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FAUNAS OF THE BOONE LIMESTONE

AT

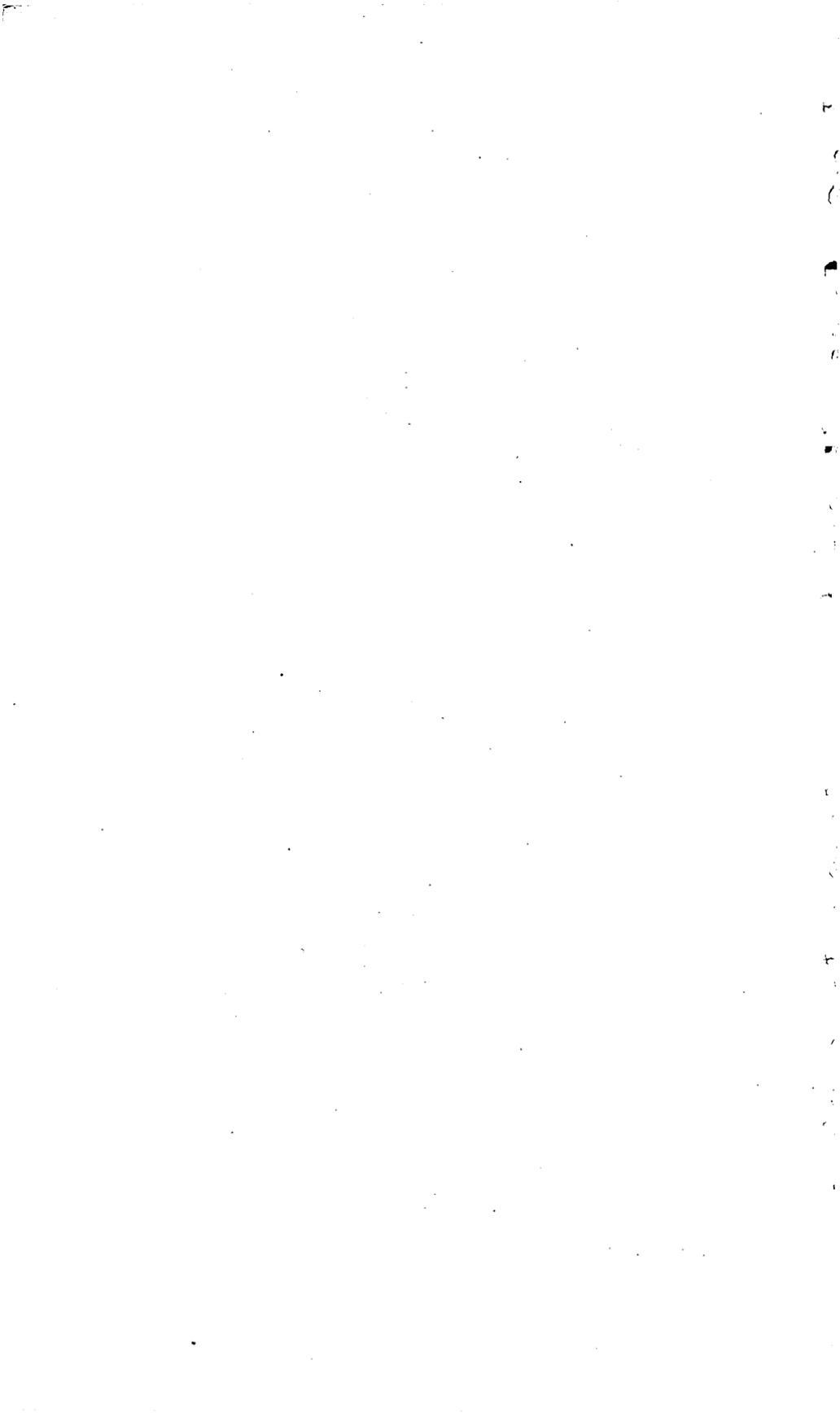
ST. JOE, ARKANSAS

BY

GEORGE H. GIRTY



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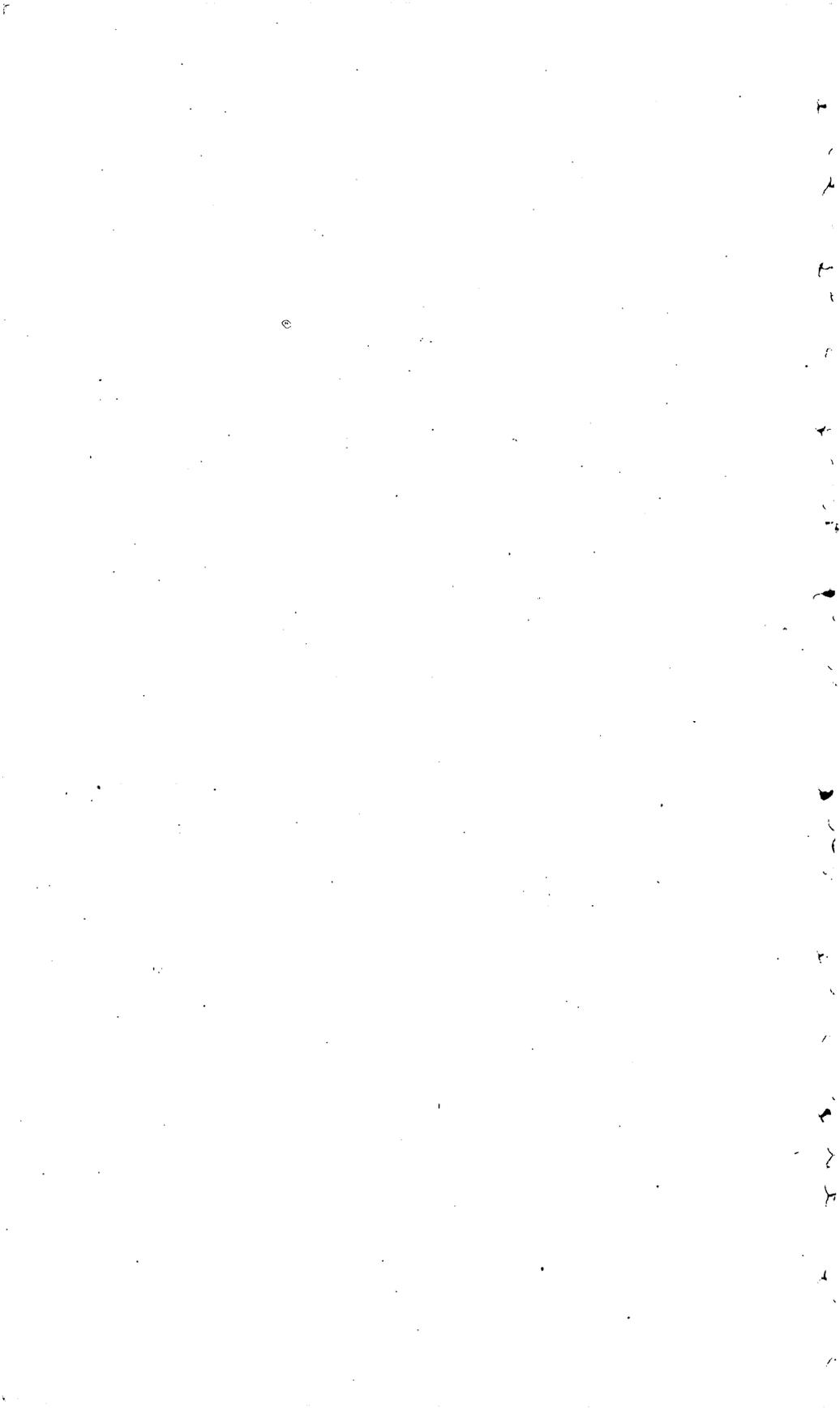


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FAUNAS OF THE BOONE LIMESTONE AT ST. JOE, ARKANSAS.

