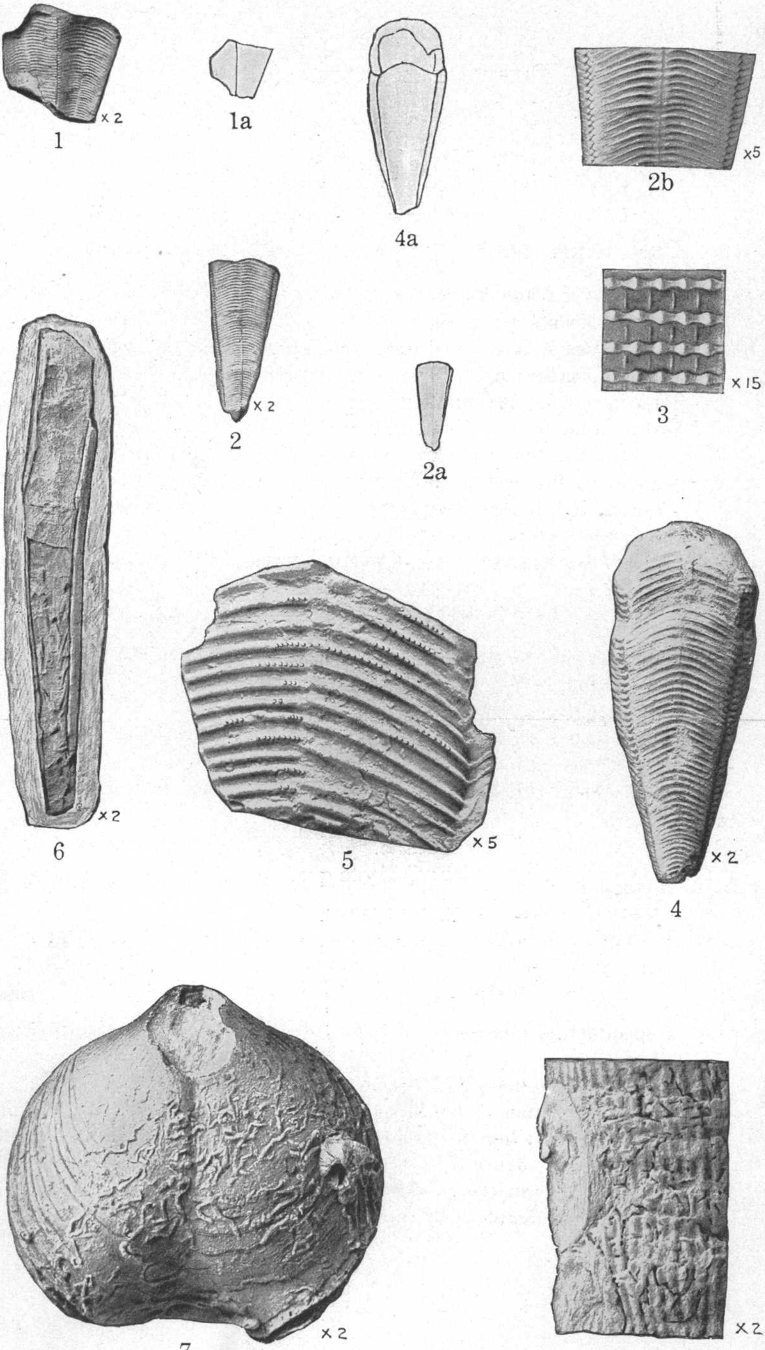
FIGURE 7. A specimen of *Composita subtilita*, thickly covered with the tubes of this form, × 2.

Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

8. Part of a specimen of *Lophophyllum profundum*, showing borings supposed to be made by this species, × 2. The specimen is the same as that shown on Plate VI, figure 12.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

For other figures of this species see Plate VI, figure 13.



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
ANNELIDA.

PLATE VI.

Rœmerella patula (p. 51).

FIGURE 1. A small dorsal valve; seen from above, × 2.

1a. Same, side view in outline, × 2.

2. A large dorsal valve. It is somewhat crushed, and to this perhaps is due the furrow down the posterior side, which is an abnormal feature. The striation is represented as somewhat too coarse because it was impossible to draw it to the natural scale.

2a. Same, side view in outline.

3. A small dorsal valve; seen from above, × 2.

3a. Same, side view in outline, × 2.

4. Internal mold of a dorsal valve; seen from above.

5. Internal mold of a dorsal valve with very strong septa; seen from above.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

6. Internal mold of a dorsal valve, showing bipartite muscle scars; seen from above, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2010).

7. A ventral valve somewhat flattened by compression; seen from above, × 2.

8. Another ventral valve, also somewhat crushed; seen from above, × 2.

9. A small ventral valve, much exfoliated; seen from above.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
For other figures of this species see Plate X, figures 14a, 14b.

Rœmerella? sp. (p. 52).

FIGURE 10. Internal mold of a dorsal valve of doubtful affinities; seen from above.

10a. Same, side view, in outline.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Lingulipora nebraskensis (p. 50).

FIGURE 11. Exterior of an imperfect specimen, × 2.

11a. Same, natural size, in outline.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

Crania modesta (p. 53).

FIGURE 12. Side view of a large specimen of *Lophophyllum profundum* which has 10 specimens of *Crania modesta* attached to it. Most of the Cranias appear to be ventral valves.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

13. A *Composita subtilita* which has a large and a small specimen attached to it. Both Cranias are probably ventral valves.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

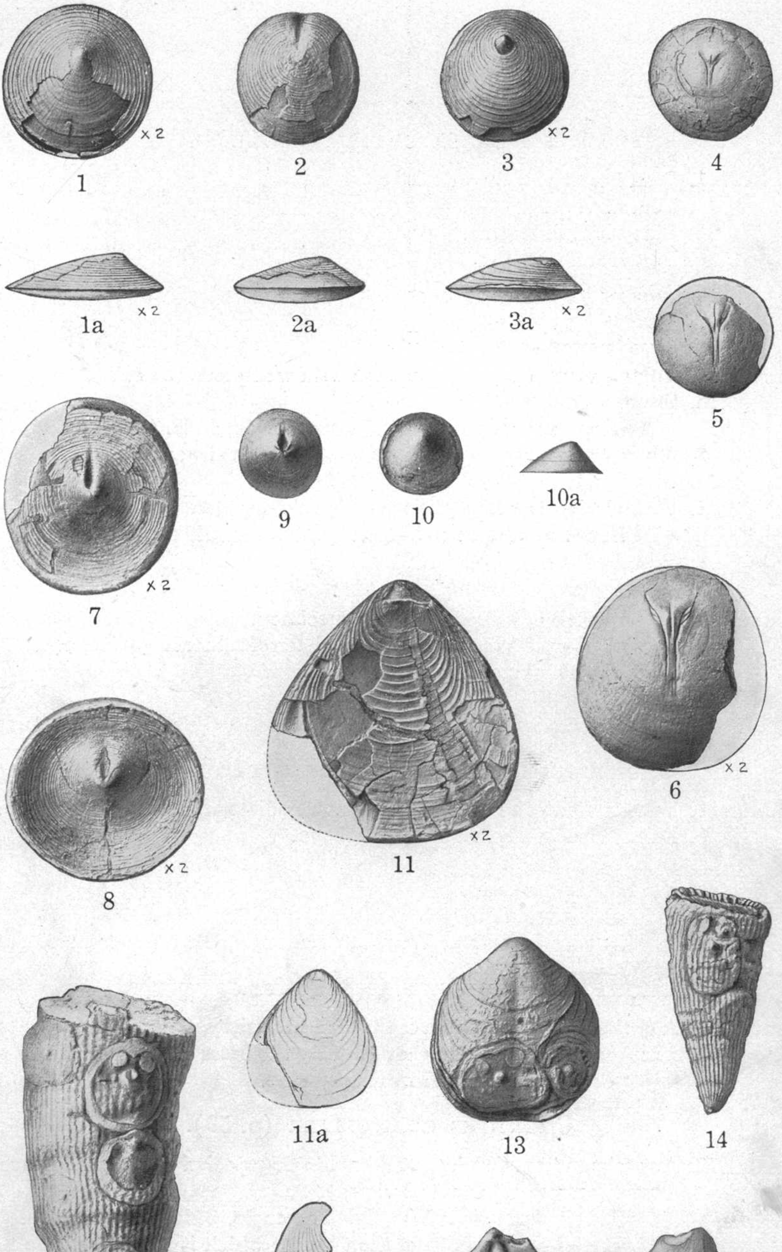
14. A ventral valve attached to *Lophophyllum profundum*. The posterior adductors are strongly elevated.
Cisco formation: Graham, Tex.

Streptorhynchus oklahomæ (p. 58).

FIGURE 15. Ventral valve of a fragmentary specimen preserved as an internal mold. No imprint of a median septum is shown.

15a. Dorsal view of same. The imprints of the rather strong dental calluses are well shown.

15b. Side view in outline.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
BRACHIOPODA.

PLATE VII.

Derbya crassa (p. 54).

FIGURE 1. Dorsal view of a characteristic specimen.
1a. Ventral view.
1b. Side view, in outline.
1c. Part of surface, × 4.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

Chonetes granulifer var. armatus (p. 62).

FIGURE 2. Ventral view of a small specimen with well-preserved spines.
2a. Same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
3. A somewhat compressed specimen of medium size; ventral view.
3a. Same, × 2.
4. Ventral view of a large, imperfect specimen, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

Chonetes mesolobus var. decipiens (p. 62).

FIGURE 5. Ventral view of a strongly lobate specimen.
6. Ventral view of a characteristic specimen of rather large size, × 2.
7. Ventral view of a characteristic specimen.
7a. Same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Chonetes mesolobus var. euampygus (p. 64).

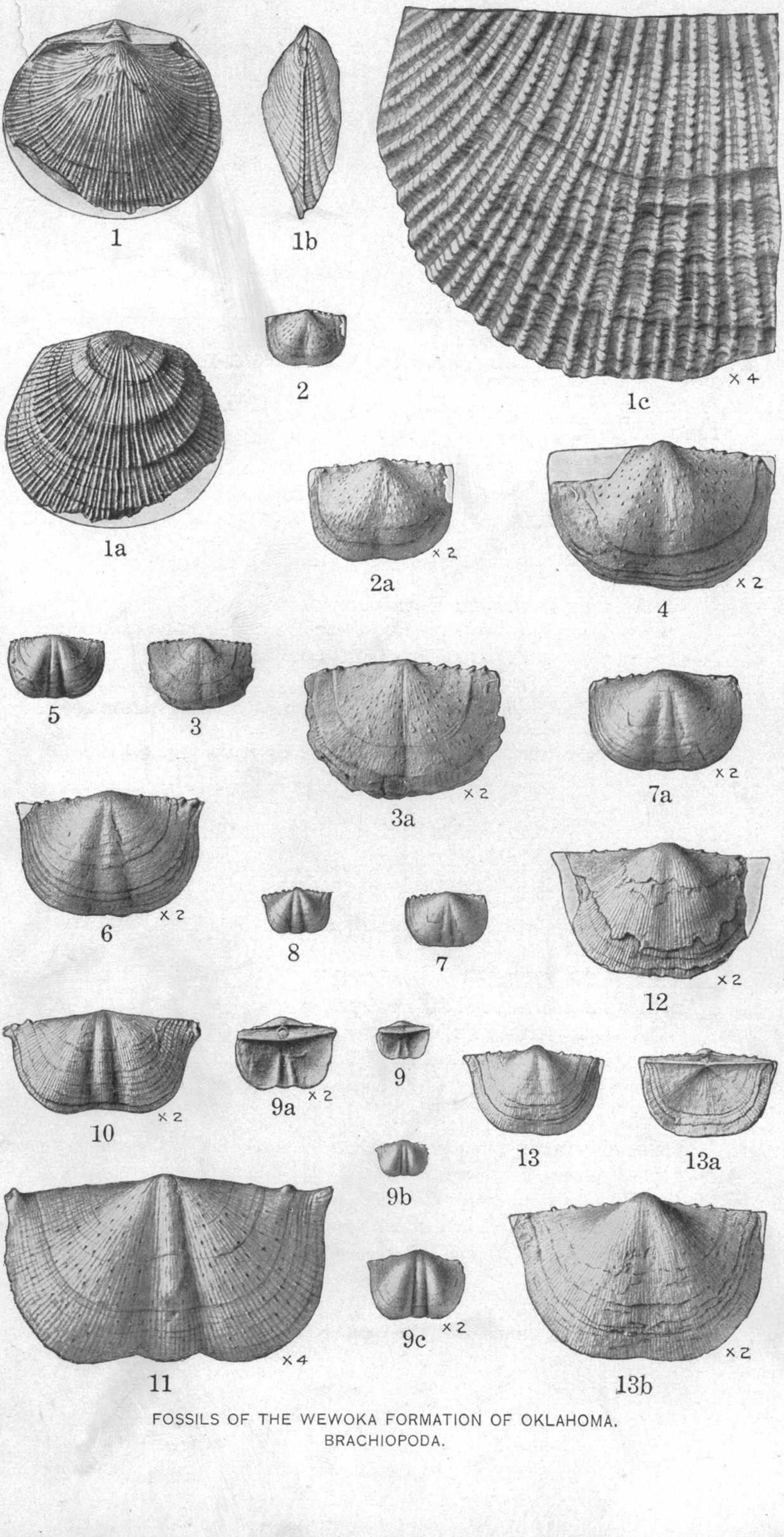
FIGURE 8. Ventral view of a large specimen intermediate with the variety *decipiens*.
9. Dorsal view of a rather small specimen.
9a. Dorsal view, × 2.
9b. Ventral view of same.
9c. Ventral view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Chonetes mesolobus (figured for comparison).

FIGURE 10. A characteristic specimen of the typical variety, × 2.
11. Another specimen which shows clearly the bases of spinules, × 4.
"Coal Measures": Flint Ridge, Ohio.

Chonetes granulifer (p. 59).

FIGURE 12. A specimen from Oklahoma referred to this species. It seems to be somewhat compressed; ventral view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
13. A characteristic specimen of the type for which it is believed the name *Chonetes granulifer* was introduced. Ventral view.
13a. Dorsal view.
13b. Ventral view, × 2.
Fort Scott limestone: Chetopa, Kans.



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
BRACHIOPODA.

PLATE VIII.

PRODUCTUS INFLATUS var. COLORADOENSIS n. var. (p. 64).

FIGURE 1. An imperfect and rather irregular ventral valve.

2. An impression of a dorsal valve.

Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

PRODUCTUS PERTENUIS (p. 75).

FIGURE 3. A large ventral valve.

3a. Same, × 2.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

PRODUCTUS CORA (p. 68).

FIGURE 4. A ventral valve, with scarcely perceptible sinus.

4a. Side view in outline.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

5. A ventral valve, in which the costæ that develop spines are raised above the others.

6. An unusual ventral valve having an extended hinge line and numerous irregularly distributed spines.

Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

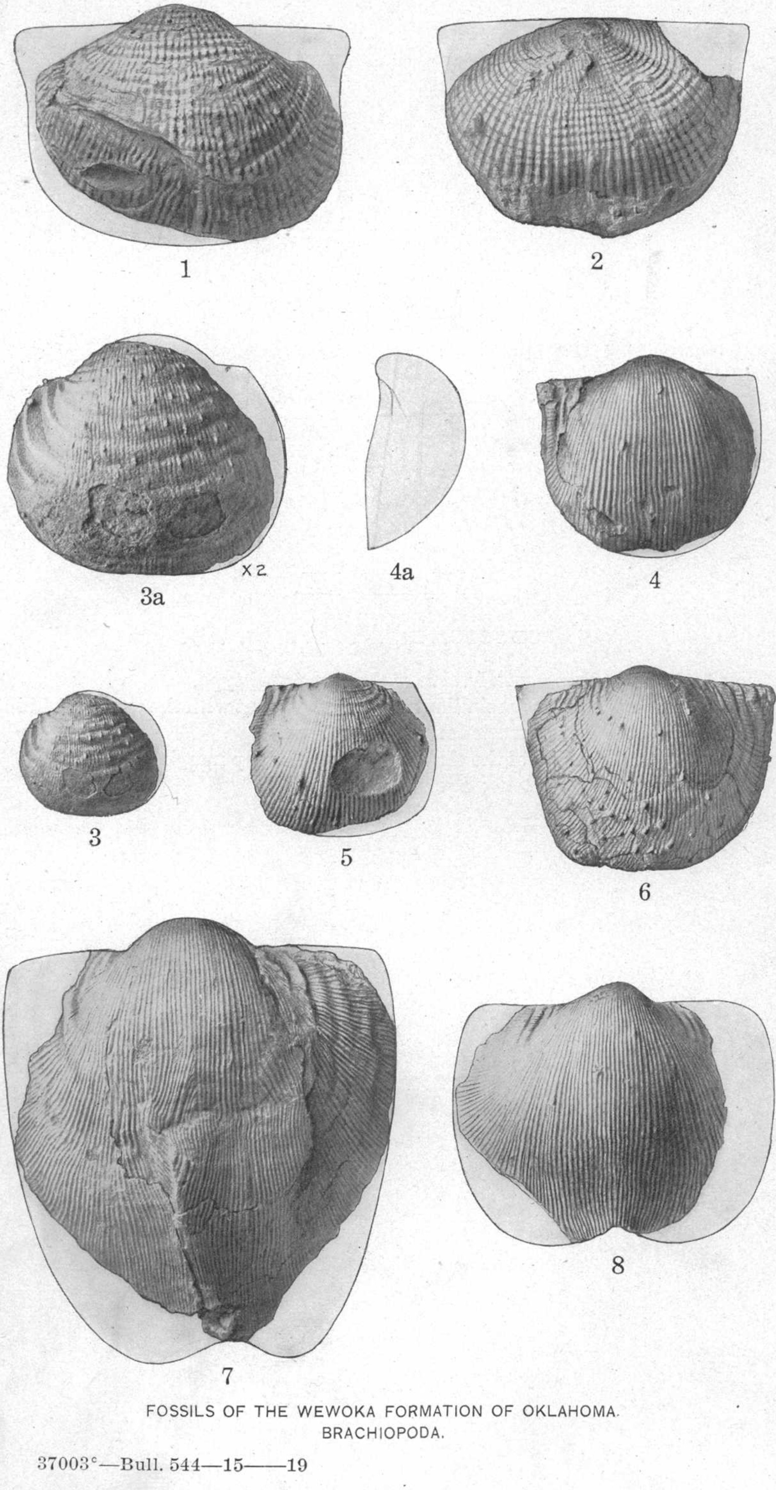
PRODUCTUS INSINUATUS (p. 72).