By GEORGE H. GIRTY.

LOWER PART OF THE BOONE LIMESTONE.

INTRODUCTION.

The Boone limestone takes its name from Boone County, in northern Arkansas, an area approximately coextensive with the Harrison topographic sheet of the United States Geological Survey. The name seems to have been used in several reports prepared simultaneously by members of the Arkansas survey, but it first appeared in a report by Penrose, published in 1891.¹ The formation in Arkansas has been described only in general terms and no type section has been given.

As the term is at present used by the United States Geological Survey the Boone limestone includes all the lower Mississippian rocks of northern Arkansas and southern Missouri, comprising equivalents of the Kinderhook, Burlington, and Keokuk formations farther north. The name has sometimes been employed to the exclusion of certain basal beds supposed to represent the Kinderhook group, and on the other hand it may well be that authors have locally included under it remnants of formations later than the Keokuk.

The upper beds of the Boone limestone in the Joplin district contain what may be called the *Productus magnus* fauna. This fauna has always been accepted as of Keokuk age, and consequently I have contended that no part of the Boone, properly so called, was younger than the Keokuk. Prof. Weller tells me, however, that he has recently obtained satisfactory evidence that the age of the *Productus magnus* fauna is not Keokuk but Warsaw. That he is correct in this conclusion is indicated by evidence that came independently into my hands last autumn, and consequently it now seems necessary to regard the Boone limestone as ranging in age from Kinderhook (Fern Glen) to Warsaw.

The rocks of the Boone extend into northern Missouri, Iowa, and Illinois, but the application of the name is restricted to areas in southern Missouri, northern Arkansas, and adjacent parts of Kansas and Oklahoma. In this region the Boone is composite, here and there differentiated into members which appear, however, to be more or less regional in their distribution. One of the most widely

¹ Arkansas Geol. Survey Ann. Rept. for 1890, p. 129, 1891.

recognized of the subdivisions of the Boone is the St. Joe limestone member, which is typically exposed at St. Joe, Searcy County, Ark., and which has been identified over much of northern Arkansas and also in northeastern Oklahoma. This is by definition the basal member of the Boone, and it has been correlated by Prof. Weller, it appears correctly, with the Fern Glen limestone member of the Kinderhook formation. Some evidence exists that the St. Joe is separated from the overlying portions of the Boone by an unconformity,¹ though its apparent absence in some sections may be due to nondeposition. In the Joplin region, where the section has been so much more thoroughly studied that it has in a measure usurped the function of the typical section, the Boone has been divided into several members. At the base are as much as 100 feet of thin, impure shaly and cherty limestones, occupying in part the position of the St. Joe limestone, but not having the St. Joe lithology. These are overlain by the Grand Falls chert member 40 or 50 feet thick. The upper 200 feet, mainly of pure limestone, is divided midway by the Short Creek oolite member. These subdivisions can not be traced into more remote regions, and others take their places.

In its fauna also the Boone is not a unitary but a composite body. Several fairly well differentiated faunal facies can be recognized in it, though these, like the lithologic subdivisions, are perhaps somewhat regional in their development.

Thus, while the Boone has been treated as a unit it has long been known that it was not such, but could probably be satisfactorily dissected into several constituents. That it has not been actually so dissected is, as I understand it, largely a practical question. Conditions are such that for defining and tracing the different members a close and constant paleontologic check would be necessary, and the end to be gained has not seemed to justify the effort when so many more desirable ends were demanding attention.

It is with the purpose, however, of making a small contribution to the investigation of the Boone problem that the present paper is written. I have described in more or less detail (pp. 25-26) the fauna of the St. Joe limestone as it occurs in a railroad cut $1\frac{1}{2}$ miles west of the depot at St. Joe, Ark. The present paper similarly describes a fauna which was found at the same locality near the base of the overlying portion of the Boone, within 10 feet of the lithologic top of the St. Joe. Small in scope though the present study be, if a sufficient number of similar papers were at hand the Boone could be analyzed in all its essential relations, even if it still seemed desirable for convenience to treat it as a single formation.

Of the character and correlation of this small but interesting fauna I propose to say but little at present. It possesses a somewhat novel

¹ Hopkins, T. C., Arkansas Geol. Survey Ann. Rept. for 1890, p. 254, 1893.

facies, owing to the presence of a considerable number of new species and to the association of types whose ranges have not heretofore been known to overlap. Of the 32 species which I have been able to identify in this fauna 8, or 25 per cent, are described as new, and several others are almost certainly new, but are represented by material so indifferent that the introduction of a new name does not seem warranted. Furthermore, a few types suggesting a Keokuk fauna, such as a new species of *Hemitrypa*, together with *Reticularia pseudolineata*, *Amplexus fragilis*, and *Spirifer suborbicularis* (all three of which, however, occur also in the Burlington), are associated with forms like *Leptæna analoga* and *Productella concentrica*, which bespeak a lower horizon. On the whole the facies may provisionally be regarded as belonging in the Burlington, where indeed the stratigraphic relations would also seem to place it.

From the St. Joe fauna, which preceded it, this marks a distinct and indeed a rather abrupt change. The St. Joe collections from this locality furnish 40 species and the present fauna comprises 32. Of these 72 species only 5 (*Cystodictya lineata*, *Leptæna analoga*, *Productella concentrica*?, *Spirifer grimesi*, and *Cliothyridina hirsuta*? or *roissyi*?) appear to be common to both faunas. I fully expect that more complete data based upon more widely distributed collections would show a closer relationship, but even then the faunal change would probably remain noteworthy.

The fauna described in this paper has been recognized in other collections from the Boone, and it probably has a fairly wide distribution. Until, however, those collections are carefully studied and the correlation verified it will be best to withhold a specific statement in regard to its geographic extent.

The two papers comprised in this bulletin were submitted for publication in the spring of 1914. They were consequently prepared without the aid of Prof. Weller's monograph on Mississippian Brachiopoda, copies of which did not reach Washington until the following November. Had this valuable work been available, some of the things which I have written would have been omitted as superfluous, and some of the species would have been differently identified.

CELENTERATA.

AMPLEXUS FRAGILIS White and St. John.

As represented in my collection this form consists of nearly straight stems which have a regularly cylindrical shape and a diameter not greater than 14 millimeters. Only three fragments have been obtained, and they do not show satisfactorily certain characters, especially the range of variation. The septa, which are very short, number about thirty, though it has not been practicable to count them accurately. The central portion of the corallum, owing to the

shortness of the septa, is very large, and is divided into chambers by regularly arranged tabulæ which are nearly flat, horizontal, and situated about 5 to 6 millimeters apart. The surface is marked by coarse striæ and also by finer intermediate ones. There are likewise obscure longitudinal markings connected with the septa.

A. fragilis was described from the Keokuk limestone. It has been cited also from the Burlington limestone, and the Burlington type described by Miller as *A. bicostatus* has been regarded as a synonym. In view of their stratigraphic position the fossils under consideration should be most like Miller's *A. bicostatus*, but they are considerably smaller with rather fewer septa and somewhat more regular tabulæ. It is a little uncertain, therefore, whether they are really identifiable with *A. fragilis*; if not, they are at least closely related.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

BRYOZOA.

CYSTODICTYA LINEATA Ulrich.

This is a rather abundant species, but the specimens, which are broken out of a limestone matrix, are probably a little exfoliated, such characters as the peristomial developments having suffered especially. The stipes have a width of 4 to 5 millimeters, a small thickness, gently convex sides, and sharp edges. One specimen shows branching at intervals of 9 millimeters, or more correctly the lower division seems to be in the nature of a branch and the upper a bifurcation. Other fragments are much longer than this without showing subdivision.

The surface is marked by longitudinal ridges and grooves of about equal size. The zoecia are situated on the ridges and are thus conspicuously arranged in longitudinal rows, of which there are eight or nine. An oblique arrangement is also conspicuous in most specimens, especially toward the margins, where obscure ridges are sometimes produced in this way. Marginally the apertures appear to be larger and the longitudinal ridges rather more indistinct. As presented in a probably exfoliated condition the apertures usually appear to be nearly circular with raised peristomes, but in places a lunarium is indicated and a trefoil-shaped aperture. About four apertures occur in 2 millimeters longitudinally.

This is almost certainly the form which Prof. Weller identified as *C. lineata* in the fauna of the Fern Glen limestone member of the Kinderhook formation, and it probably also occurs in the St. Joe limestone member of the Boone limestone, though the St. Joe specimens are too poor for an accurate determination of this point.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

FENESTELLA RUDIS Ulrich?

The largest and most satisfactory of the group of specimens included under this title shows a large, gently curved zoarium which apparently has the zoecial apertures on the outer side. It is much exfoliated and can be only partly described. Seven or eight branches occur in 5 millimeters and from four to four and one-half fenestrules longitudinally in the same distance. The growth is regular. The branches are slender, straight, slightly narrower than the fenestrules and slightly larger than the dissepiments. The fenestrules are elliptical with a length about one and one-half times their width. The backs of the branches are finely striated. Three zoecial apertures occur opposite each fenestrule, with or without an additional one opposite the dividing dissepiment. The other characters are obscured by exfoliation.

In all the characters preserved this form agrees very closely with the Keokuk species *F. rudis*.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

FENESTELLA sp. a.

Of this type our collection contains two specimens, both on the same slab, both showing the reverse side, and both more or less deeply exfoliated. The frond appears to have been large and nearly flat and the growth very regular. Ten branches occur in 5 millimeters, and five and a half to six fenestrules longitudinally in the same distance. The branches are slender and straight, apparently finely striated on the back. On the obverse the dissepiments appear to be narrow (about one-half the width of the branches) and to make rectangular fenestrules, and on the reverse they appear to be broader and to make elliptical fenestrules. The fenestrules are elongated, their length being about one and one-half times their width or a little more. They are slightly wider than the branches.

The apertures occur about four to a fenestrule, sometimes three opposite the fenestrule and one opposite the dissepiment. The characters of the peristome and of the carina are not shown.

This species resembles *F. rudis* and *F. herrickana* but is rather more finely constructed than either. It is also related to *F. cavernosa*. So far as examined, however, there is no described species with which it agrees in all particulars.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

FENESTELLA sp. b, c, d, and e.

The presence of four other species of *Fenestella* is indicated in the collection by fragments so small that a description of them would

hardly be worth while. They are all rather finely reticulate forms varying chiefly in proportional measurements with nothing otherwise very distinctive, so far as known.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

POLYORA n. sp.

A single specimen (showing the reverse side) of what is clearly a new species of *Polypora* occurs in the collection, but owing to the insufficiency of data it seems undesirable to introduce a new name in this place. The type is distinguished by its largely and loosely reticulate growth with relatively slender branches and dissepiments. The growth is in fact rather irregular, the branches dividing frequently and enlarging considerably before division. The slender dissepiments, about half as wide as the branches, occur at irregular intervals, leaving subquadrate fenestrules, all longer than wide and some relatively much longer than others.

The backs of the branches are covered with very fine discontinuous or inosculating striæ and by rather numerous papillæ.

It is, of course, of the obverse face that our information is especially deficient, and of this I am able to state only that the zoœcia appear to be arranged in three rows.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

HEMITRYPA n. sp.

The only specimen of this singular species is a slender, gradually enlarging, almost cylindrical zoarium, which has a length of nearly 50 millimeters and still is incomplete at the lower if not also at the upper end, where it has a diameter of only 8 millimeters. The zoarium is poriferous on the outer side. Only the superstructure is presented to view, and of that only the inner surface. This shows a series of equal circular apertures, very regularly arranged in longitudinal rows, the branches and dissepiments (to adopt the terms used for analogous structures in the true zoarium) being exactly equal save only that the alternate branches are slightly larger, so that the apertures are more or less clearly grouped in double series. The longitudinal divisions, or branches, are of course continuous, and the transverse divisions, or dissepiments, are discontinuous. Seven apertures occur in 2 millimeters longitudinally.

As already noted, no data relating to the inhabited portion of the zoarium can be given.

If this specimen is at all normal it is clearly a new species, distinguished, if by nothing else, by its singular manner of growth. Corresponding structural differences, however, would doubtless be found in the complete specimen and indeed are already shown or

suggested by the very regular arrangement of the openings in the superstructure and by their circular shape.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

BRACHIOPODA.

LEPTÆNA ANALOGA Phillips.

A single fragmentary specimen represents this type, but its relationship is unmistakable.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

CHONETES ORNATUS var. ARKANSANUS n. var.

Plate I, figures 4, 4a.

Shell very small, transverse, somewhat extended at the hinge line, rather inflated centrally, with strongly depressed ears and incurved beak. Surface marked by relatively coarse, strongly elevated liræ, about four in 1 millimeter, crossed by very fine regular concentric liræ.

This form is very similar to *C. ornatus* Shumard, of which it might be considered a small variety. The high convexity indicates that the specimens are mature, and in spite of their very much smaller size they have costæ of about the same absolute size as Shumard's species and therefore relatively very much coarser. The concentric liræ are, on the other hand, actually much finer, though possibly not finer in proportion to the size of the shell. They are, however, much finer in proportion to the size of the costæ. The shape is also somewhat more transverse and more extended at the hinge line than is the case in typical *C. ornatus*.

In this connection it may be proper to restrict *C. ornatus* to the form which occurs in the Louisiana ("Lithographic") limestone at Louisiana and Hannibal, Mo. It is probable that Shumard's type specimen came from that region and that formation. He cites *C. ornatus* not only from there, however, but also from the Chouteau limestone in Cooper County and elsewhere, but it is a little improbable that the form was the same in both places.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

PRODUCTELLA CONCENTRICA Hall.

Plate I, figures 3-3b.

This species is represented by two specimens, both of which are very small but, judged by their convexity, are mature or nearly so. The width is only about 5 millimeters. The convexity is fairly strong, rather narrowed across the top transversely.

The surface is nearly smooth, with almost invisible growth lines and a few large incremental striæ. There is also evidence of a few spines that spring from the surface without much development of a prominence or spine base.

This is hardly the typical form of *P. concentrica* (which shows, however, many modifications both in size and markings), for it is much smaller and lacks the strong concentric wrinkles and elevated spine bases, shown in most specimens of *concentrica*, which tend to produce costæ or plications toward the front of the shell.