FIGURE 7. A crushed ventral valve referred to this species.

8. Another ventral valve of different proportions.

Wewoka formation: Wewoka quadrangle, Okla. (station 2009).

For other figures of this species see Plate IX.



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
BRACHIOPODA.

PLATE IX.

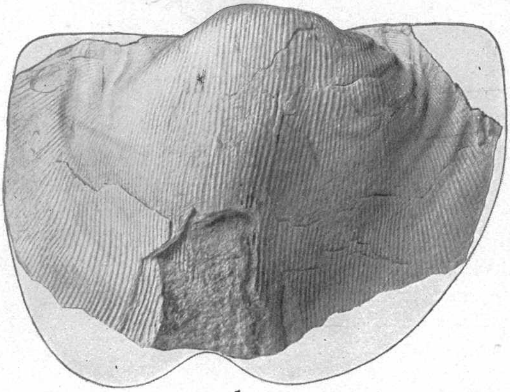
PRODUCTUS INSINUATUS (p. 72).

FIGURE 1. An imperfect ventral valve of the transverse type.

2. An imperfect valve similar to the foregoing but with the angular fold intact.
   Fort Scott limestone: Chetopa, Kans.

3. A ventral valve of the elongate type with deep marginal sinus.
   Piqua limestone: Fredonia, Kans.

3a. Side view in outline.



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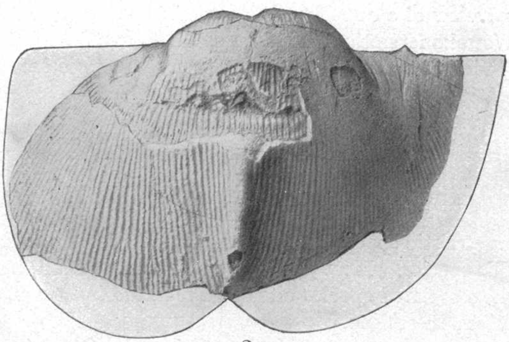

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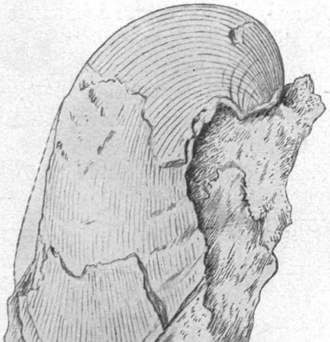

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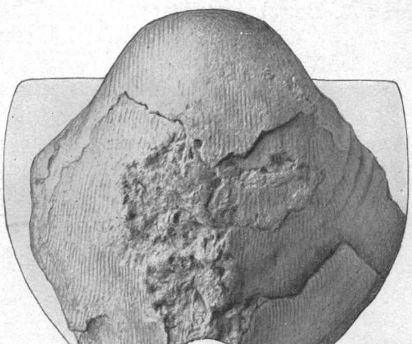

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FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
BRACHIOPODA.

PLATE X.

MARGINIFERA SPLENDENS (p. 76).

FIGURE 1. Ventral view of a characteristic specimen.
1a. Anterior view.
1b. Side view, in outline.
2. Dorsal view of a somewhat smaller specimen.
2a. Side view, in outline.
2b. Ventral view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

MARGINIFERA MURICATA (p. 78).

FIGURE 3. Ventral view of a coarsely ribbed specimen.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
4. Dorsal view of a characteristic specimen of the type found in the Wewoka formation.
4a. Ventral view of same.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

MARGINIFERA LASALLENSIS ? (p. 79).

FIGURE 5. A characteristic specimen of a rather variable form provisionally referred to this species. It may not be a Marginifera at all, but only a variety of the associated species cited as *Productus inflatus* var. *coloradoensis*.
5a. Side view, in outline.
Wewoka formation: Wewoka quadrangle: Okla. (station 2006).

PRODUCTUS NEBRASKENSIS (p. 65).

FIGURE 6. Dorsal view of a specimen without a sinus, without coarse concentric undulations, and with small, crowded, subequal spines.
6a. Ventral view.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).
7. Ventral view of a specimen with a sinus, with coarse, transverse undulations, and with spines of two distinct series.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

STROPHALOSIA SPONDYLIFORMIS ? (p. 80).

FIGURE 8. The only specimen discovered. It is attached to a corallum of *Lophophyllum profundum*, × 4.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Pugnax osagensis var. percostata (p. 83).

Figure 9. Dorsal view of a small specimen, intermediate between the species and the variety.
9a. Anterior view, in outline.
9b. Ventral view.
10. Dorsal view of the typical specimen.
10a. Ventral view of same.
10b. Anterior view, in outline.
10c. Side view, in outline.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Pugnax osagensis (p. 81).

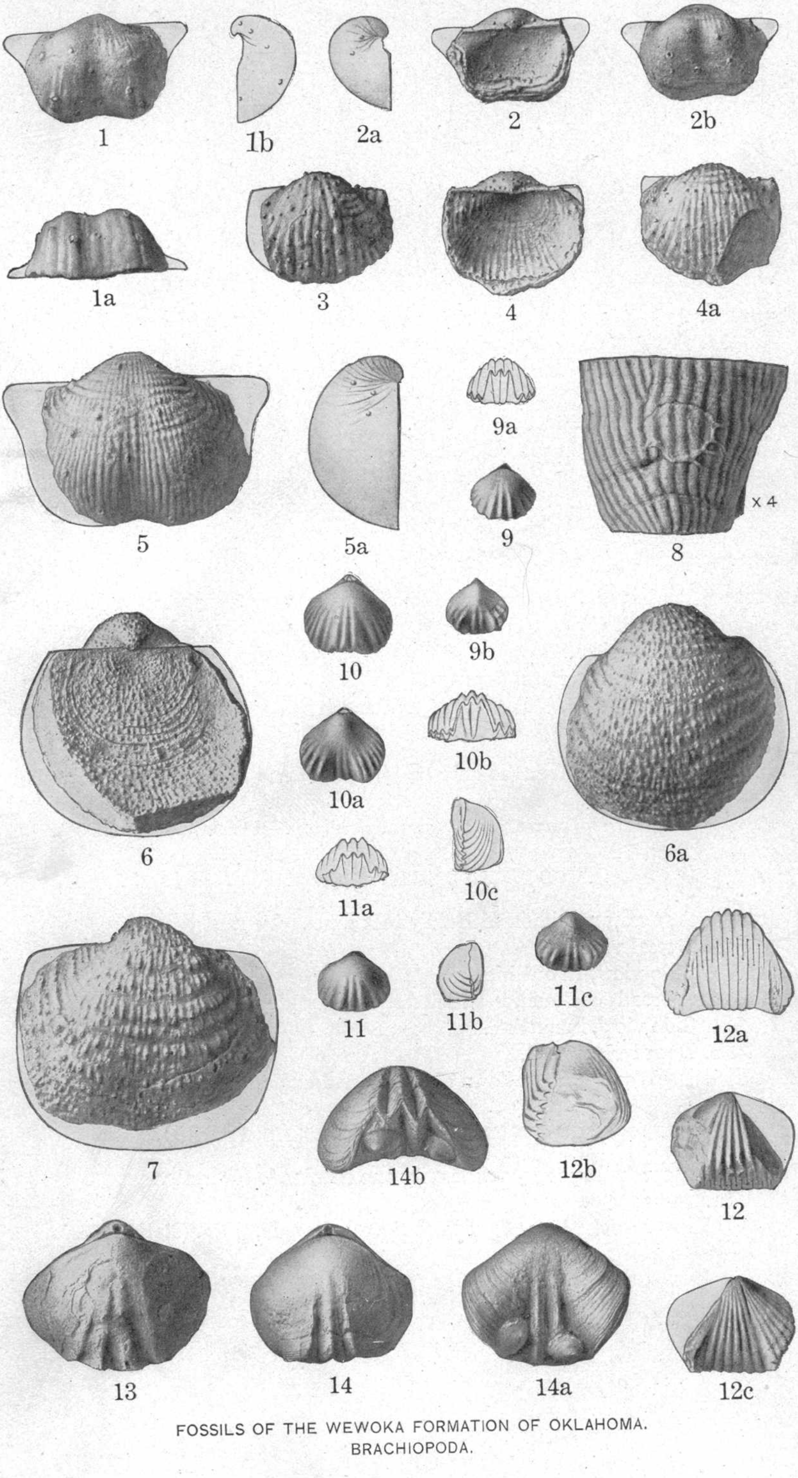
Figure 11. Dorsal view of a characteristic specimen.
11a. Anterior view, in outline.
11b. Side view, in outline.
11c. Ventral view.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Rhynchopora illinoisensis (p. 85).

Figure 12. The only specimen found. It is an internal mold and very imperfect. Dorsal view.
12a. Anterior view, in outline.
12b. Side view, in outline.
12c. Ventral view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Pugnax rockymontana (p. 83).

Figure 13. Dorsal view of an abnormal specimen with four plications on the fold.
14. Dorsal view of a characteristic specimen.
14a. Ventral view showing two young specimens of *Rœmerella patula* in the sinus.
14b. Anterior view of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
BRACHIOPODA.

PLATE XI.

SQUAMULARIA PERPLEXA (p. 92).

FIGURE 1. An average, though perhaps somewhat gibbous specimen. Dorsal view.
1a. Side view, in outline.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
2. An elongate and very gibbous specimen. Dorsal view.
2a. Side view, in outline.
3. A young, transverse specimen. Dorsal view.
3a. Side view, in outline.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

SPIRIFER CAMERATUS (p. 87).

FIGURE 4. An imperfect specimen referred to this species. Side view, in outline.
4a. Ventral view.
4b. Dorsal view.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

SPIRIFER aff. S. BOONENSIS (p. 91).

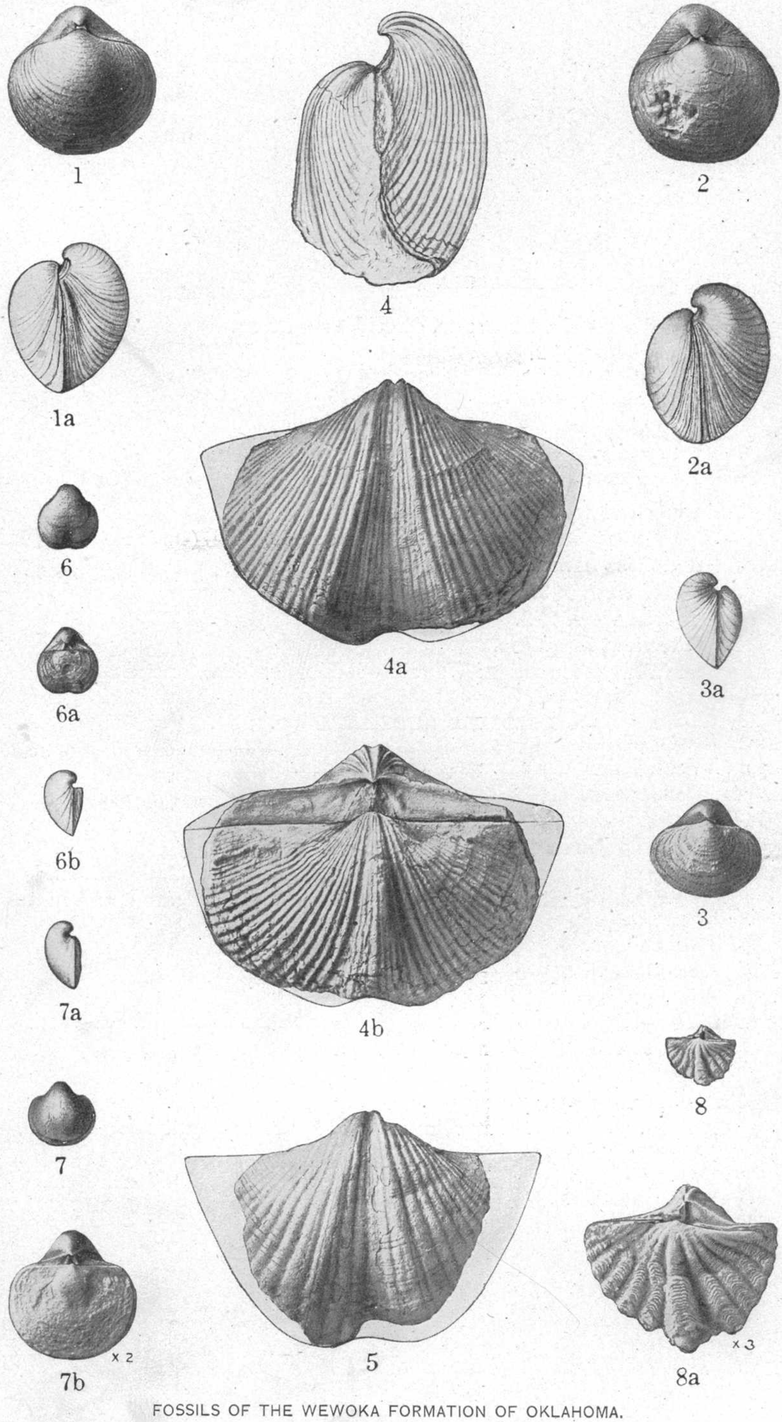
FIGURE 5. A ventral valve, the only specimen of the species found, and of doubtful affinities.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

AMBOCŒLIA PLANICONVEXA (p. 94).

FIGURE 6. A narrow specimen with a distinct sinus. Ventral view.
6a. Dorsal view.
6b. Side view, in outline.
7. A broad specimen, in which a sinus is lacking. Ventral view.
7a. Side view, in outline.
7b. Dorsal view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

SPIRIFERINA KENTUCKYENSIS (p. 85).

FIGURE 8. A crushed specimen, the only one obtained. Dorsal view.
8a. Same, × 3.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
BRACHIOPODA.

PLATE XII.

Cleiothyridina orbicularis (p. 101).

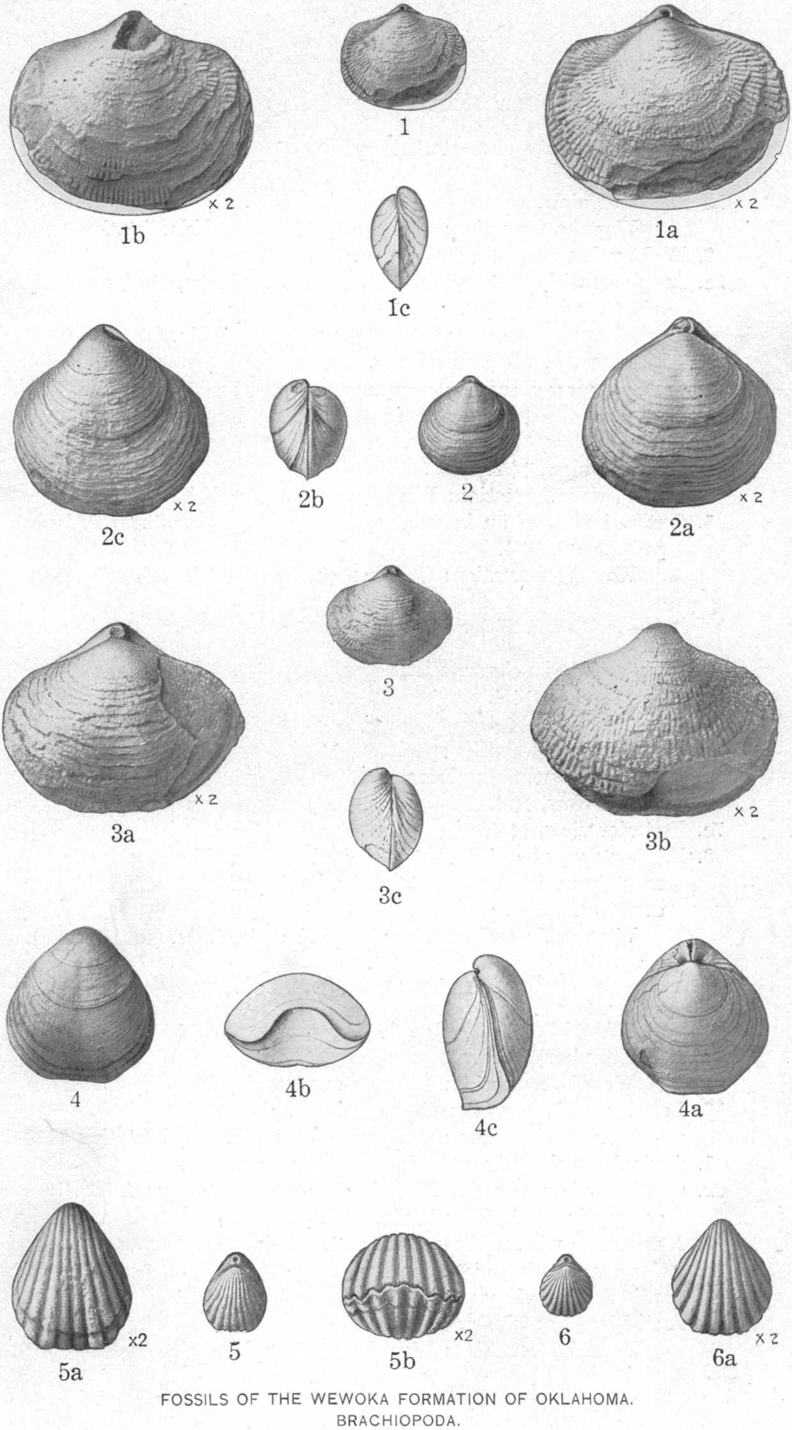
Figure 1. Dorsal view of a transverse, discoidal specimen.
1a. Dorsal view, × 2.
1b. Ventral view, × 2.
1c. Side view, in outline.
2. A gibbous, elongate specimen. Dorsal view.
2a. Dorsal view, × 2.
2b. Side view, in outline.
2c. Ventral view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
3. A gibbous transverse specimen. Dorsal view.
3a. Dorsal view, × 2.
3b. Ventral view, × 2.
3c. Side view, in outline.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Composita subtilita (p. 96).

Figure 4. Ventral view of a characteristic specimen.
4a. Dorsal view.
4b. Anterior view, in outline.
4c. Side view, in outline.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
For additional figures of this species, see Plate V, figure 7, and Plate VI, figure 13.

Hustedia mormoni (p. 103).

Figure 5. A large specimen with only 13 plications on the dorsal valve and a distinct fold and sinus. Dorsal view.
5a. Ventral view, × 2.
5b. Anterior view, × 2.
6. Dorsal view of a small specimen with 16 plications on the dorsal valve.
6a. Ventral view, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
BRACHIOPODA.

PLATE XIII.

NUCULA ANODONTOIDES? (p. 111).

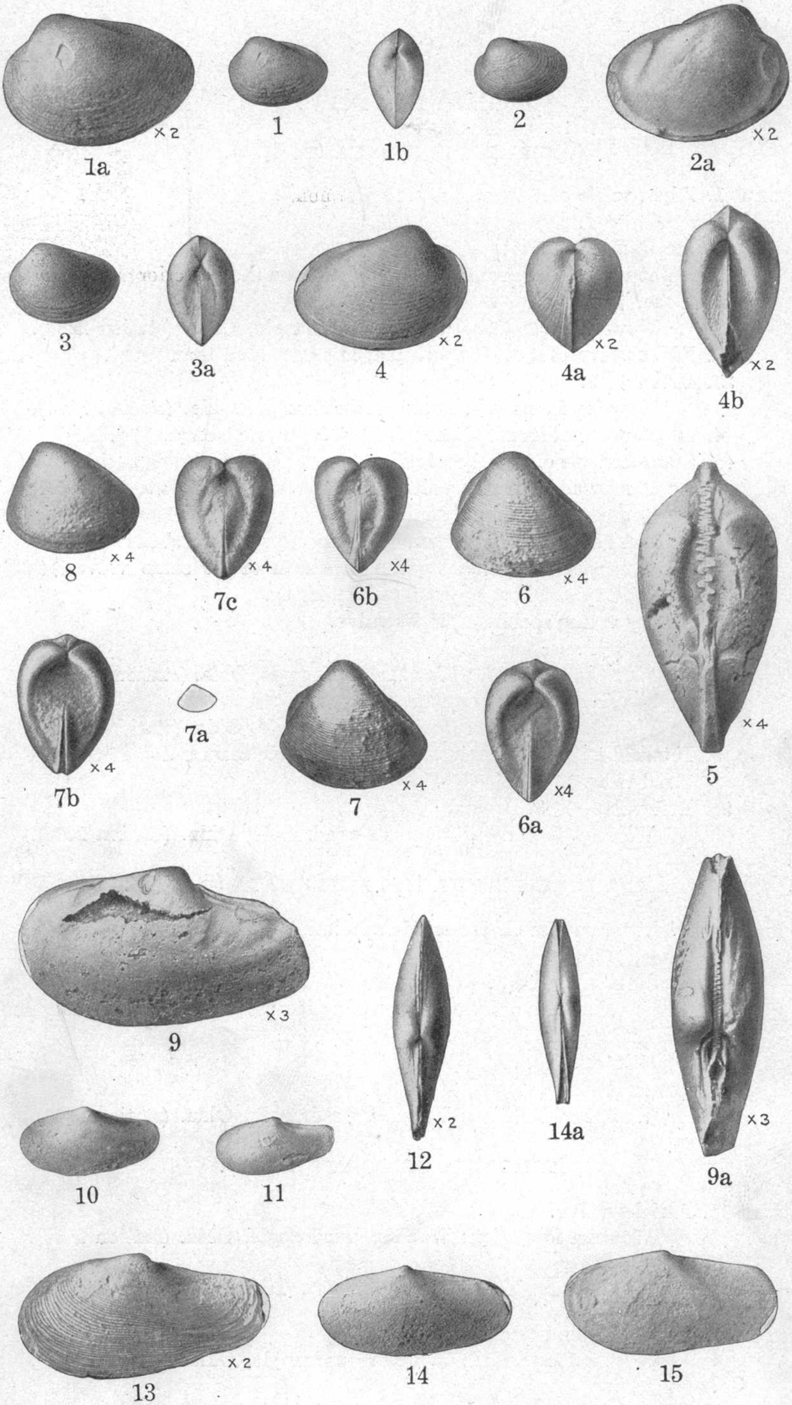
FIGURE 1. Right valve of a characteristic specimen.
1a. Same, × 2.
1b. Cardinal view.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).
2. Right valve of another specimen.
2a. Internal mold of left valve of same, showing large anterior and posterior adductor scars, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
3. Right valve of a large specimen.
3a. Cardinal view of same.
4. Left valve of a specimen with rather distinct lunule and escutcheon, × 2.
4a. Posterior view, × 2.
4b. Cardinal view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
5. Cardinal view of an internal mold, showing the anterior and posterior pedal scars, × 4.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

NUCULA WEWOKANA (p. 110).

FIGURE 6. Right valve of a characteristic specimen, × 4.
6a. Cardinal view, × 4.
6b. Posterior view, × 4.
7. Right valve of a similar specimen, × 4.
7a. Same in outline, natural size.
7b. Cardinal view, × 4.
7c. Posterior view, × 4.
8. Right valve of a differently shaped specimen having the lunule and escutcheon ill defined, × 4. The identification of this species is doubtful.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

YOLDIA GLABRA (p. 126).

FIGURE 9. Internal mold of a left valve showing muscle scars, × 3.
9a. Cardinal view of the same specimen, × 3.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
10. Left valve of a nearly perfect specimen.
Wewoka formation: Coalgate quadrangle. Okla. (station 7193).
11. A specimen shaped much like the type; left valve.
12. Cardinal view of a specimen having structures resembling ligamental grooves in front of the beaks, × 2.
13. A specimen with well-marked constriction; left valve, × 2.
14. Left valve of a large specimen.
14a. Cardinal view of same.
15. A still larger specimen; left valve.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
PELECYPODA.

PLATE XIV.

LEDA BELLISTRIATA (p. 122).

FIGURE 1. Right valve of a characteristic specimen.
1a. Same, × 2.
1b. Cardinal view of same specimen, × 2.
2. Right valve of a specimen less produced on the posterior end than usual.
2a. Same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
3. Right valve of a small specimen, less extended than usual.
3a. Same, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
4. Right valve of an internal mold showing muscle scars, × 2.
4a. Cardinal view of same specimen, × 2. This view shows, besides the large posterior adductors, a pair of small anterior and posterior pedal scars, and a pair of umbonal impressions.
5. Interior of a right valve showing the chondrophore and the dentition, × 2.
6. Another specimen, showing the dentition of the same valve, × 2. A chondrophore here appears to be missing.
7. A very young specimen, right valve.
7a. Same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
8. Right valve of an abnormal specimen.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
9. Internal mold of a specimen showing muscle scars and dentition. Cardinal view, × 3.
9a. Left valve, × 3.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

LEDA BELLISTRIATA var. ATTENUATA (p. 125).

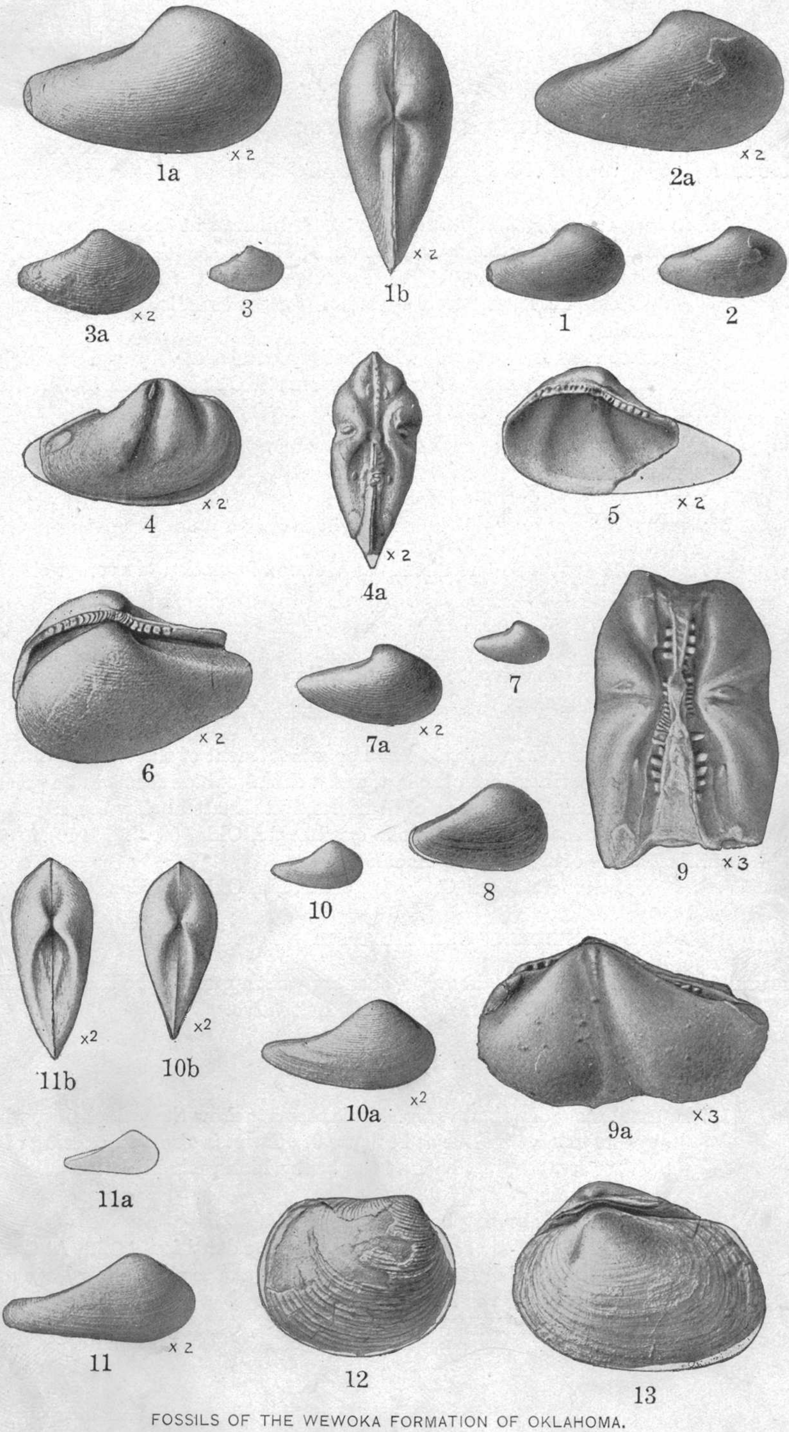
FIGURE 10. Right valve of a characteristic specimen.
10a. Same, × 2.
10b. Cardinal view, × 2.
11. Right valve of a specimen showing extreme characters, possibly somewhat exaggerated by compression, × 2.
11a. Same in outline, natural size.
11b. Cardinal view of same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

EDMONDIA GIBBOSA (p. 107).

FIGURE 12. A right valve.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

EDMONDIA OVATA (p. 106).

FIGURE 13. Left valve of a large specimen.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
PELECYPODA.

PLATE XV.

Nuculopsis ventricosa (p. 117).

FIGURE 1. Internal mold of a right valve, showing the large anterior and posterior scars, × 2.

1a. Anterior view, × 2, showing two other small scars at the anterior end.

2. Internal mold of another right valve, × 2.

2a. Cardinal view of same, × 2. This view shows the line of interlocking denticles, the large posterior scar, and a pair of smaller pedal (?) scars just anterior.

3. Cardinal view of a specimen with the ligamental area very well shown, × 2.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

4. A large specimen, well preserved, and very characteristically shaped. Left valve.

4a. Same, × 2.

4b. Anterior view, × 2.

4c. Cardinal view, × 2.

Cisco formation, Ivan, Tex.

5. Left valve of a specimen from the Wewoka formation of average size and characteristic shape.

5a. Cardinal view.

5b. Anterior view.

6. Interior of a left valve, × 2. The small posterior teeth appear to terminate abruptly against the large anterior ones without any visible chondrophore.

7. Interior of a right valve, × 2. The arrangement of the teeth is different in this specimen from the last, and a chondrophore seems to be present, not interrupting the line of denticles, but situated below them.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

8. Left valve of a young specimen.

Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

Anthraconeilo taffiana (p. 114).

FIGURE 9. Internal mold of a right valve, showing what appears to be the pallial line.

10. A characteristic mature specimen. Left valve.

10a. Cardinal view.

11. Left valve of smaller specimen.

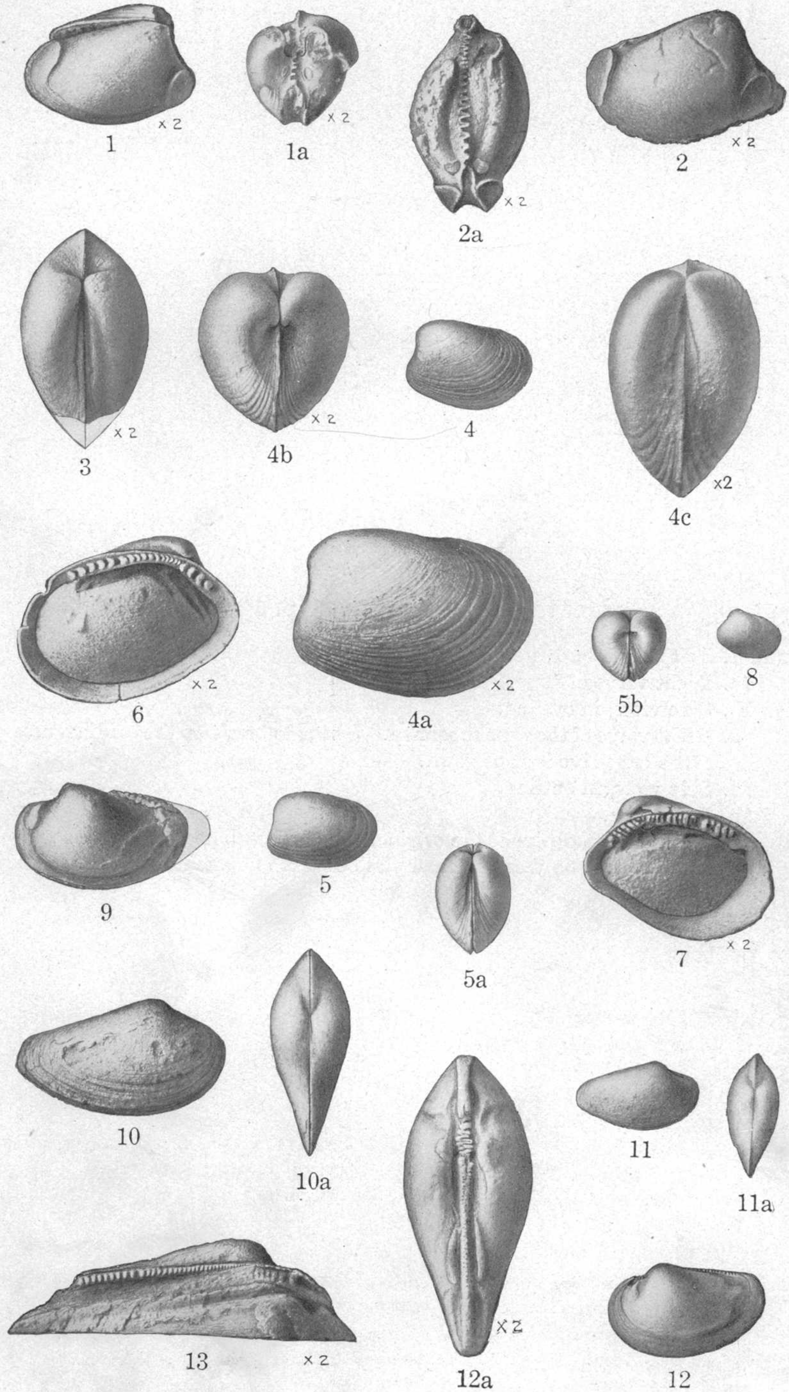
11a. Cardinal view of same.

12. Internal mold of a right valve. This seems to show the pallial line, which appears to have a sinus as in figure 9. There is also a thickening of the shell, or septum, just back of the beak which probably helps define the posterior scar.

12a. Cardinal view, showing both valves, × 2.

13. The cardinal portion of a right valve, showing dentition, × 2. At the left are a large number of small denticles and at the right a few large ones, the intermediate portion being concealed.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
PELECYPODA.

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PLATE XVI.

DELTOPECTEN TEXANUS (p. 132).

FIGURE 1. Left valve of a large specimen.

1a. Right valve of same.

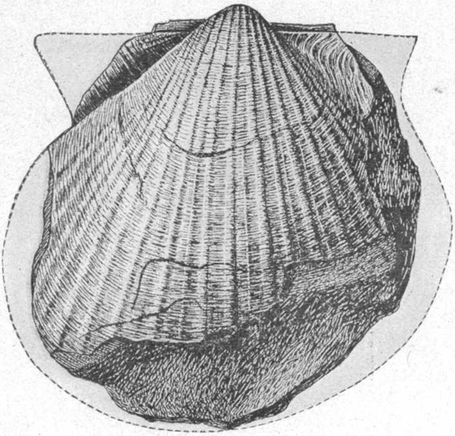
1b. Side view, in outline.