The synonymy of this species offers some difficulty. On Plate VII of his Iowa report¹ Hall figures two specimens, one as *Productus shumardianus* and one as *P. concentricus*. Both appear to have been found at Burlington, and both almost certainly represent the same species, the one (*P. concentricus*) being based on a dorsal valve of the other. Both species are described as new in the work mentioned. Hall also figures another specimen of *P. shumardianus* from another locality (Clarksville?) and probably belonging to another species.² I propose to restrict the name *shumardianus* to the latter form and to use *P. concentricus* for the two Burlington specimens (one figured as *P. shumardianus*) represented on Plate VII. In connection with this proposal to divide *P. shumardianus* attention may be called to Hall's footnote under *P. pyxidatus*,³ which would be much more appropriate if it were really intended to refer to *P. shumardianus*, since Hall records no specimens of *P. pyxidatus* from Burlington either in text or plates. Hall makes another obvious error under *P. shumardianus* in referring to figure 1 of Plate VII instead of figure 2. I regard *P. cooperensis*, which was described subsequently to *P. concentricus*, as belonging to the same species.

These small shells are very suggestive of *Productus indianensis*, from which they differ in having smaller and less numerous spines.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

PRODUCTELLA SEMICOSTATA n. sp.

Plate I, figures 6-6d, 7-7c.

Shell small, transverse, semicircular or subquadrate in outline. Ventral valve rather strongly arched, not greatly produced anteriorly. Dorsal valve planate over the visceral region, more or less geniculate about the margin. Ears small, quadrate; depressed in the ventral valve.

In the ventral valve the posterior portion is devoid of costæ, but the anterior portion is divided by radial grooves or striæ into a number of relatively broad, flat ribs of very large size for a small shell. A few somewhat elongated spine bases are developed on the

¹ Geol. Survey Iowa Rept., vol. 1, pt. 2, 1858.

² Idem, Pl. III, fig. 9.

³ Idem, p. 499.

posterior portion, especially toward the points where the costæ are initiated, but they are not connected with the formation of the costæ, being much narrower. The posterior part is also marked by fine microscopic incremental striæ and by rather fine, somewhat irregular concentric wrinkles. Over the costate portion these markings are replaced by fine, regular, concentric liræ, finer than the wrinkles and coarser than the incremental markings of the posterior area. The dorsal valve has a corresponding sculpture but in reverse, so that a mold of the dorsal exterior corresponds in points of sculpture with the exterior of the ventral valve.

This form is very closely allied to *P. concentrica* and perhaps is only a variety of it. The specimens seen, however, differ in being much smaller than the average specimen of *P. concentrica* and more persistently marked by costæ which are more regular, more large, and usually more distinct.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

PRODUCTELLA PATULA n. sp.

Plate I, figures 1-1b, 2.

Shell rather large, transverse, low and spreading. Dorsal and ventral valves similar in configuration, save that the ventral is more convex and has a more prominent beak and umbonal region.

The surface is marked by fairly strong, subequal, more or less wavy incremental striæ and by numerous fine, subequal, rather regular concentric wrinkles which cover the entire shell. Probably there were a few small spines. No indication of spines was observed on the type specimen, but an external mold of the dorsal valve shows toward the front a few small, slightly elongated nodes, which represent pits or dimples on the shell itself and doubtless correspond to spines on the companion valve. A very few irregularly distributed radial plications or costæ are also developed on some shells, as on the type specimen. The latter also shows traces of very obscure, wavy, longitudinal striæ, visible only on local areas and probably due to exfoliation or to some internal markings showing through. At least such an explanation is possible.

This type is evidently very closely related to *P. hirsutiformis*, and in point of the fine, obscure, radiating striæ it especially recalls a specimen which I figured from the Moorefield shale of Arkansas.¹ It differs from *P. hirsutiformis* in the stronger and more regular concentric wrinkles and the less numerous spines.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

¹ Girty, G. H., U. S. Geol. Survey Bull. 439, Pl. III, fig. 3, 1911.

PRODUCTELLA MILLESPINOSA n. sp.

Plate I, figures 5-5c.

Shell small, slightly transverse, with small depressed ears and small slightly prominent beak.

The surface is marked by rather fine, regular, concentric wrinkles, which extend well toward the front margin, and by great numbers of small elongate spine bases. The bases are short over the posterior portion of the shell, but gradually become more elongated, with the spines more conspicuously located at their anterior end, until they pass into irregular discontinuous costæ as they approach the anterior margin. In the posterior portion of the shell, where the wrinkles are developed, the short spine bases stand in concentric rows and the evanescence of the wrinkles appears to be correlated with the prolongation of the spine bases. This region of strong wrinkles and small, concentrically arranged spine bases is more restricted in some specimens than in others. In some there are scarcely any very elongated bases; in others all the anterior portion is covered with fairly persistent, if irregular, costæ. Another variable feature is the shape, some specimens being regularly globose with small depressed beak and others more narrowly arched with somewhat more prominent umbonal region.

The dorsal valve of this type is not known unless it is represented by those globose shells with less prominent and smaller beaks which I am regarding as mere individual variations.

This rather peculiar species is distinct from any Mississippian type known to me. It rather recalls certain Devonian species, such as *Productella costulata*.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

PRODUCTUS BURLINGTONENSIS Hall.

The material thus identified comprises four specimens, two dorsal and two ventral valves. They vary somewhat, one modification having slightly coarser costæ and slightly stronger and more regular wrinkles across the visceral area. They agree so closely with *P. burlingtonensis* that I feel little hesitation in referring them to that species.

In the synonymy of this species I believe that Prof. Weller's *P. fernglenensis* should be included. I have specimens from Fern Glen which appear to belong to Weller's species and yet which agree very closely with specimens of *P. burlingtonensis* from Burlington. If they are true *P. fernglenensis* the differences by which Prof. Weller distinguished that species from *P. burlingtonensis* seem to me to be neither constant nor very important. If *P. fernglenensis* is to be

retained as a distinct species, I should either have to record it at Burlington or *P. burlingtonensis* at Fern Glen, or both.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

SCHIZOPHORIA SWALLOWI Hall.

Although they are much smaller and although they do not certainly belong to the genus *Schizophoria*, I would not venture on the evidence at hand to distinguish these specimens from *S. swallowi*. They are three in number, the largest and most perfect being a ventral valve. It is transversely subelliptical in shape and has a length of 14 millimeters and a width of 18 millimeters. The cardinal line is long (11 millimeters) and the small beak not strongly elevated. The surface is marked by the usual fine liræ (twenty-one in 5 millimeters), some of which appear to have been spiniferous.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

RHYNCHOPORA PINGUIS n. sp.

Plate I, figures 8–Sc.

The type specimen of this species is finely preserved and has the following characters: Shell large, transverse. Outline transversely elliptical to subpentagonal. Length 16 millimeters, width 20 millimeters. Convexity rather high. Fold and sinus well developed. The fold bends abruptly downward toward the front, so that its junction with the ventral sinus is considerably below the flat-topped upper surface. Costæ rounded but sharply defined, ten occurring on the fold and nine on each side of the dorsal valve.

I have been somewhat in doubt whether this form should not be identified with *R. beecheri* Gregor, in which the variation in the number and arrangement of the costæ, as given by Gregor, is very great. In view, however, of certain differences which undoubtedly exist and of the different geologic location, and to some extent of the different faunal association, it seems better provisionally to regard this as a distinct and therefore a new species. The differences are these: The size is 30 per cent larger and the number of plications on the fold is greater (Gregor gives four to eight). An additional difference may be found in the fact that the costæ (in this specimen) are not obsolete posteriorly and that the fold of the dorsal valve bends abruptly downward in front, a feature not mentioned by Gregor.

Provisionally I am including here two smaller specimens only 10 millimeters long, one of which has ten ribs on the fold and nine on the lateral areas of the dorsal valve, one rib on either side of the fold being somewhat smaller than the rest and not so elevated, being, as it were, situated on the sides of the fold. The other specimen, which is per-

haps abnormal, is narrow and has eight ribs on the fold and only seven lateral ones, the final two or three on either side being represented chiefly by denticulations at the margin.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

RHYNCHOPORA sp.