2. Right valve of the type specimen. Owing to breakage the cardinal area of the left valve is also shown.

2a. Side view, in outline.

2b. Left valve.

These are copies of the original illustrations based on specimens from Texas, the Wewoka examples being too fragmentary for illustration.



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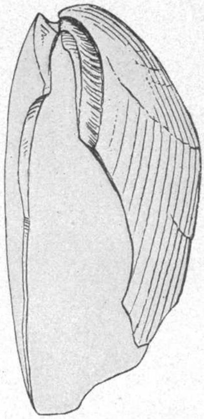

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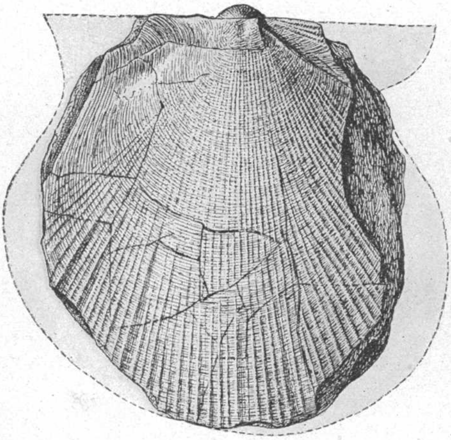

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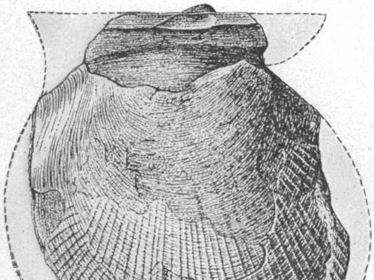
2a



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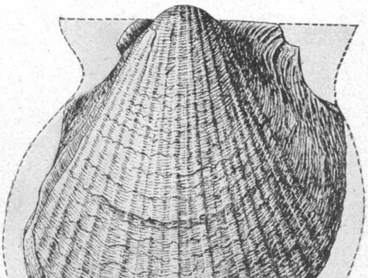


2b

FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
PELECYPODA.

PLATE XVII.

Aviculipinna americana (p. 128).

Figure 1. Right valve of an imperfect specimen.
1a. Cross section of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Schizodus affinis? (p. 131).

Figure 2. Left valve of a well-preserved specimen.
2a. Cardinal view of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Schizodus alpinus (p. 130).

Figure 3. An imperfect left valve.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Pseudomonotis kansasensis (p. 129).

Figure 4. A small convex specimen apparently grown upon a larger, flatter specimen of the same species, × 1½.
4a. The smaller example, natural size.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Deltopecten vanvleeti? (p. 133).

Figure 5. A fragmentary specimen preserved as an internal mold.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Limatula? fasciculata (p. 138).

Figure 6. An imperfect left valve.
6a. Same, × 2.
6b. Side view of same, × 2.
7. Another specimen, provisionally referred to the same species in spite of its much more rotund shape, × 2. Because of the abrupt deflection of the shell at the right side this would appear to be a right instead of a left valve.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Lima retifera (p. 137).

Figure 8. An imperfect left valve.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Acanthopecten armiger.

Figure 9. A copy of Conrad's figure of *Pecten armigerus;* given to show its probable identity with *Acanthopecten carboniferus.*
Carboniferous: Allegheny Mountain, Pa.

ACANTHOPECTEN CARBONIFERUS (p. 134).

FIGURE 10. An impression of a left valve.
10a. Same, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

PLAGIOSTOMA ? ACOSTA (p. 140).

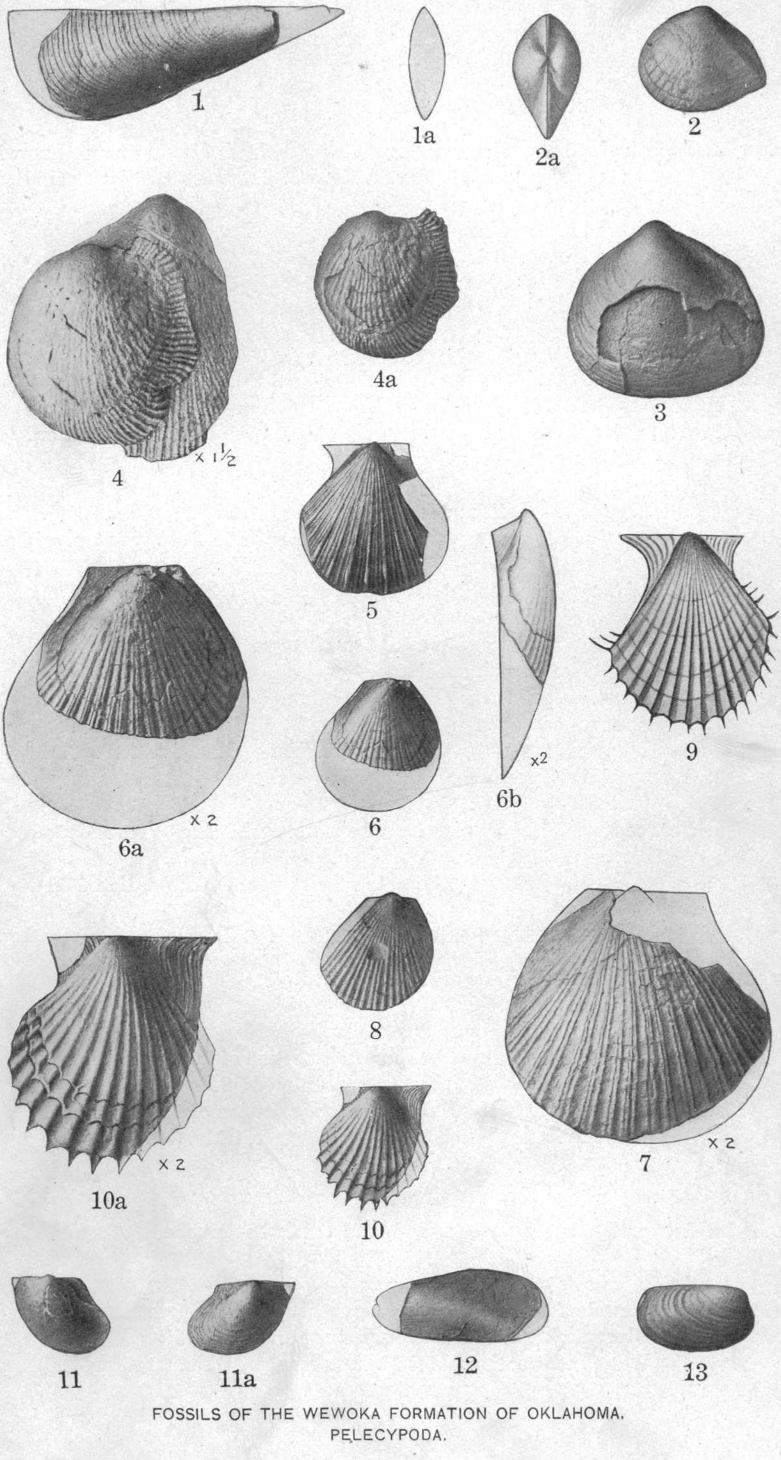
FIGURE 11. A bivalve specimen. Right valve.
11a. Left valve.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

MODIOLA SUBELLIPTICA ? (p. 141).

FIGURE 12. Left valve of an imperfect specimen.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

ALLERISMA ? sp. (p. 141).

FIGURE 13. Right valve of a small shell of doubtful specific affinities.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
PELECYPODA.

PLATE XVIII.

Astartella varica? (p. 145).

Figure 1. Right valve of a specimen resembling *A. concentrica* in shape, but with coarser sculpture. Many variations in shape are found with similarly widely spaced lamellæ.

1a. Cardinal view.

1b. Anterior view.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Astartella concentrica (p. 142).

Figure 2. A copy of Conrad's figure of *Nuculites concentricus.*

Carboniferous: Allegheny Mountain, Pa.

3. Left valve of a characteristic specimen from the Wewoka formation.

3a. Cardinal view.

3b. Anterior view.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

4. Right valve of a young specimen very similar to *Posidonia moorei* Gabb (fig. 8).

Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

5. Left valve of a contracted variety.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

6. Right valve of a small specimen.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

7. Right valve of an extremely abbreviated, subcircular specimen.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

8. A copy of Gabb's figure of *Posidonia moorei.*

"Coal Measures": Fort Belknap, Tex.

9. Part of the surface of an abnormal specimen showing traces of costæ, × 3. This may be due to weathering or to exfoliation.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

Phillipsia sangamonensis (p. 265).

Figure 10. A large specimen, more of less disjointed.

11. A well-preserved pygidium.

12. An imperfect cranidium; upper side.

12a. Under side, × 2, showing the posterior portion of the hypostoma.

13. Upper side of another imperfect cranidium, × 2.

13a. Lower side of same, showing the anterior portion of the hypostoma, × 2.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Griffithides parvulus (p. 268).

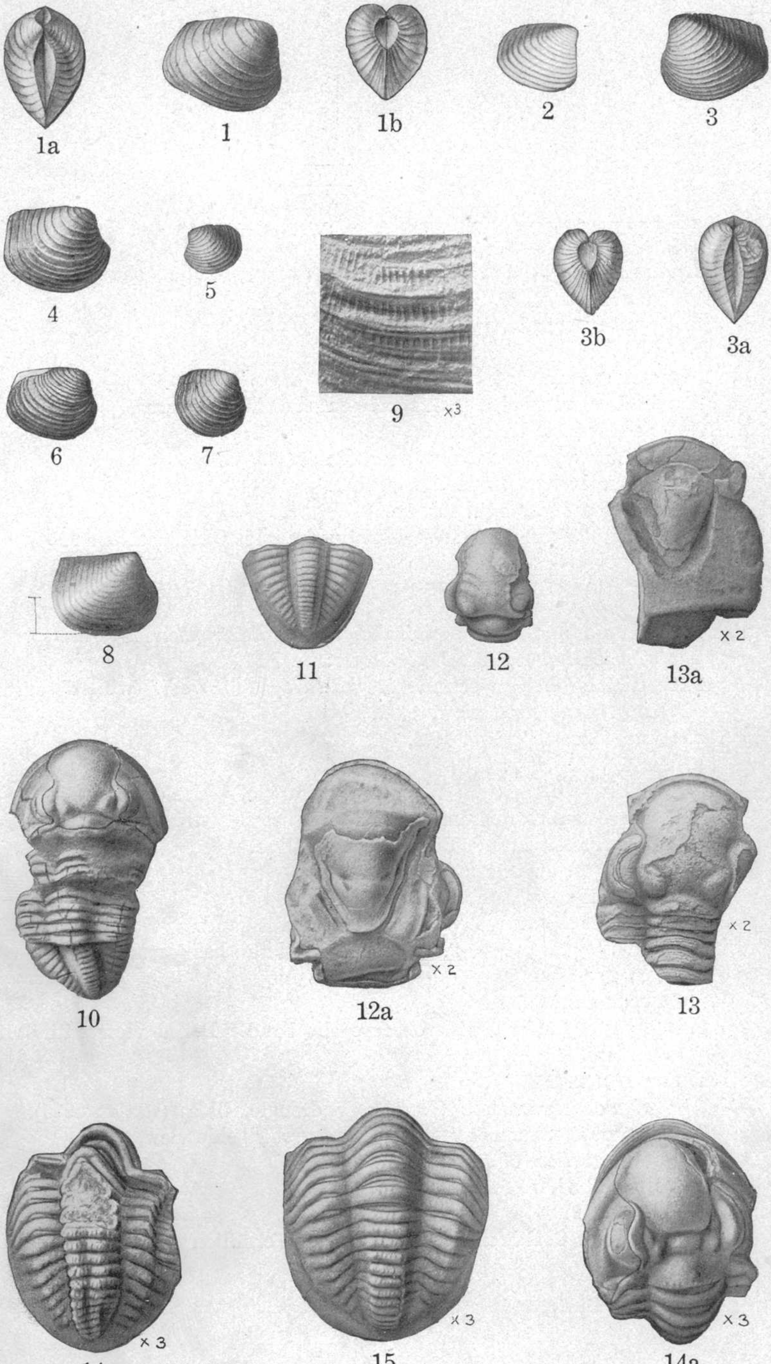
Figure 14. A complete specimen, inrolled, and somewhat crushed. Posterior half, × 3.

14a. Anterior half, × 3.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

15. Posterior portion of another complete specimen, × 3.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
PELECYPODA AND TRILOBITA.

PLATE XIX.

BELLEROPHON CRASSUS var. WEWOKANUS (p. 164).

FIGURE 1. An imperfect specimen. Side view, somewhat tilted, showing the closed umbilicus, × 2.

1a. Same, apertural view.

1b. Same, side view, in outline.

1c. Same, "dorsal" view, × 2.

2. "Dorsal" view of a small specimen, showing the fissure.

2a. Same, apertural view.

3. "Dorsal" view of a narrow specimen, × 2.

3a. Apertural view of same, in outline.

3b. Side view of same, in outline.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

PHARKIDONOTUS PERCARINATUS (p. 165).

FIGURES 4, 4a. Copies of Conrad's original figures of *Bellerophon percarinatus*. Carboniferous: Allegheny Mountain, Pa.

5. A characteristic specimen of "*Bellerophon harrodi*," with obscure slit band. Apertural view, × 2.

5a. Same, "dorsal" view, × 2.

5b. Same, side view, × 2.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

6. A specimen more transitional to the variety *tricarinatus*, showing no trace of a slit band. Side view in outline.

6a. "Dorsal" view of same.

6b. Apertural view, in outline.

7. A small specimen having an obscure slit band. "Dorsal" view, with aperture oblique, × 2. This specimen also has features suggesting the variety *tricarinatus*.

7a. Same, natural size.

8. A small specimen with obscure slit band. Dorsal view with oblique aperture.

8a. Same, × 2.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

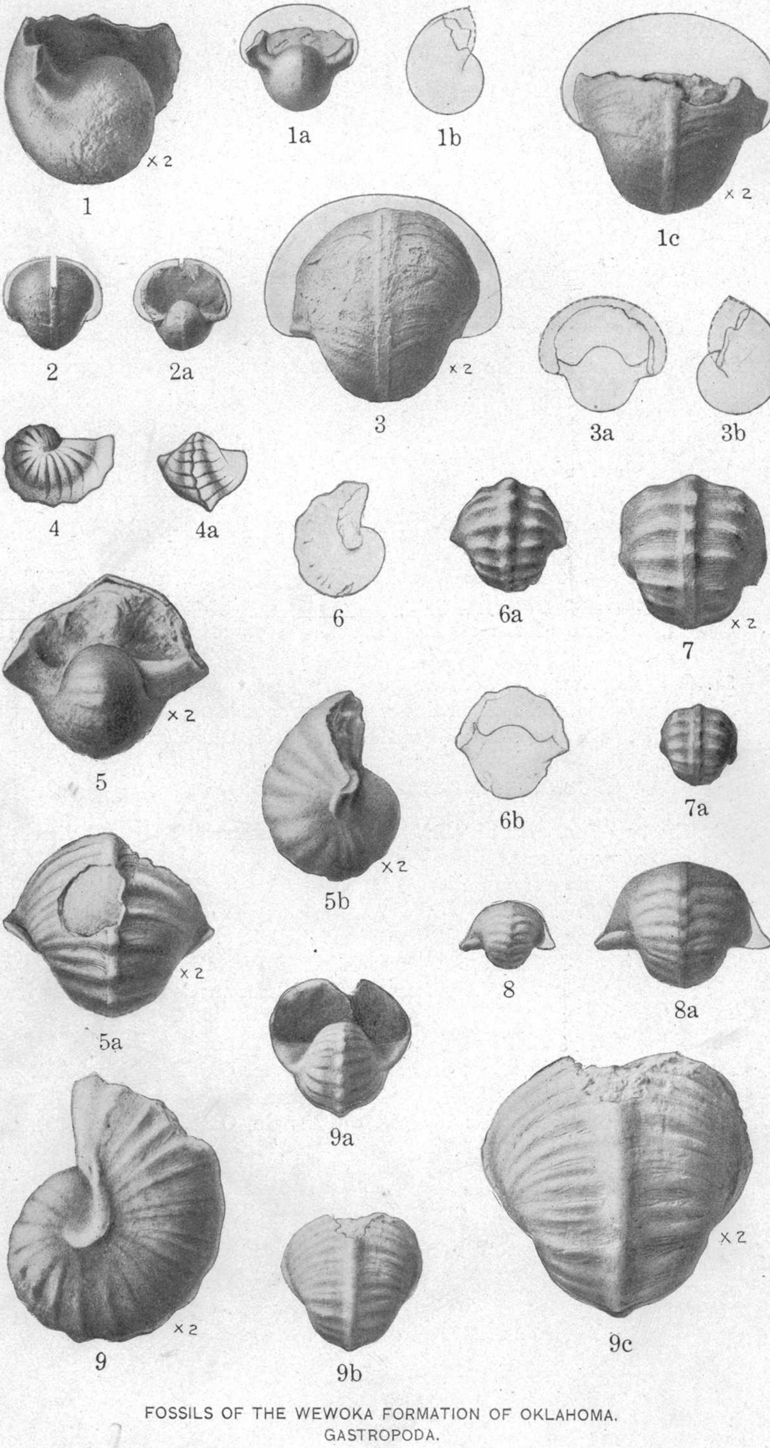
9. The type specimen of "*Bellerophon harrodi*;" side view, × 2.

9a. Apertural view of same.

9b. "Dorsal" view of same.

9c. Same, × 2.

"Upper Coal Measures": Oakwood, Vermilion County, Ill.



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
GASTROPODA.

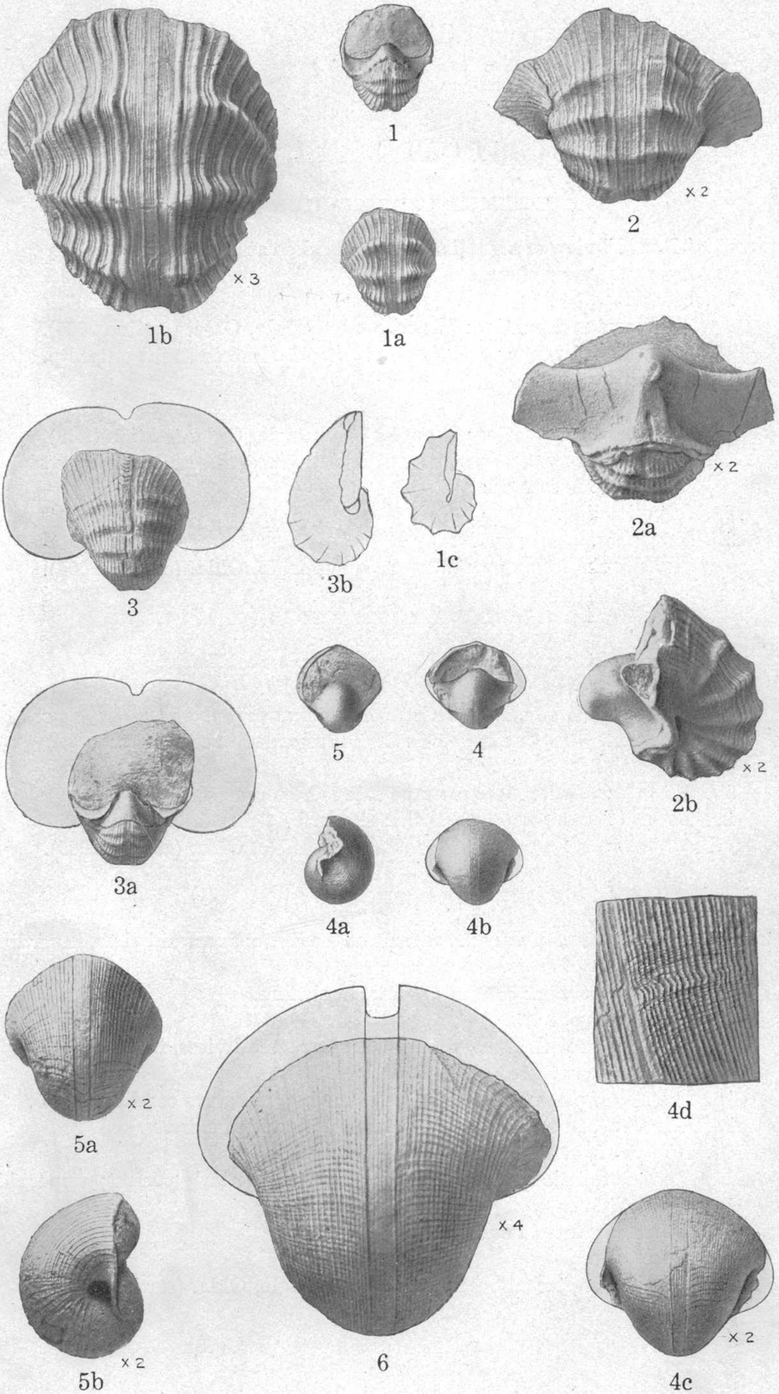
PLATE XX.

Patellostium montfortianum (p. 172).

Figure 1. A specimen much broken at the aperture but with well-preserved sculpture; apertural view.
1a. "Dorsal" view.
1b. Same, × 3.
1c. Side view, in outline.
2. "Dorsal" view of a specimen much broken at the aperture, × 2.
2a. Opposite view, showing the greatly developed callosity, × 2.
2b. Side view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
3. The least imperfect specimen examined, one which is less strongly plicated than some of the others. "Dorsal" view with the flaring aperture restored.
3a. Opposite view of same.
3b. Side view of same, in outline without restoration.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Bucanopsis meekiana (p. 169).

Figure 4. The type specimen of "*Bellerophon tenuilineatus;*" apertural view.
4a. Side view of same.
4b. "Dorsal" view of same.
4c. Same, × 2.
4d. Part of the surface; the slit band is at the left.
"Upper Coal Measures," near Oakwood, Vermilion County, Ill.
5. A nearly perfect specimen from the Wewoka formation; apertural view.
5a. "Dorsal" view, × 2.
5b. Side view, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).
6. A specimen with well-preserved and rather coarse sculpture, × 4.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
GASTROPODA.

PLATE XXI.

Euphemus carbonarius (p. 174).

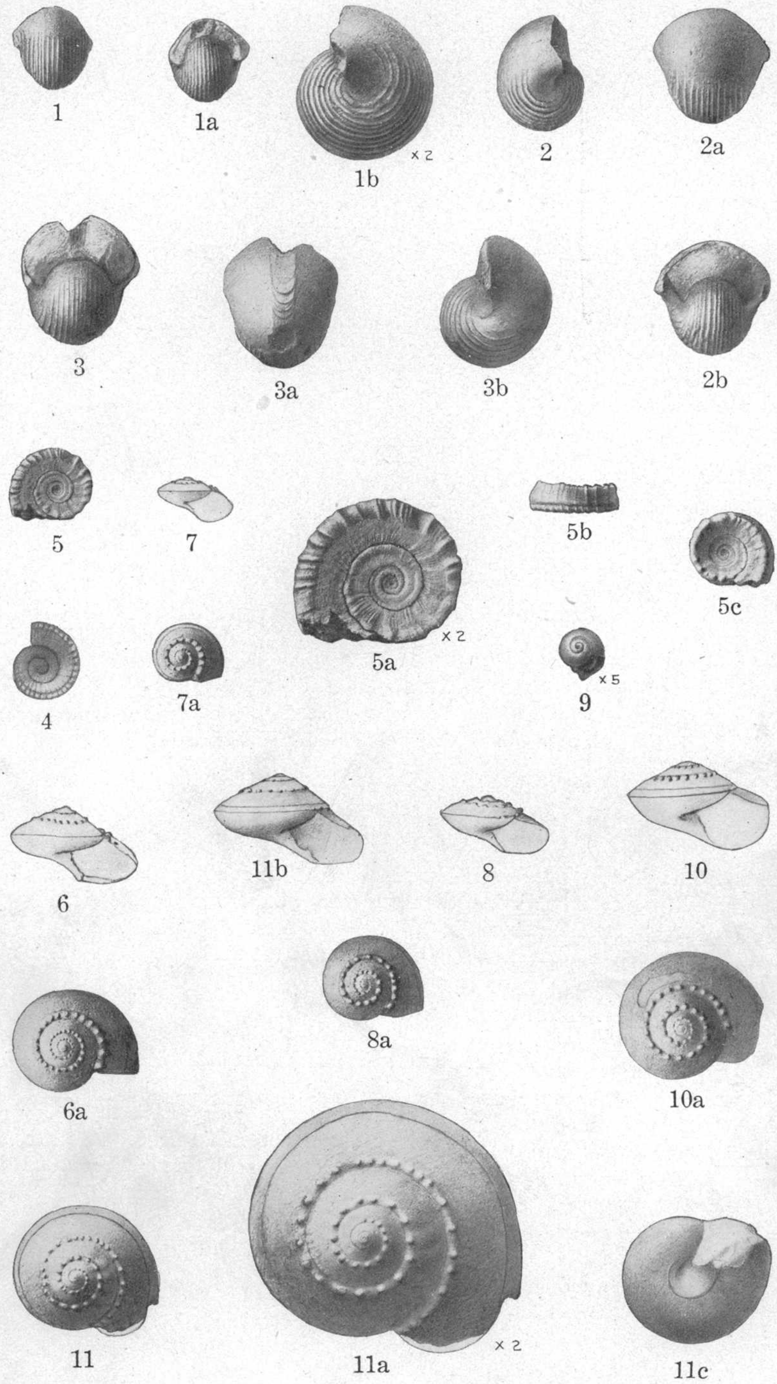
FIGURE 1. "Dorsal" view of a small specimen, broken at the aperture.
1a. Apertural view of same.
1b. Side view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
2. Side view of a characteristic specimen, also broken at the outer lip.
2a. "Dorsal" view.
2b. Apertural view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
3. Apertural view of a specimen with well-preserved sculpture and with the outer lip nearly complete.
3a. Opposite side.
3b. Side view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Schizostoma catilloides (p. 179).

FIGURE 4. A copy of Conrad's original figure of *Inachus catilloides*.
Carboniferous: Allegheny Mountain, Pa.
5. A small specimen characteristic of the form as it occurs in the Wewoka formation. Upper side (if the shell is regarded as sinistral).
5a. Same, × 2.
5b. Side view. The more concave side is here uppermost.
5c. Lower (?) side, opposite to that shown by figure 5.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Trepospira depressa (p. 158).

FIGURE 6. A specimen with very prominent nodose zone; apertural view, in outline.
6a. Upper side of same.
7. Young specimen; apertural view, in outline.
7a. Upper side of same.
8. A specimen with large, coarse nodes; apertural view, in outline.
8a. Upper side of same.
9. The apical portion of a large shell showing immature condition, × 5.
10. Side view, in outline, of a specimen with a high spire.
10a. Upper side of same.
11. A characteristic specimen having the outer lip nearly perfect; upper side.
11a. Same, × 2.
11b. Apertural view in outline.
11c. Lower side.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.

GASTROPODA.

PLATE XXII.

WORTHENIA TABULATA (p. 152).

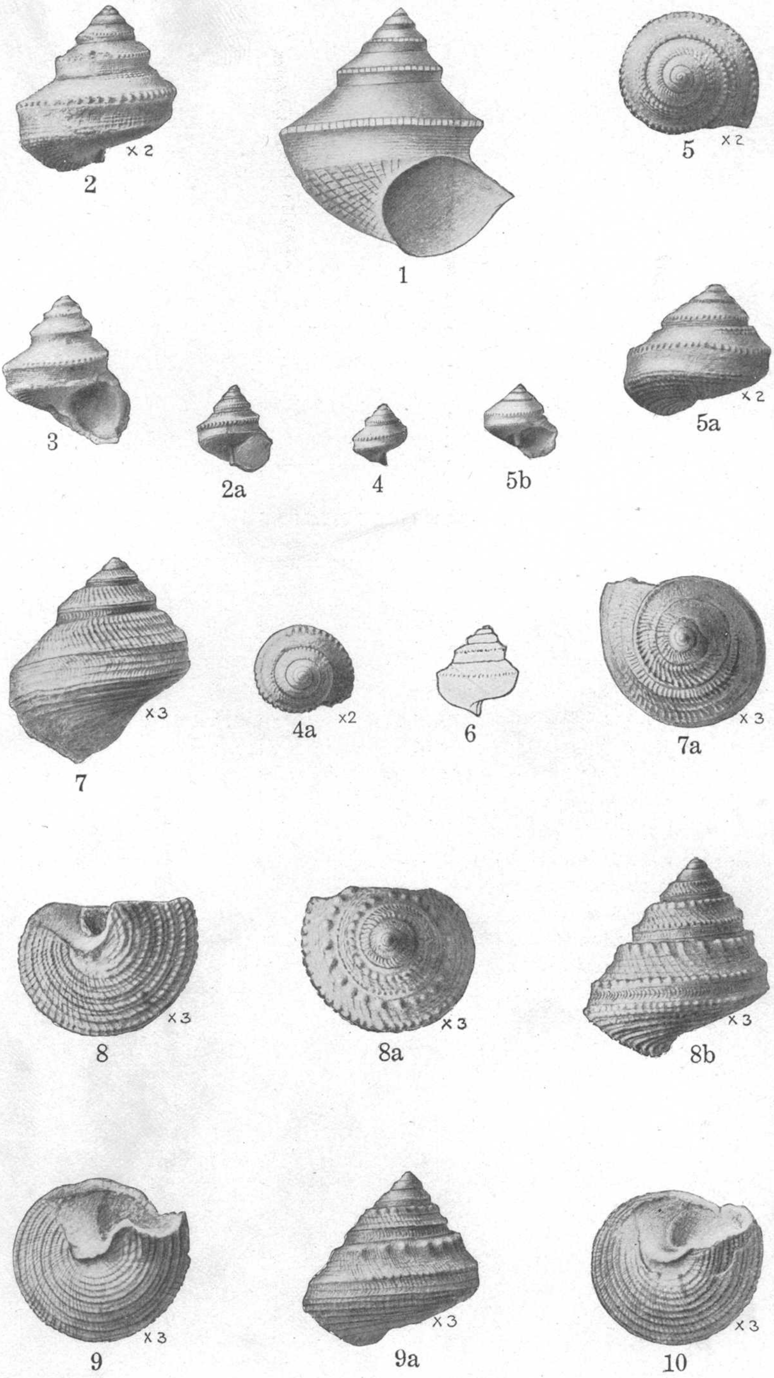
FIGURE 1. A copy of Conrad's original figure of *Pleurotomaria tabulata*.
Pennsylvanian: Allegheny Mountain, Pa.
2. Side view of a small specimen from the Wewoka formation, × 2.
2a. Apertural view of same.
3. Apertural view of the largest specimen seen.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
4. Side view of a very young specimen (somewhat tilted).
4a. Same; seen from above, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

WORTHENIA TABULATA var. (p. 154).

FIGURE 5. A specimen especially resembling *W. speciosa;* seen from above, × 2.
5a. Same; side view, × 2.
5b. Same; apertural view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
6. Side view, in outline, of a specimen having more the shape of a low-spired *W. tabulata*.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

ORESTES NODOSUS (p. 156).

FIGURE 7. Side view, × 3, of a specimen included with doubt in this species. If it proves to be distinct the name *Orestes lineatus* is proposed for it.
7a. Same; seen from above, × 3.
8. A specimen having a rather high spire; seen from below, × 3. This may be considered the type specimen.
8a. Same; seen from above, × 3.
8b. Same; side view, × 3.
9. A specimen of somewhat lower spire; seen from below, × 3.
9a. Same; side view, × 3.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
10. Another specimen; seen from below, × 3. This figure, together with figures 8 and 9, shows the resorption of the sculpture on the inner lip.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
GASTROPODA.

37003°—Bull. 544—15——21

PLATE XXIII.

IANTHINOPSIS GOULDIANA (p. 223).

FIGURE 1. Side view of a unique specimen.

1a. Opposite side.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

PHANEROTREMA GRAYVILLENSE (p. 149).

FIGURE 2. Side view, in outline, of a large specimen with acute spiral angle.

2a. Another outline of same, showing slit band.

2b. Apertural view in outline.

3. A small, well-preserved specimen; seen from above, × 2.

4. Lower side of a specimen, viewed somewhat obliquely, showing the lower lip, × 2.

5. A specimen with broad spiral angle; apertural view, in outline.

6. A small specimen; apertural view, in outline.

6a. Lower side of same, × 3.

6b. Upper side, × 3.

6c. Side view, × 3.

7. Side view of another specimen, × 3.

7a. Same, seen from above, × 3.

7b. Apertural view, in outline.

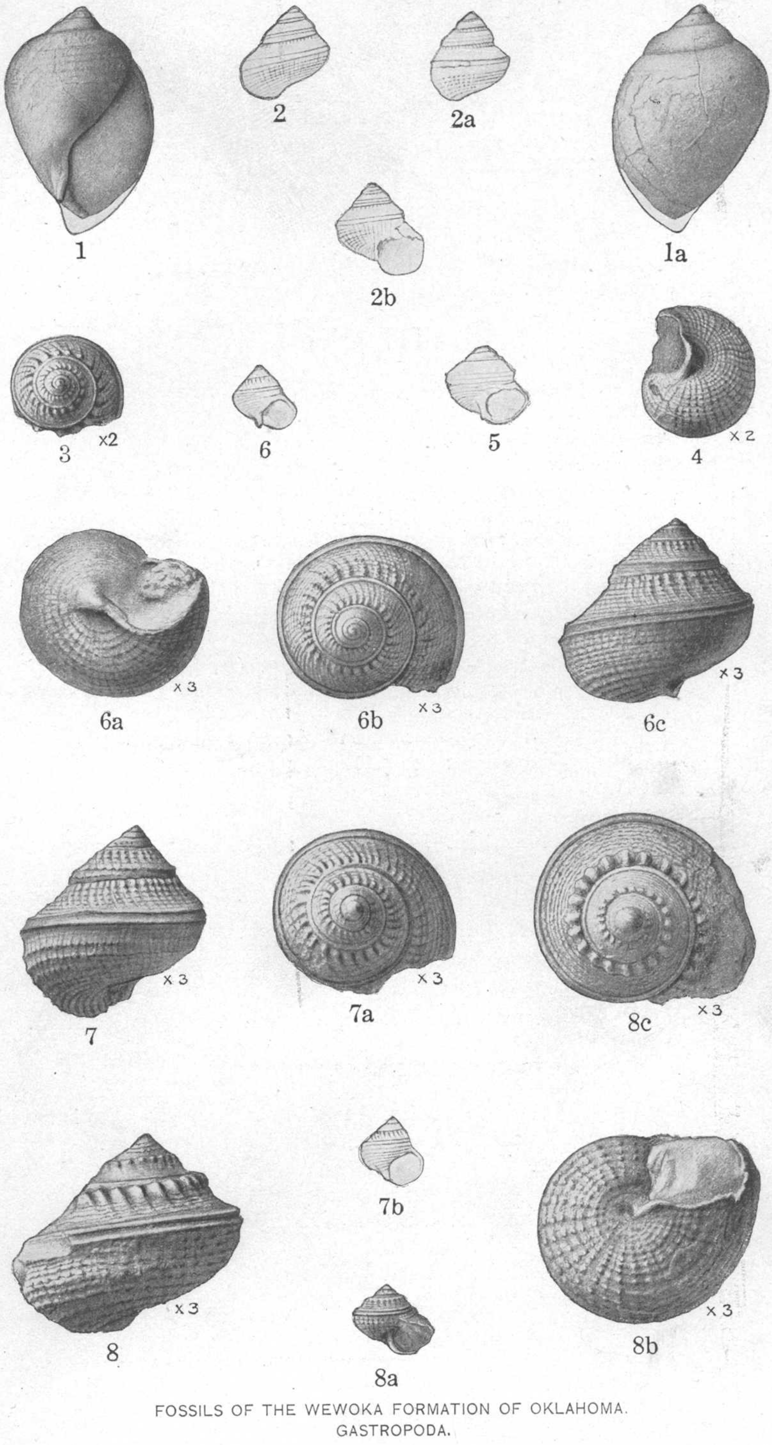
8. Side view of another specimen, × 3.