A single imperfect specimen appears to represent a species different from *R. pinguis*. The sinus is occupied by six or seven costæ, the exact number not being determinable, and there are but five lateral ribs. The costæ, at least the lateral ones, appear to be large and chiefly marginal in their development.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

SPIRIFER SUBORBICULARIS Hall.

This type is represented in my collection by three specimens having an indicated length of about 40 millimeters and a width slightly greater. The shell contracts at the hinge with a more or less circular shape. The fold and sinus are simple, the former being well defined but not the latter. On each side there are about seven costæ which occupy about three-fourths of the lateral surface, the parts near the hinge being apparently without ribs. The ribs themselves are large and somewhat ill defined and obscure. My specimens are exfoliated, but they show traces of fine, regular, concentric striæ with larger striæ due to inequalities of growth.

This is pretty clearly the species described by Hall as *S. suborbicularis*. Hall did not figure the species, but my specimens closely correspond to his description. They also agree with Meek and Worthen's figures, except that they apparently contract a little more strongly at the hinge line and that their ribs are a little narrower.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

SPIRIFER GRIMESI Hall?

The three specimens included here do not indicate a size even approximately equal to that of *S. grimesi* and hence must be regarded as immature. The largest is only 20 millimeters long. Apparently the width is considerably greater (about as four to three). The cardinal angles are quadrate or slightly obtuse. The most significant feature is perhaps the rather strong, narrow, freely bifurcating ribs which have a very fine radial sculpture. So far as can be determined these specimens have all the characters of the form from the underlying St. Joe limestone which I have referred to *S. grimesi*.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

SPIRIFER CARINATUS Rowley?

Plate II, figures 1-1b.

This species is peculiar in the prolongation of the fold and sinus into an angular projection at the front of the shell. The single specimen in my collection is small and has a length and breadth about equal, 18 millimeters. The cardinal angles are nearly quadrate. The area is low. The fold is not well defined, but very rapidly increases in prominence anteriorly. It is subangular rather than rounded and seems to be formed by a general rise of the shell from either side into a dihedral angle whose edge is its median line. The sinus is broad, shallow, and ill defined, making up for the prominence of the fold by projecting in a sort of nasute extension. The ribs are fine, strong, and freely bifurcating and are crossed by fine, regular, imbricating, concentric lamellæ.

I know of only two species which have this peculiar configuration, both described by Prof. Rowley from the lower part of the Burlington limestone of Louisiana, Mo. In fact, *S. carinatus* and *S. pikensis* appear to be so similar that it is difficult to make out any character save size in which they markedly differ. *S. pikensis* is much the larger. The only character in which the present form appears to differ from *S. carinatus* is the concentric, imbricating striæ, the possession of which is not clearly indicated in Prof. Rowley's description.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

RETICULARIA PSEUDOLINEATA Hall.

It is not difficult to find specimens in the Keokuk limestone a good deal larger than Hall's type specimen of *R. pseudolineata*, but the representatives in the collection from St. Joe are still larger. Aside from a very fragmentary example, these are only two in number. The smaller has both valves in conjunction but somewhat misplaced. The shape is very transverse and regularly elliptical, the dorsal valve being 46 millimeters wide and 32 millimeters long. The larger specimen, a dorsal valve, must have been fully 70 millimeters wide and 48 millimeters long. The shape of this specimen tends rather more to the quadrate and is of course not so transverse. All three are covered with strong, rather regular, and rather fine concentric striæ, while from the bases of the intermediate raised bands proceeded the usual small double-barreled spines in concentric rows.

Typical *R. pseudolineata* does not as a rule have the concentric striæ so strong and so completely covering the surface as do these specimens. Nevertheless, there seems to be almost no doubt that

they should be referred to *R. pseudolineata*, which, moreover, I have in my collection from the Burlington limestone at Burlington.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

SPIRIFERINA aff. SPIRIFERINA SUBTEXTA White.

Plate II, figures 2, 2a.

A single ventral valve represents this type in my collection. It is 10 millimeters long and 14 millimeters wide. The cardinal angles are slightly rounded and the outline curves from each side rapidly to the front. The convexity is rather high, but the beak is strongly arched, so that the area is only moderately elevated. The sinus is narrow and very deep. The ribs which guard it on either side are larger and more prominent than the others. There are six of these on each side, making fourteen in all, rapidly decreasing laterally in definition and in size.

The surface is considerably exfoliated but apparently was traversed by fine, strong, regular lamellose concentric ridges.

The shell substance is finely punctate.

The species of *Spiriferina* which apparently resemble this most closely have not been authentically figured. I mean *S. clarksvillensis*, *S. solidirostris*, and *S. subtexta*. Weller¹ says that *S. clarksvillensis* and *S. solidirostris* lack the punctate shell structure of *Spiriferina* and are therefore probably referable to the genus or subgenus *Delthyris*. This is certainly an error so far as *S. solidirostris* is concerned, for one of the specimens on the type card shows unmistakably that the shell is coarsely punctate. Even the two specimens which Weller has selected and described as the typical ones and which appear to belong to the same species as the other show punctate structure, though in a somewhat less unambiguous manner. An appearance similar to that which they present is sometimes produced by granular silicification or by the impression of small grains of sand, but such an interpretation would here scarcely be justified.

White, the author of two of the species mentioned, especially considered this character in connection with their generic position, stating in effect that *S. solidirostris* had a punctate shell and a median septum, that *S. subtexta* also had a punctate shell and a median septum, and that *S. clarksvillensis* had an impunctate shell and a median septum. According to our present valuation of these characters the first two species would be true *Spiriferinas* and the last, as Prof. Weller says, a *Delthyris*. Even if it should actually prove that among his authentic specimens from Burlington (the Hamburg citation is probably a *Delthyris*) White had two distinct types, one with punctate and one with impunctate shell structure, it seems to me

¹ St. Louis Acad. Sci. Trans., vol. 16, p. 446, 1906.

that this subsequent discussion indicates that the name *S. solidirostris* should be restricted to the punctate form. We may fairly suppose that he was accurate in his observations and that if he based them on specimens which were not typical he would have said so.

Spiriferina or *Delthyris clarksvillensis* being therefore ruled out of the comparison, the form from St. Joe more nearly resembles *Spiriferina subtexta*, for it lacks the median plication on the fold and sinus which is a character of *S. solidirostris*.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

ATHYRIS LAMELLOSA L'Éveillé.

I have but a single specimen of this type, apparently a young individual. It is more transverse than the shell from the St. Joe limestone member referred to *A. hannibalensis*, and hence I am identifying it as *A. lamellosa*. It also has more well-developed and spreading lamellæ than the latter species is known to possess, though there may be no real difference in this particular. The width of the dorsal valve, exclusive of the lamellæ, is 19 millimeters and the height 14 millimeters. The outline is irregularly elliptical. The widest point is a little above the middle, where also the outline is most sharply curved. The convexity of both valves is low and neither has a fold or sinus developed to an appreciable degree. One of the frill-like lamellæ, only 8 millimeters from the apex, is partly preserved and is nearly 5 millimeters wide; when complete it was probably considerably wider. It is more or less strongly and irregularly fluted.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

CLIOTHYRIDINA HIRSUTA Hall?

Here are included four small lenticular shells, the largest of which is 11 millimeters long and the smallest only 3 millimeters. The largest has the length and breadth about equal and is nearly circular. The smallest has the length greater than the breadth and is oval. A fold and sinus are not developed.