8a. Apertural view of same.

8b. Lower side, × 3.

8c. Upper side, × 3.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
GASTROPODA.

PLATE XXIV.

SPHÆRODOMA INTERCALARIS (p. 205).

FIGURE 1. A small, slender specimen; apertural view.
1a. Opposite side of same.
2. A characteristic specimen of the type referred to this species; side view.
2a. Apertural view.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

SPHÆRODOMA GRACILIS (p. 204).

FIGURE 3. Apertural view of the only specimen observed, × 2.
3a. Opposite side of same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

SPHÆRODOMA VENTRICOSA (p. 213).

FIGURE 4. Side view of a specimen in close agreement with the type of the species.
4a. Apertural view of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

SPHÆRODOMA PALUDINIFORMIS (p. 207).

FIGURE 5. Side view of a rather large specimen, turned slightly to one side. The specimen is more gibbous than the drawing shows.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
6. Side view of a small specimen.
6a. Apertural view of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

SPHÆRODOMA BREVIS var. (p. 204).

FIGURE 7. Apertural view of a specimen representing a narrow form related to *S. brevis*.
7a. Opposite side of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

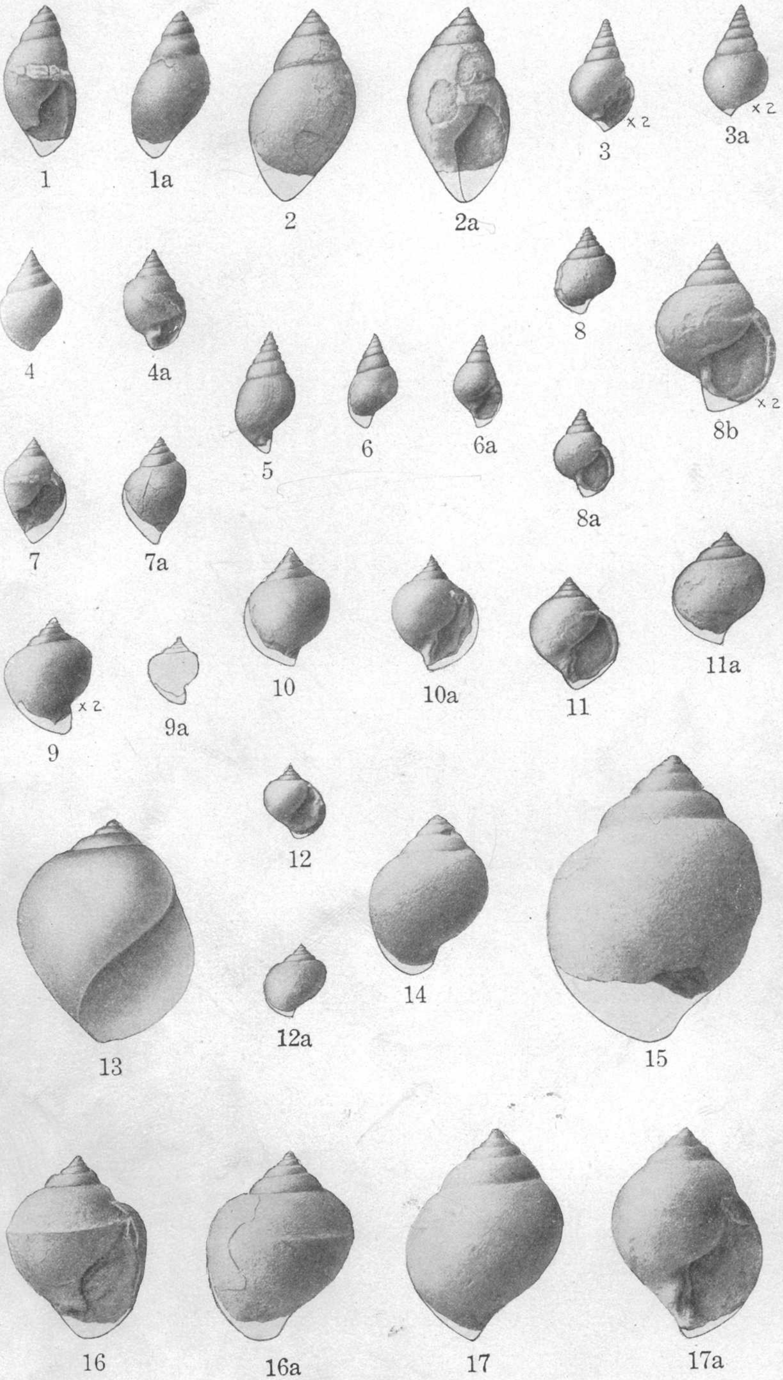
SPHÆRODOMA BREVIS (p. 201).

FIGURE 8. A specimen provisionally referred to this variety. The spire is too high and regularly enlarging to be characteristic. Side view.
8a. Apertural view.
8b. Same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
9. Side view of a young specimen, × 2.
9a. Same, natural size, in outline.
10. Side view of a typical specimen.
10a. Apertural view of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

FIGURE 11. Apertural view of another specimen.
11a. Opposite side of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
12. Apertural view of a smaller specimen.
12a. Opposite side of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

SPHÆRODOMA PRIMIGENIA (p. 208).

FIGURE 13. A copy of Conrad's original figure of *Stylifer primigenius*.
Carboniferous: Allegheny Mountain, Pa.
14. Side view of a rather small and gibbous specimen.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
15. The largest and perhaps the least ventricose specimen referred to this species.
16. A specimen with broader spiral angle; apertural view.
16a. Opposite side of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
17. A small, nearly perfect specimen representing about the average of those referred to this species; side view.
17a. Apertural view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
GASTROPODA.

PLATE XXV.

ZYGOPLEURA RUGOSA (p. 183).

FIGURE 1. Apertural view of a well-preserved specimen referred to this species.
1a. Opposite side of same.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

ZYGOPLEURA MULTICOSTATA ? (p. 184).

FIGURE 2. Side view of a somewhat compressed specimen with poorly preserved sculpture.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

ZYGOPLEURA PARVA ? (p. 184).

FIGURE 3. Side view, in outline, of a poorly preserved specimen.
3a. Apical portion of same, × 5.
3b. Side view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

ZYGOPLEURA PLEBEIA ? (p. 185).

FIGURE 4. Side view of the only specimen of the species found.
4a. Same, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

MEEKOSPIRA PERACUTA var. CHOCTAWENSIS (p. 216).

FIGURE 5. Apertural view of a small specimen.
5a. Same, × 2.
6. Apertural view of a large imperfect specimen showing the inner lip.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
7. Side of a full-sized, nearly perfect specimen.
7a. Apertural view of same.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
8. Side of the apical portion of a large specimen; in outline.
8a. Same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

MEEKOSPIRA BELLA ? (p. 218).

FIGURE 9. Side view of the only specimen found.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

BULIMORPHA INORNATA ? (p. 222).

FIGURE 10. Apertural view of the only specimen found.
10a. Opposite side.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

Dentalium semicostatum (p. 145).

Figure 11. A fragmentary specimen, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Dentalium indianum (p. 145).

Figure 12. Side view of the type specimen, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Dentalium subleve (p. 146).

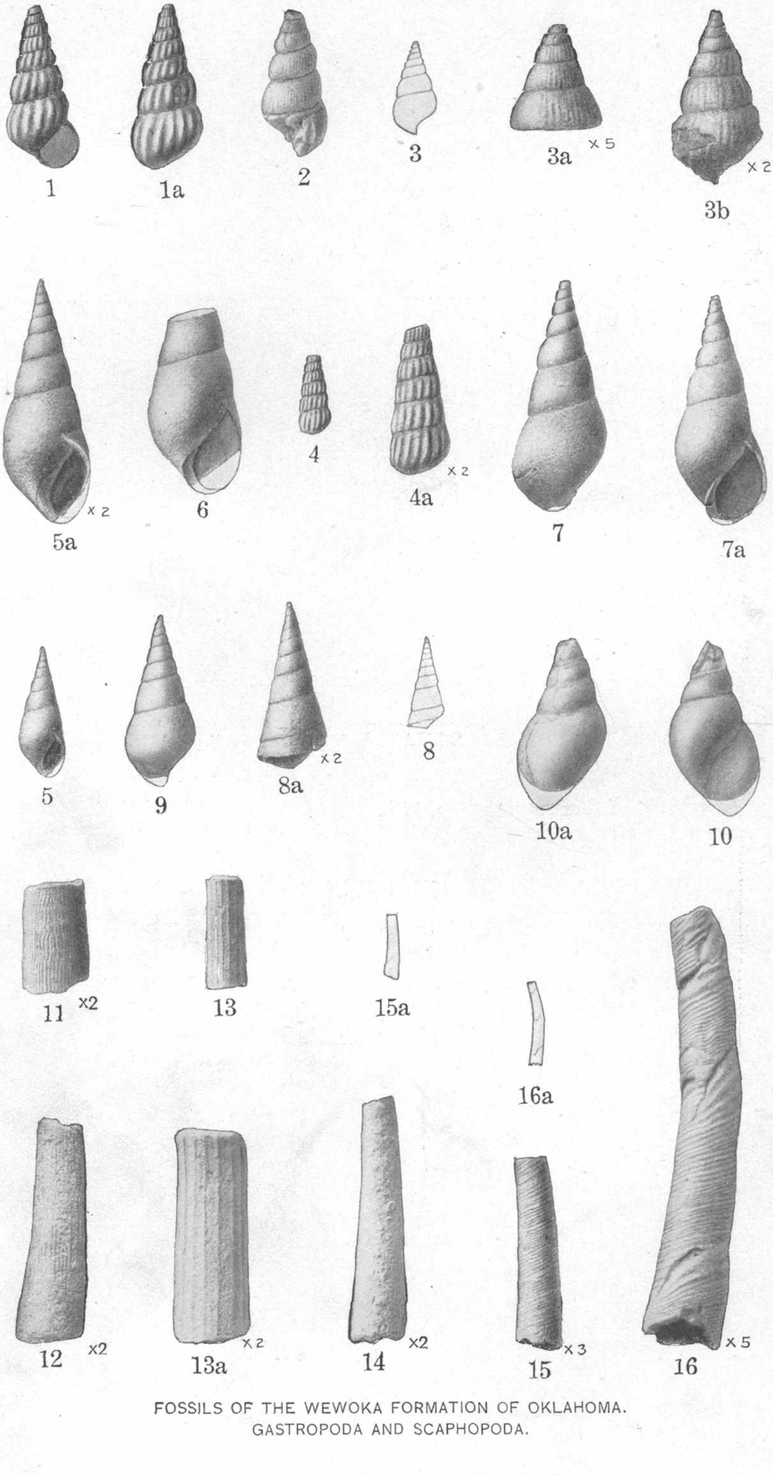
Figure 13. Side view of a fragment referred to this species.
13a. Same, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Plagioglypta meekiana (p. 148).

Figure 14. Side view of a fragment referred to this species, × 2. Some fine obscure oblique incremental striæ which can be made out on the specimen are not shown in the figure.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Plagioglypta annulistriata (p. 147).

Figure 15. Side view of a fragmentary specimen referred to this species, × 3.
15a. Same in outline, natural size.
16. A small specimen showing remarkable irregularity in the striation, owing in part to repair of injuries received during growth. Side view, × 5.
16a. Same, in outline, natural size.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
GASTROPODA AND SCAPHOPODA.

PLATE XXVI.

Orthoceras tuba (p. 224).

Figure 1. Side view of a typical specimen.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).
2. Side view of another specimen.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
3. A specimen doubtfully included in the species.
4. Another doubtful specimen, showing the position of the siphuncle.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Fistulipora carbonaria (p. 44).

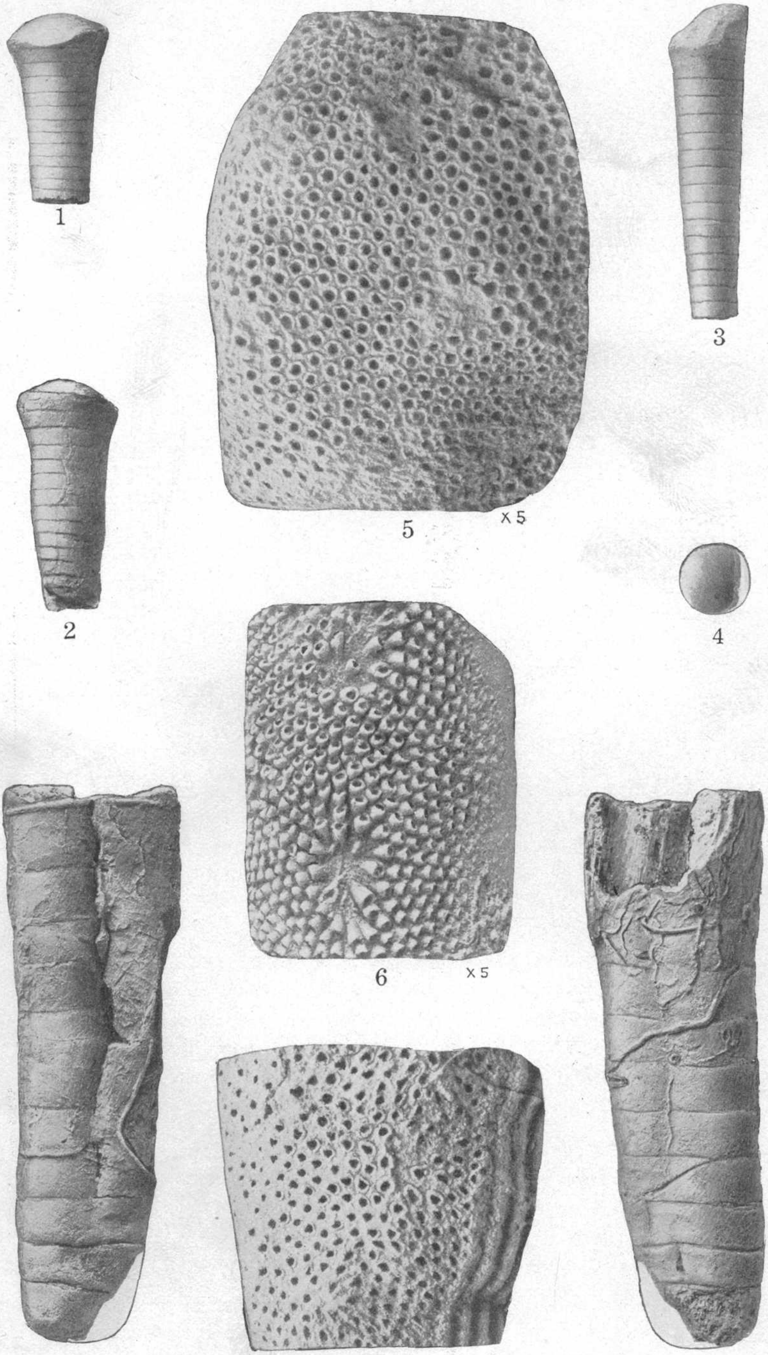
Figure 5. Part of a mature zoarium, × 5.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).

Fistulipora carbonaria var. nebraskensis (p. 45).

Figure 6. Part of an immature colony referred to this variety, × 5.
7. Part of a mature zoarium, × 5.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Orthoceras sp. C (p. 226); Enchostoma serpuliforme (p. 38).

Figure 8. The Orthoceras is an internal mold and has the Enchostoma, which is testiferous, apparently attached to it.
8a. Opposite side of same. The Enchostoma is broken away in one place, leaving a groove in the mold. The Enchostoma can hardly have been attached to the inside of the shell since it passes across the septa.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



FOSSILS OF THE WEWOKA FORMATION OF OKLAHOMA.
BRYOZOA AND CEPHALOPODA.

PLATE XXVII.

PSEUDORTHOCERAS KNOXENSE (p. 227).

FIGURE 1. A specimen ground down nearly to the siphuncle, showing the marginal filling of the chambers, × 2.

2. A specimen similarly ground, so that the section passes through the siphuncle, × 2.

3. A specimen showing the obliquely truncated initial portion, × 2.

4. A characteristic specimen.

5. A specimen showing the "false siphuncle" represented by a row of holes.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

6. A similar specimen with the "false siphuncle" represented by limonite. The septation here is very irregular.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

PSEUDORTHOCERAS SEMINOLENSE (p. 234).

FIGURE 7. Side view of a somewhat crushed specimen.

8. A smaller specimen, also crushed and showing some peculiar structures. The longitudinal markings suggest a marginal siphuncle, but are probably not to be thus interpreted. The transverse markings are due in part to the septa and in part to the characteristic annular deposits about the lower portion of each chamber.

8a. Opposite side of the same. At the top the thickening of the walls, which has a somewhat cystose appearance, is shown in the partly exposed chamber. Below, a very slender chord of limonite, the "false siphuncle," can be seen.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

PROTOCYCLOCERAS? RUSHENSE? (p. 235).

FIGURE 9. The broad side of a characteristic specimen.

9a. The narrow side.

9b. Cross section.

10. The broad side of another specimen.

10a. The narrow side.

10b. Cross section.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

PROTOCYCLOCERAS? RUSHENSE var. CREBRICINCTUM (p. 236).

FIGURE 11. The broad side of a specimen.

11a. The narrow side.

11b. Cross section.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

ORTHOCERAS sp. B (p. 226).

FIGURE 12. Side view of a characteristic specimen. The downward deflection (or lobe) of the constriction at the sides does not come out in this view.

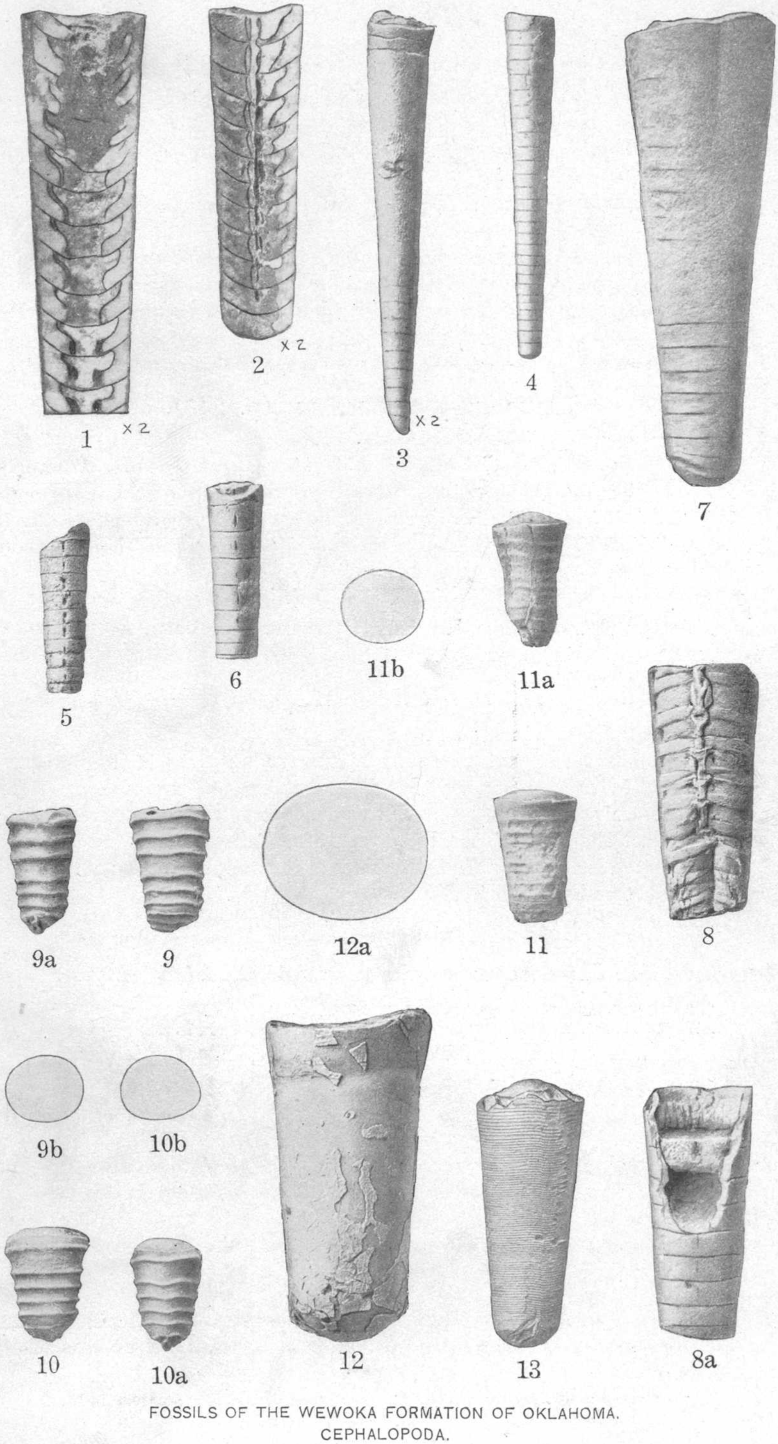
12a. Cross section.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

ORTHOCERAS sp. A (p. 225).

FIGURE 13. A fossil of doubtful affinities. The fine cross striæ consist of a delicate film coating a conical mold of matrix. No really substantial shell remains.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).



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CEPHALOPODA.

PLATE XXVIII.

Cyrtoceras peculiare (p. 246).

Figure 1. The only specimen collected; lower side.
1a. Dorsal? view, in outline.
1b. Side view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Coloceras liratum (p. 237).

Figure 2. Ventral view of a large, imperfectly preserved specimen.
2a. Apertural view, in outline.
2b. Side view.
3. Side view of a small testiferous specimen.
3a. Apertural view, in outline.
3b. Part of the side opposite figure 3, showing the sculpture, × 3.
4. Ventral view of an imperfect specimen showing the shape of the aperture.
4a. Apertural view in outline. The aperture being filled by matrix, and its exact shape concealed thereby, allowance has not been made in the sketch for the inflection which would be produced in the outline of the aperture by the deep sinus.
5. Internal mold of a small specimen which can not with certainty be referred to this species. Ventral view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
6. Ventral view of a large, testiferous specimen.
6a. Part of the surface along the middle of the venter, × 5.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

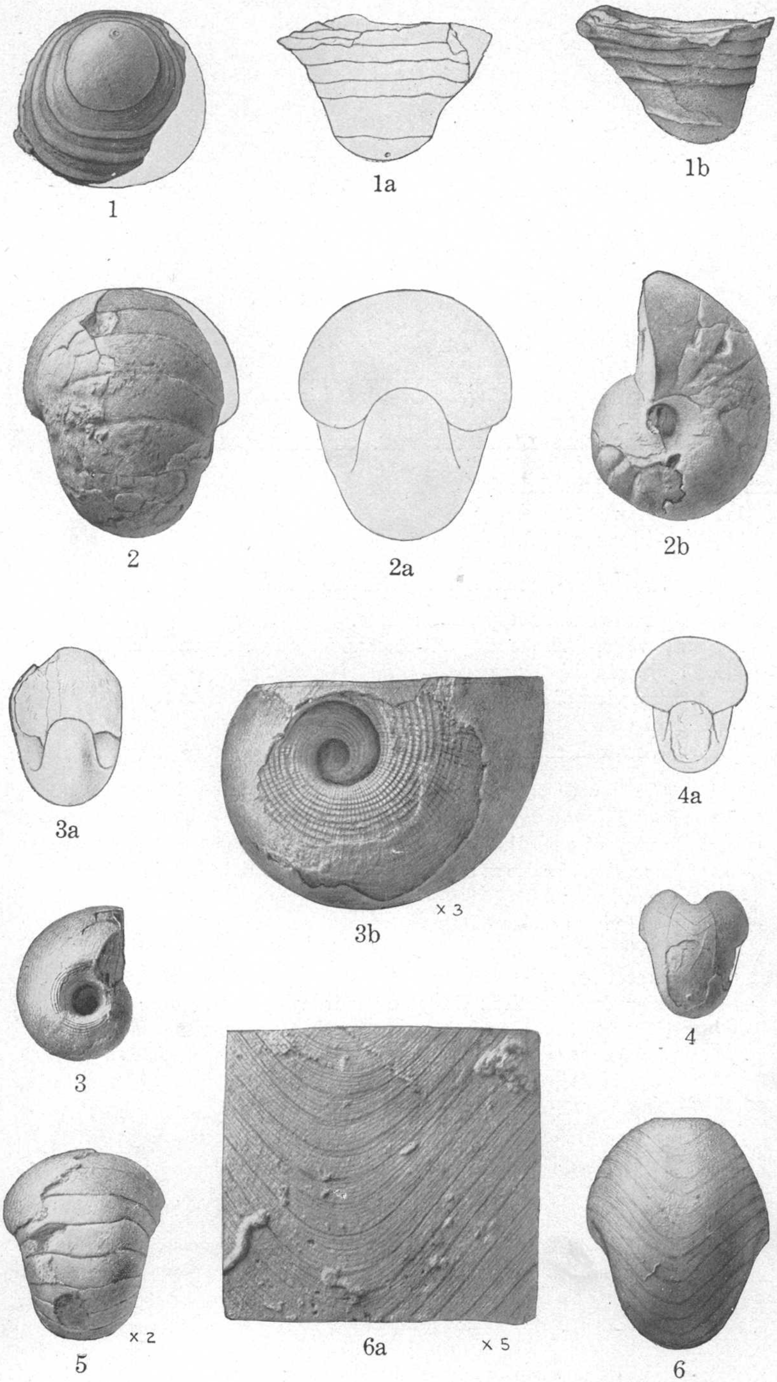

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PLATE XXIX.

COLOCERAS LIRATUM var. OBSOLETUM (p. 238).

FIGURE 1. An internal mold doubtfully referred to this variety; apertural view, × 2.
1a. Side view, × 2.
1b. Ventral view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
2. Ventral view of an unusually contracted specimen showing the shape of the aperture and its hyponomic sinus.
2a. Side view. The emargination made by the hyponomic sinus does not appear in this figure.
3. Ventral view of a fragmentary specimen.
3a. Dorsal view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

METACOCERAS CORNUTUM (p. 240).

FIGURE 4. Side view of a small, rather perfect specimen.
4a. Cross section of same at the break on the lower right-hand side.
4b. Apertural view.
5. Ventral view of a large fragmentary specimen.
5a. Side view of same.
5b. Cross section.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

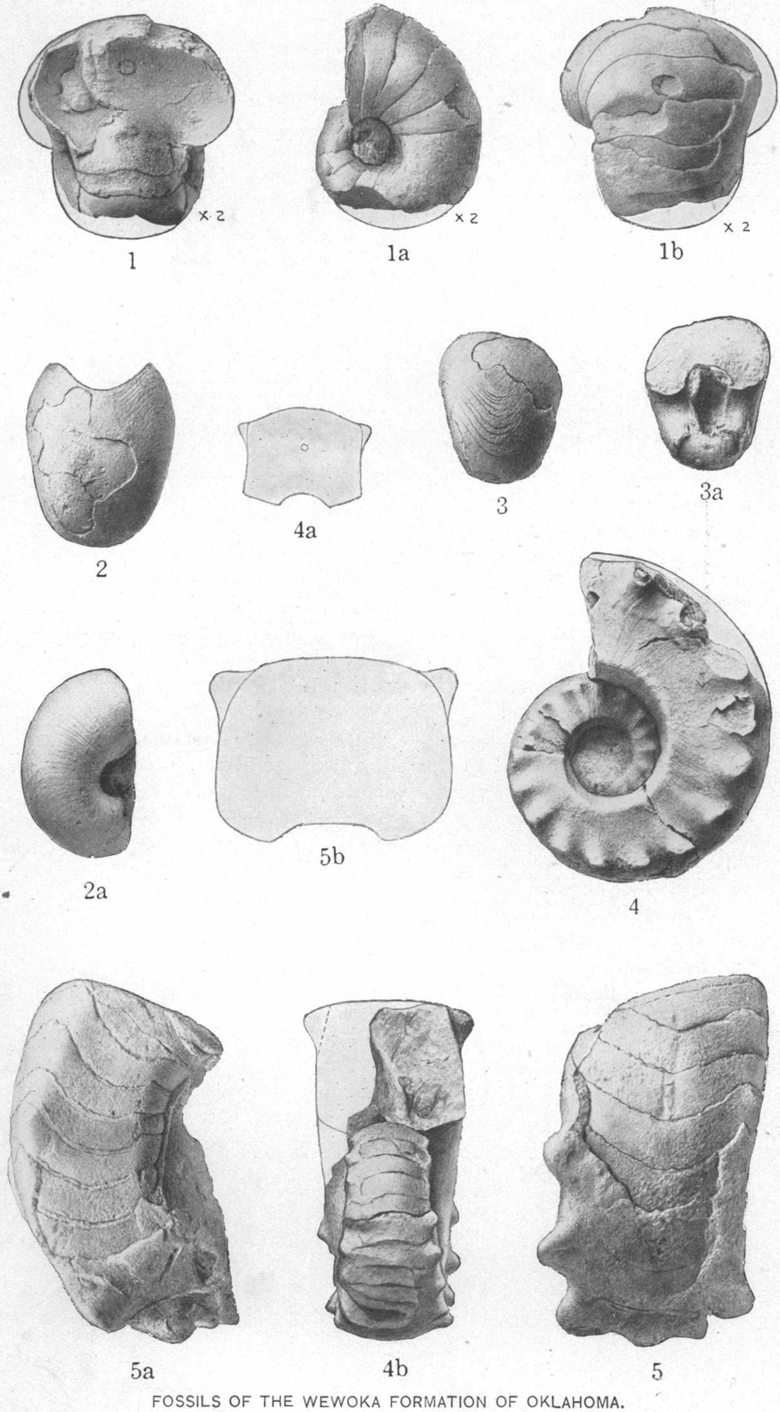

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PLATE XXX.

Metacoceras cornutum var. sinuosum (p. 242).

Figure 1. Side view of a testiferous specimen.
1a. Ventral surface of same.
1b. Cross section.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

Metacoceras cornutum var. multituberculatum (p. 243).

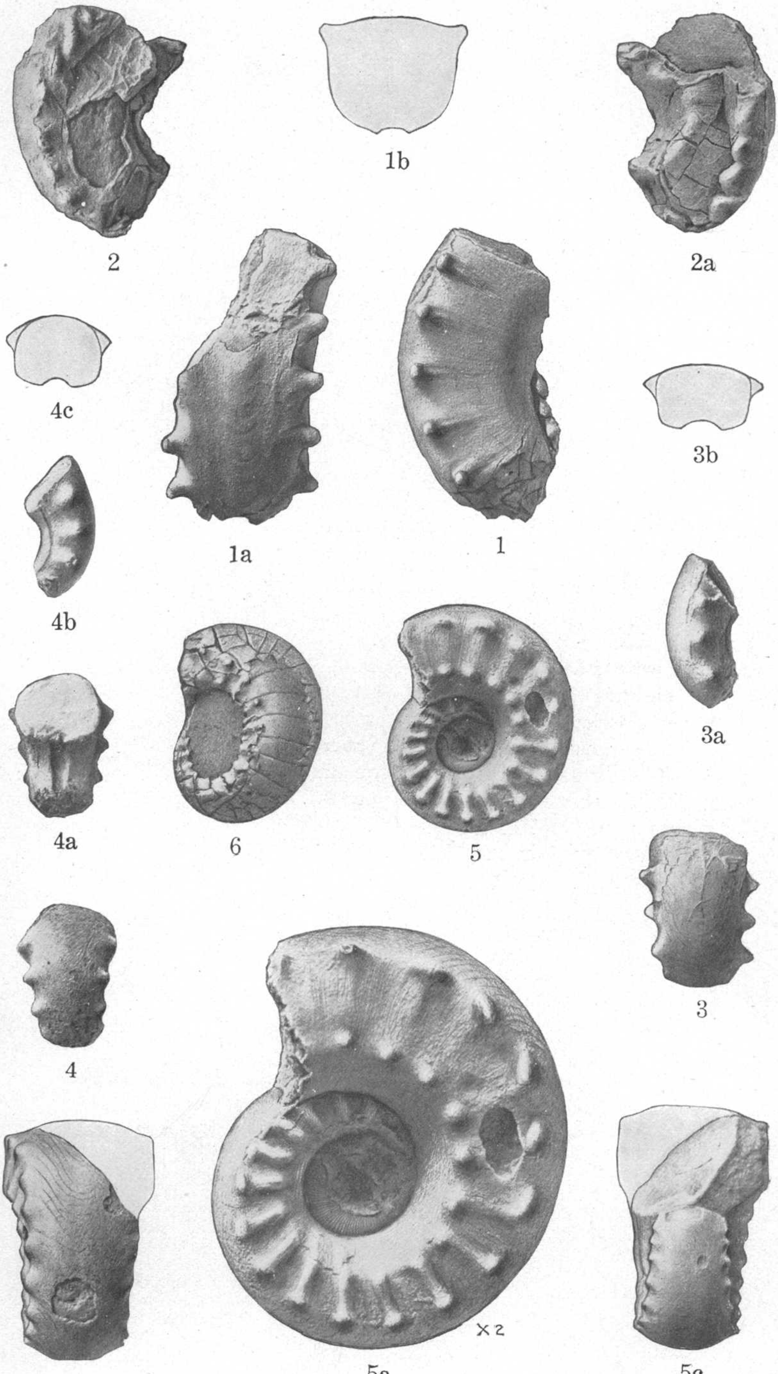
Figure 2. Side view of a crushed specimen.
2a. Opposite side.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).

Metacoceras cornutum var. carinatum (p. 243).

Figure 3. Ventral side of an imperfect specimen.
3a. Side view of same.
3b. Cross section.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
4. Ventral side of a more rapidly expanding fragment.
4a. Dorsal side of same.
4b. Side view.
4c. Cross section.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

Metacoceras perelegans (p. 244).

Figure 5. Side of the typical specimen.
5a. Same, × 2.
5b. Ventral view of same.
5c. Apertural view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
6. A somewhat crushed specimen, showing the suture.
Wewoka formation: Coalgate quadrangle, Okla. (station 7193).



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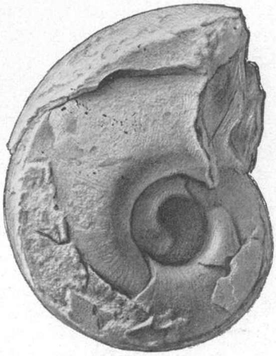
CEPHALOPODA.

PLATE XXXI.

METACOCERAS SCULPTILE (p. 245).

FIGURE 1. Side view of a crushed specimen.
1a. Opposite side.
1b. Apertural view, in outline.
1c. Ventral view.
1d. Part of the outer surface near the aperture, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
2. Side view of a large imperfect specimen.
2a. Same; apertural view, in outline.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).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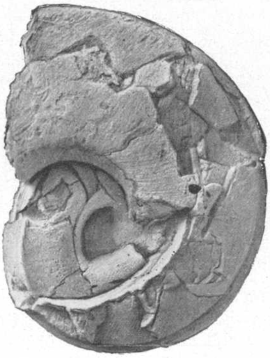
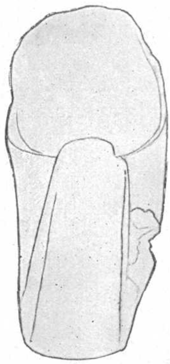

1a


1b


1d × 2


1c


2

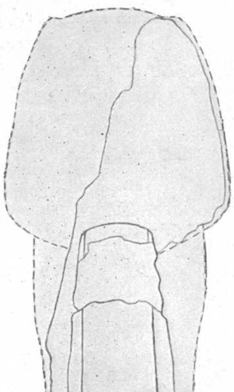

2a

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PLATE XXXII.