All show more or less definite traces of the characteristic fimbriæ, as closely arranged concentric ridges; and the matrix from which one specimen was broken clearly shows the spines themselves in an exfoliated condition. In their present form these specimens could hardly be distinguished from *C. hirsuta*, but they may be only young examples of a much larger species such as *C. incrassata*, and they very likely represent the species which occurs in the St. Joe limestone and which, to show its relation to the Fern Glen form, I identified as *C. roissyi* Weller non L'Éveillé.

Horizon and locality.—Boone limestone, in beds, overlying the St. Joe limestone member, St. Joe, Ark.

PELECYPODA.

CYPRICARDINIA RUGOSA n. sp.

Plate II, figures 3-3c.

Shell rather small, transversely elongate, subovate. Width 7 millimeters, height $4\frac{1}{2}$ millimeters. Hinge line nearly straight, about two-thirds the entire width. Inferior outline very gently convex, rounding inward strongly under the nearly terminal beaks and contracting anteriorly with the hinge. Posterior outline straight and truncated above, where it makes an obtuse angle with the hinge line, rounding below in a strong, regular curve into union with the inferior outline. Convexity rather low, about equal in the two valves. Umbonal ridge undefined but strong. Beaks small, nearly terminal, conspicuously curved forward as well as downward. A broad, indistinct constriction seems to be developed in the anterior third of the shell, which is compressed over the post-umbonal portion.

The surface is marked by regular concentric sulci, separating regular concentric ridges. The discontinuous, sometimes cancellating radial striæ found in certain species of *Cypricardinia* have not been made out, though they may have been obliterated by exfoliation. On the other hand, the concentric ridges give evidence of being marked by concentric striæ, but these too may be due to exfoliation and a chipping away of the shell along the concentric layers of which it is composed. The corrugation of the right valve appears to be distinctly more subdued than that of the left, the concentric ridges being lower and narrower and the grooves broader and flatter. This inequality in the sculpture of the two valves is a feature which I have not before noted in *Cypricardinia*. It may be due in this specimen to unequal exfoliation, although I think this explanation is probably not the true one. The feature is well shown by the type specimen, which retains both valves in conjunction. The only other specimen observed is a left valve, and it is strongly rugose, like the left valve of the type.

Cypricardinia rugosa appears to be distinguished by its rather strongly contracting outline, its prominent umbonal ridge, and its highly rugose surface. In the character of the umbonal ridge especially it differs from *C. fayettevillensis*. From certain Waverly forms (such as *C. consimilis*) it differs in the more contracting shape and in the probable absence of radial markings, and from all these species possibly in the unequal sculpture of the two valves.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

CARDIOMORPHA ORBICULARIS n. sp.

Plate II, figures 4, 4a, 5, 5a.

This type, from its symmetrical, almost circular shape, might casually be mistaken for a dorsal valve of some Composita or possibly for a rotund terebratuloid, if the presence of a little wing on the posterior side of the beak and of regular concentric striæ on the surface did not give a key to its true relationship. It must, however, find place among the Pelecypoda, but its true generic position is somewhat in doubt.

The shape of the right valve is subcircular, slightly wider than long, about 14 millimeters in one direction and 15 millimeters in the other. On the anterior side of the only left valve seen the outline is obscure though it seems to round inward to the umbo, but on the posterior side a very small triangular wing is developed. The convexity is unusually high and the umbones large and strongly incurved. The small wing is depressed.

The surface is marked by fine, regular, concentric striæ and a few irregular varices of growth. The concentric markings become inconspicuous at the sides and the small auricle is crossed by minute radial liræ.

The single specimen representing the left valve is somewhat smaller than the right, described above, and is distinctly more convex. On the anterior side the outline rounds inward so strongly below the beak that an emargination is produced. The posterior side, however, is prolonged into a broad alation. The convexity is high and the rather small beak strongly incurved. The surface shows some pronounced irregularities of growth and retains traces of fine, regular, concentric striæ similar to the sculpture of the other specimen.

The generic position of this form is a matter of doubt. From its configuration, which of course is not decisive, one would say that it was congeneric with *Cardiomorpha subglobosa* of the Waverly group of Ohio, and that in turn may well be congeneric with typical *Cardiomorpha* of Europe. The American shells at present resting within the genus, however, almost certainly do not all belong together, and probably when completely known they will be found to represent a number of groups not at all closely related.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

GASTROPODA.

PLATYCERAS EQUILATERA Hall.

A single specimen is included here. It is rather large, measuring 45 millimeters in extreme length. The apex is closely coiled, gradually enlarged, and turned so that the shell is dextral. The anterior

portion is very rapidly expanded, gently curved, and more symmetrical. The shell is strongly inclined backward, and the aperture has a subtriangular shape, broad on the anterior side and much contracted posteriorly.

The peripheral surface is flattened toward the margin and bears two indistinct grooves. These correspond to sinuses in the peristome, which thus has a somewhat linguiform projection near the middle, bounded on each side by a sinus, on either side of which again the shell once more projects somewhat. The lateral surfaces are marked by strong flexures beyond which the shell is gently convex, contracting to the narrow posterior surface (more abruptly on the upper or dextral side), which is abruptly rounded.

The surface was probably marked by fine incremental striæ which followed the sinuosities of the aperture. At present the thick shell is exfoliated, giving it a lamellose surface.

This form appears to be very closely related to if not identical with *P. equilatera*.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

CEPHALOPODA.

CÆLONAUTILUS sp.

This type is represented by a single fragmentary specimen. The diameter is about 30 millimeters, and apparently the whorls slowly enlarged and embraced part way so as to form a rather wide umbilicus. The cross section is subcircular or subquadrate, slightly higher than wide, and slightly flattened at the sides and venter; impressed on the dorsal area. The sculpture consists of fine revolving liræ which are coarser on the sides but grow finer as they pass onto the ventral surface, where they become relatively more widely spaced and are perhaps wanting altogether mesially. The suture (on one of the younger whorls) appears to be straight, but it is incompletely shown.

This is very likely a new species, but it is hardly well enough known for description. Its generic position also is rather doubtful.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

TRILOBITA.

BRACHYMETOPUS? ELEGANS n. sp.

Plate II, figures 6, 6a.

This species is known only from a pygidium which is semicircular, somewhat wider than long, and which has an entire and regularly curved outer margin. The width is 13 millimeters and the length

9.5 millimeters. The axis terminates some distance in front of the margin, is abruptly rounded off at the posterior extremity, and expands rather rapidly forward. It is subangular rather than curved in cross section, or, more exactly, it is made up of four surfaces which form a median ridge and two lateral ridges. It is well defined by lateral furrows. The lateral lobes are oblique, moderately convex near the axis, but recurved toward the margin, so that they have a sigmoidal shape in cross section. Both the convex and the concave flexures die down posteriorly and the narrow strip which passes around the end of the axis is almost flat, though directed obliquely downward. The segments, of which there are nine on the sides and fourteen on the axis, are defined by rather deep broad grooves. As would be inferred from the difference in number of segments, the segmentation of the axis is discrepant with that of the sides, and neither the segments nor the grooves which divide them are continuous from one to the other, though this is less obvious at the front of the pygidium than posteriorly. On either side of the axis near the axial furrows the grooves abruptly expand and deepen, so that they resemble little pits, thus allowing the axial segments to become expanded at their termination. A row of pointed nodes is developed along the middle of the axis and a row of smaller ones a little less than halfway down the sides. This gives the axis its four-sided shape in cross section. The pleural segments are double, the anterior moiety in each case being larger and more prominent than the posterior. Furthermore, the smaller or posterior portion terminates at what may be called the border or upturned rim of the pygidium, but the larger extends to its very margin, being, if anything, stronger on the border and more angular. The larger segments also bear nodes, two apiece, which form two rows on each of the pleural surfaces. The nodes are of unequal size, the smaller ones occurring next the axis. This row is not persistent and appears to be absent from the last two segments, on which, however, the larger nodes are developed in especial strength. The final segments of the lateral lobes are parallel and directed straight backward from the sides of the axis, the space between them being slightly raised.