GASTRIOCERAS VENATUM (p. 254).

FIGURE 1. Side view of a large testiferous specimen.
1a. Apertural view, in outline.
1b. Side view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
2. A smaller specimen preserved as an internal mold; apertural view, in outline.
2a. Suture, × 2.
Wewoka formation: Coalgate quadrangle, Okla. (station 2004).
3. Side view of a still smaller specimen preserved as an internal mold, × 2.
3a. Apertural view in outline.
3b. Ventral view, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

CYRTOCERAS ?? sp. (p. 247).

FIGURE 4. Side view of a specimen of uncertain affinities, × 2.
4a. Same, natural size.
5. A smaller, apparently related specimen; side view, in outline.
5a. Lower side, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

GASTRIOCERAS HYATTIANUM (p. 254).

FIGURE 6. A large specimen referred to this species; side view, in outline.
6a. Apertural view, in outline.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).
For other figures of this species see Plate XXXIII.

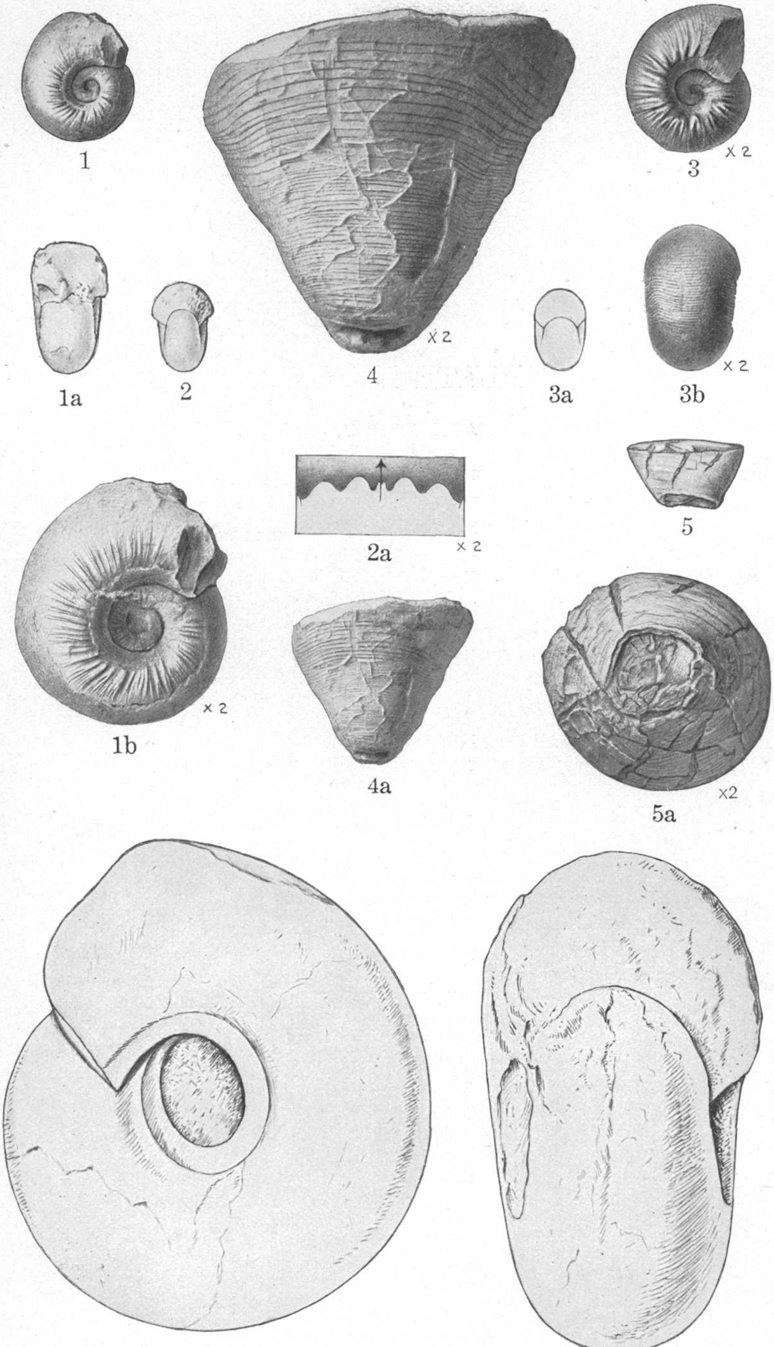

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PLATE XXXIII.

GASTRIOCERAS HYATTIANUM (p. 254).

FIGURE 1. A large specimen referred to this species. The shell is almost smooth; very obscure transverse striæ cross the ventral surface, and a few fine revolving liræ are developed at the angular umbilical shoulder. Side view, in outline.

1a. Apertural view, in outline.

Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

2. Ventral view of a young shell, × 2.

2a. Apertural view, in outline.

2b. Side view, in outline.

2c. Suture, × 2.

Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

3. A larger specimen, apertural view, in outline.

3a. Suture, × 2.

3b. Part of the sculpture across the venter of the inner whorl, × 2.

3c. Same, near side, × 2.

4. Side view of a small testiferous specimen.

4a. Same, × 2.

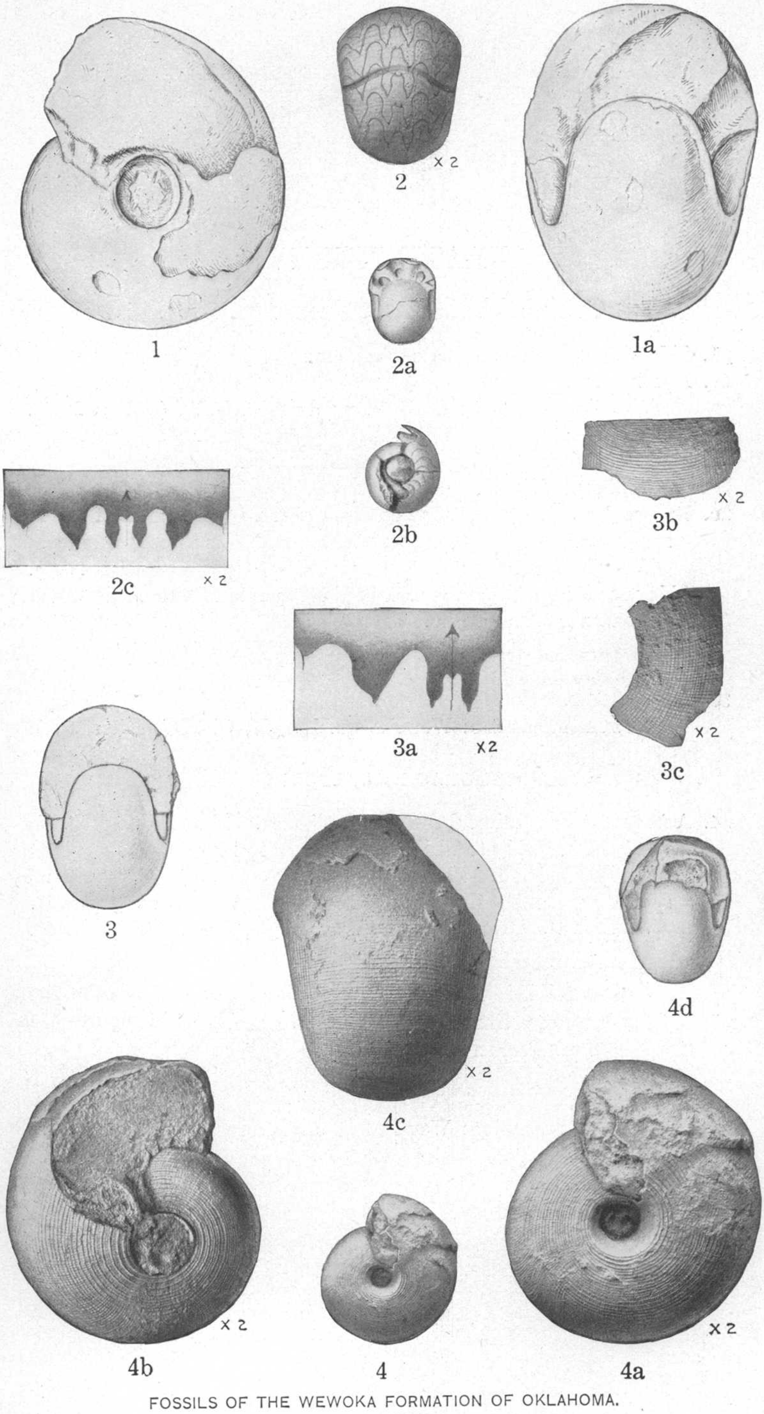
4b. Opposite side, × 2.

4c. Ventral view, × 2.

4d. Apertural view, in outline.

Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

For other figures of this species see Plate XXXII, figures 6, 6a.



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CEPHALOPODA.

PLATE XXXIV.

GASTRIOCERAS ANGULATUM (p. 256).

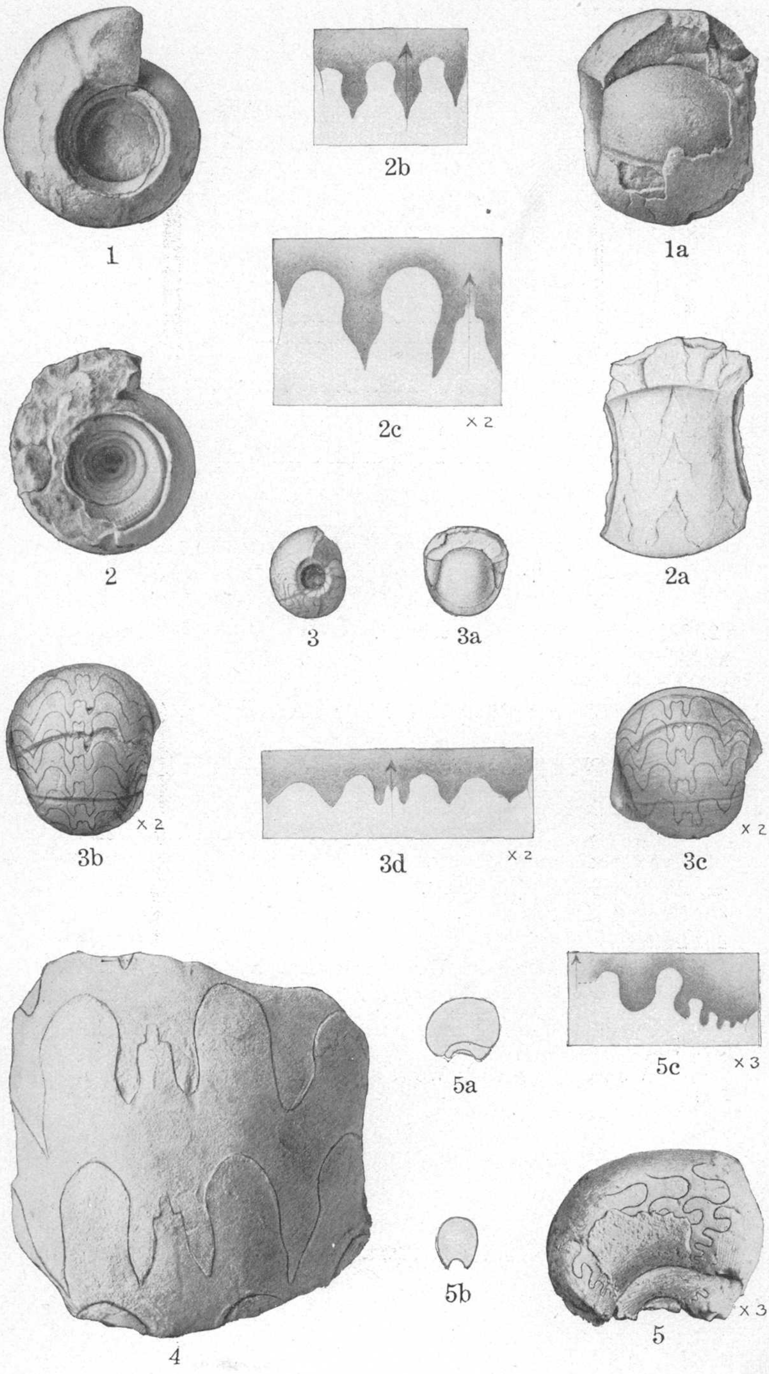
FIGURE 1. Side view of a characteristic specimen.
1a. Apertural view.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).
2. Side view of a specimen taken as the type.
2a. Apertural view, showing the internal sutures.
2b. Internal suture.
2c. External suture, × 2. The outlines of the sutures are not clear on the specimen and the drawing may not be accurate in consequence.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
3. Side view of a young specimen doubtfully referred here.
3a. Apertural view, in outline.
3b. Ventral view, × 2.
3c. Same, tilted backward, × 2.
3d. Suture, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

GASTRIOCERAS EXCELSUM (p. 258).

FIGURE 4. A fragmentary specimen, the only one found. The mold is probably somewhat worn, owing to which the shape of the sutures may be proportionally distorted. The ventral saddle is not clearly shown by the specimen, and the drawing may not be accurate in consequence.
Wewoka formation: Coalgate quadrangle, Okla. (station 2001).

PRONORITES ?? sp. (p. 247).

FIGURE 5. A fragmentary specimen, the only one of its kind in the collection, × 3.
5a. Same, natural size, in outline.
5b. Cross section.
5c. Suture, × 3.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



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CEPHALOPODA.

PLATE XXXV.

DIMORPHOCERAS LENTICULARE (p. 259).

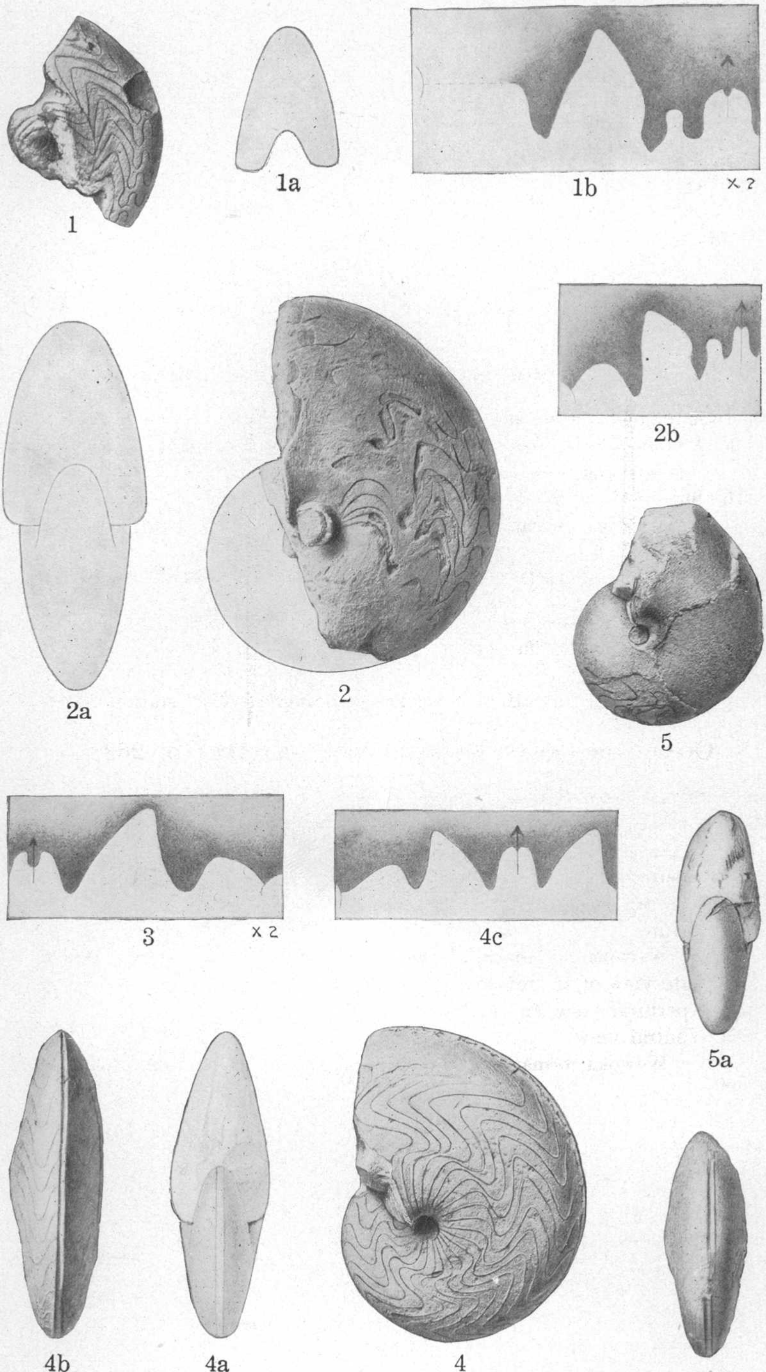
FIGURE 1. A fragment taken as the type, side view.
1a. A cross section, restored below at the sides but probably very close to the true shape.
1b. Suture, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).

DIMORPHOCERAS OKLAHOMÆ (p. 260).

FIGURE 2. Side view of the type specimen.
2a. Apertural view, in outline.
2b. Suture.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).

GONIOLOBOCERAS WELLERI var. GRACILE (p. 263).

FIGURE 3. Suture taken from a fragment, × 2.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).
4. Type specimen, side view.
4a. Apertural view, in outline.
4b. Ventral view.
4c. Suture.
Wewoka formation: Wewoka quadrangle, Okla. (station 2005).
5. Side view of an immature specimen.
5a. Apertural view, in outline.
5b. Ventral view.
Wewoka formation: Wewoka quadrangle, Okla. (station 2006).



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