This species is unique, so that a comparison with other American types is unnecessary. It seems most to resemble certain species of *Brachymetopus*, and on that account it has been provisionally placed in that genus, but an accurate determination of the generic relationship is not possible from the pygidium alone.

Horizon and locality.—Boone limestone, in beds overlying the St. Joe limestone member, St. Joe, Ark.

THE ST. JOE LIMESTONE MEMBER.

INTRODUCTION.

During the summer of 1904, at Louisiana, Mo., I had the privilege of examining the interesting collection of Carboniferous fossils owned by Prof. R. R. Rowley. Some specimens from a reddish shaly rock especially drew my attention by their excellent preservation, the unusual character of some of the species, and the fact that they resembled, in some respects very strikingly, a fauna from the far-distant Lake Valley limestone of New Mexico. Upon inquiry it proved that these fossils were obtained at Fern Glen, west of St. Louis, in the limestone subsequently called by Prof. Weller the Fern Glen formation. Somewhat later in the same year I was able to visit Fern Glen and to obtain a suite of specimens of my own.

It was my purpose at that time to prepare a report describing the combined fauna of the Fern Glen and Lake Valley limestones, and I assembled considerable material to that end, but other more pressing matters intervened and the project was deferred from year to year. So, when Prof. Weller's paper on "The fauna of the Fern Glen formation" appeared, in 1909,¹ my work was still in an inchoate state.

In the report just mentioned Prof. Weller pointed out the relations of the Fern Glen and Lake Valley faunas, but was unable to include the latter in his discussion, except so far as it had been described by S. A. Miller.² Prof. Weller furthermore correlated the Fern Glen fauna with that of the Chouteau limestone, a relationship to which my own studies had pointed, and also with the fauna of the St. Joe limestone member of the Boone limestone of northern Arkansas, with which I was then unacquainted. At the time when Prof. Weller wrote only 29 species were known from the St. Joe limestone and only 2 (*Zaphrentis* sp., crinoidal columns, and *Spirifer grimesi*) from the typical locality at St. Joe. Furthermore, the 29 species were merely listed with perhaps rather hasty identifications and with the possibility of the same type appearing under different names.

The Survey collections from St. Joe comprise 40 species,³ considerably more than were previously known from the entire St. Joe limestone and greatly more than were previously known from the same locality. By briefly describing this fauna in the form of an annotated list, it seemed that I might make a small addition to geologic data and at the same time return to the study of a fauna in which at one time I felt considerable interest.

¹ Geol. Soc. America Bull., vol. 20, pp. 265-332, 1909.

² Cincinnati Soc. Nat. Hist. Jour., vol. 4, p. 306 et seq., 1881.

³ In addition to the 40 invertebrate species it is important to record the presence of a *Dynichthyid* tooth which may provisionally be identified as *Dynichthys gouldi*. This identification I owe to the courtesy of Dr. Bashford Dean and of Prof. C. R. Eastman, both of whom examined it.

In the present classification of the United States Geological Survey, the St. Joe limestone is regarded as a member of the Boone limestone. The name appears to have been introduced in 1893 by Hopkins,¹ who, however, did not designate a type section nor describe the formation bed by bed. It is clear, however, that the typical locality is St. Joe, Ark., and it is not unlikely that the typical locality is that from which most of my collections were obtained—beside the railroad along Mill Creek, a short distance northwest of St. Joe. Hopkins describes the St. Joe as consisting of from 25 to 40 feet of limestone without chert, varying in color from light pink to dark chocolate, interspersed with spots of white, gray, or pea green. It comprises the basal beds of the Boone and has been recognized over the greater part of northern Arkansas. According to Hopkins the St. Joe is entirely lacking in some sections, the chert of the higher Boone resting directly upon the Silurian rocks. Unless the St. Joe has changed out of all recognition lithologically, this fact would suggest an unconformity between the St. Joe and the rest of the Boone. The paleontologic features of the St. Joe have been described by H. S. Williams.²

It has seemed best to restrict the scope of the present paper to the material obtained at the typical locality, at or near St. Joe. This material consists principally of two collections, one made by E. O. Ulrich and the other made subsequently by myself. A third collection was made by Prof. Weller in 1891, while he was connected with the United States Geological Survey, and this is the one mentioned above, which was listed by Prof. Williams² and included by Prof. Weller himself in the list of St. Joe fossils in his Fern Glen paper.³

My own collection was obtained from an exposure along the railroad about 1½ miles northwest of the station at St. Joe. The rock here consists of red crinoidal limestone in thin beds with partings of red shale, the original color of which appeared to be greenish. Hand specimens of the St. Joe limestone show that the color ranges from light gray or greenish to a dark dull red, and the texture from very fine to coarse. The texture, and to some extent the color, appears to depend directly on the amount of crinoidal material present. Seemingly the rock is made up of two elements, a fine calcareous mud and crinoidal segments (and some plates) in quantity, some layers being practically composed of this material. The fine mud or paste seems to range in color from greenish or gray to red, the red mud being partly calcareous but less so than that which is greenish. The greenish and pinkish colors seem generally to be associated with

¹ Hopkins, T. C., Arkansas Geol. Survey Ann. Rept. for 1890, vol. 4, pp. 253, 290, 1893.

² Arkansas Geol. Survey Ann. Rept. for 1892, vol. 5, p. 331, 1900.

³ Geol. Soc. America Bull., vol. 20, pp. 265-332, 1909.

the crinoidal bands; possibly the intensely red sediments do not occur in the crinoidal layers at all. They do occur with other fossils, however, adhering so closely to many of them as to obscure their superficial characters. Though the strata appear to have been but little disturbed, some of the fossils are compressed and folded together, more or less slickensiding of the red paste accompanying the movement. A few fossils are faulted, narrow veins of calcite occupying the fracture.

Below the St. Joe limestone 1 foot to 4 feet of very variable beds were found, mostly greenish, grayish, or black shale with some harder rock, the top layer being usually a hard, fine, semicalcareous ledge about 6 inches thick containing black phosphatic (?) nodules. The rocks overlying the St. Joe belong to the Boone limestone with a rather well defined division between the two, the St. Joe being red and containing no chert or but very little, whereas the overlying part of the Boone is a white rock varying from coarse and crinoidal to fine and hard in texture and bedded with white chert, which at higher horizons becomes predominant. The thickness of the St. Joe at this point was estimated to be 30 feet and most of the fossils were found near its base. As Mr. Ulrich's collection is supposed to have been made at the same place and horizon as my own, the two will not be distinguished in this paper.

Prof. Weller also, it would appear, visited this locality in 1891. His notes describe the rock as a red marble and give its thickness as 30 feet. Above, there was said to occur 5 feet of coarse, gray, crystalline crinoidal limestone overlain by intermingled chert and limestone, and below there occurred 4 inches of white or blue sandstone containing numerous hard black pebbles. Prof. Weller obtained no fossils here, the place where his small collection was made being described as 1 mile southeast of station 1238B, which is given as Tomahawk Creek, 5 miles east of St. Joe. This collection was obtained in the upper instead of the lower part of the St. Joe, and for this reason separate mention seems desirable in spite of the small number of species present. As I have identified them these include, besides crinoid fragments, *Amplexus rugosus?*, *Zaphrentis* aff. *Zaphrentis dalei*, and *Spirifer grimesi*. The *Spirifer* and probably the *Zaphrentis* have been found in the larger collections made by Mr. Ulrich and myself, and *Amplexus rugosus?*, a species described from the Fern Glen limestone, points to the same faunal association.

Thus the fauna of the St. Joe limestone from St. Joe comprises as now known 40 species, of which 3, or in reality only 2, were known there before. Most of the species are already in the literature. Two of them are undescribed, and possibly more would prove to be so if

definite conclusions were not prevented by the rather imperfect preservation in which most of the fossils were found.

A comparison of this fauna from St. Joe with faunas from other points in the St. Joe limestone may well await another occasion and larger collections.

As already noted, Prof. Weller correlates the St. Joe and Fern Glen limestones, and the paleontologic evidence which he advances is considerably increased by the data which I have been able to record. He distinguished 66 species in the Fern Glen fauna, 15 of which were common to the St. Joe limestone. Or, from the other point of view, of the 29 species before recorded from the St. Joe over half were found in the Fern Glen limestone. Of the species distinguished in the present paper 12 probably or certainly occur also in the Fern Glen fauna, and if to these be added, on Prof. Weller's authority, 8 St. Joe species not yet obtained at the typical locality, which likewise occur in the Fern Glen fauna, 20 out of the 66 Fern Glen species are at present known in the St. Joe limestone. The strength of this evidence becomes a little clearer if it is remembered that 16 of the 66 Fern Glen species are crinoidal types and that though crinoidal remains play a very important part in the composition of the St. Joe limestone no determinable crinoids have yet been found in it. It should be noted again here that this evidence, strictly interpreted, correlates only the lower portion of the St. Joe limestone with the Fern Glen limestone. On the other hand, the St. Joe seems to be uniform in lithologic character, and the very small fauna which I have mentioned from the upper part points more or less uncertainly to the same correlation as that from the lower beds.

As already remarked, Prof. Weller correlates the Fern Glen limestone and therefore the St. Joe limestone with the Chouteau limestone; and with this correlation I am quite in accord. I may, however, differ with him in his correlation of the Chouteau limestone itself. In brief, he places the Chouteau limestone in the Kinderhook and therefore below the Burlington, whereas I am disposed to think that it may correlate with the lower part of the Burlington.

I have had this possibility in mind for a number of years but have not found time to arrange for presentation or to entirely verify the evidence which seems to support it. For this reason, and because I hope to return to the subject, I will only indicate at this place the general character of this evidence.

I believe that the proper boundary between the Kinderhook and the Burlington is at the base of the upper or principal oolite in the Burlington section, this strictly calcareous bed being thus thrown with the limestone series above rather than with the mainly sandstone

series below. If the Burlington is thus defined, the lower Burlington fauna will, I believe, be rather sharply distinguished from the Kinderhook.

Though crinoid specialists have long distinguished an upper Burlington and a lower Burlington fauna, adequate recognition of the dual nature of the Burlington appears to have been by no means general. The Burlington fauna described by Hall is essentially the upper Burlington fauna, and most references to the Burlington pertain, I believe, to this rather than to the lower facies. Not only so, but at Sedalia, Chouteau Springs, and other localities in Missouri, which may be called typical for the Chouteau limestone, it appears, from the fauna, to be not the lower part of the Burlington but the upper part which follows that formation in the geologic series. The fauna of the lower part of the Burlington is not only considerably different from the fauna of the upper part, but it strikingly resembles the fauna of the Chouteau limestone.

These statements, as already noted, need verification and are not made unqualifiedly. It seems worth while, however, to cast this suggestion into the arena of discussion, even in advance of a more complete and careful presentation, rather than to allow the correlation of the St. Joe with the Chouteau limestone and its classification as Kinderhook to go unquestioned.

If the Chouteau limestone does correlate with the lower Burlington, it will be necessary to redefine the Kinderhook group so as to exclude the Chouteau limestone and its correlates, and also to reclassify the section at Burlington itself so as to include with the Burlington limestone the upper oolite, commonly placed in the Kinderhook. This would diminish considerably the distribution of the Kinderhook rocks, but give greater uniformity to the Kinderhook fauna.

CŒLENERATA.

ZAPHRENTIS aff. *ZAPHRENTIS DALEI* Milne-Edwards and Haime.

This form suggests *Z. dalei* chiefly by its large size, one specimen measuring no less than 5 centimeters across the calyce. The specimen is a mere fragment, but the dimension given, though estimated, is probably not far from accurate. Another specimen provisionally assigned to the same species has a diameter of 2.5 centimeters, which is in close agreement with the typical size. In the smaller specimen, which is also a fragment, the surface is nearly smooth; in the larger the septa produce slender ribs on the exterior, the crests of which are a little less than 2 millimeters apart. The larger has also fine concentric striæ.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

ZAPHRENTIS sp.

Here are included a group of specimens characterized by being rather small, rather curved, rather rapidly expanded, and rather deeply calyced. It is hardly possible to give more exact data or to identify the form from the scanty and imperfect material at hand. I am not even certain that all the specimens are congeneric. An average example would be about 25 millimeters long and 15 millimeters in diameter.

In general appearance this form resembles Prof. Weller's *Amplexus brevis*, but has a deeper calyce. It is doubtful whether either species belongs in the genus *Amplexus*.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

AMPLEXUS RUGOSUS Weller?

I am including here a single fragmentary specimen whose shape is generally cylindrical, though it is much contorted and constricted. The external surface is marked by fine concentric striæ, by coarser annulations, and by irregular constrictions. The diameter is about 13 millimeters. The septa number twenty-one. They leave a space in the middle equivalent to one-third of a diameter or less, occupied only by tabulæ.

This species resembles *A. rugosus*, but is somewhat larger and has a larger central area not traversed by the septa. In this it has more the character of typical *Amplexus*, to which I would judge *A. rugosus* somewhat doubtfully belongs.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CYATHAXONIA ARCUATA Weller?

In this group are placed a few poor specimens, one of which shows the *Cyathaxonia* structure. They are distinguished from the form called *C. minor*? by being larger and more arcuate. None of them is produced to the length of the type specimen (of *C. arcuata*) figured by Prof. Weller.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CYATHAXONIA MINOR Weller?

The specimens under consideration are so imperfect and so few that a sure identification is not possible. One of them at least is congeneric with *Cyathaxonia minor*, and all suggest it specifically in such characters as can be made out.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CLADOCHONUS AMERICANUS Weller?

This form is represented by a few fragmentary corallites only. They are not attached to any other body, and on this account their generic position is probably with *Cladochonus* rather than with *Aulopora* or *Monilipora*. In their imperfect condition the corallites have neither the length nor the radial dimensions of *C. americanus* (they measure 3 millimeters in diameter and 6 millimeters in length), but the indications are that both dimensions were appreciably greater in the complete specimen. The mode of growth in this particular colony, however, is apparently not quite so linear as that of the particular colony taken as the type.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

ECHINODERMATA.

CRINOIDAL REMAINS.

Crinoidal remains are common in the St. Joe limestone. In fact some layers consist of little else. They comprise circular stem segments, many of which are rather large, though few exceed 15 millimeters in diameter. A few specimens of what are possibly basal plates of some species of *Platycrinus* have been observed.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

BRYOZOA.

FISTULIPORA RUBRA n. sp.

Plate III, figures 1-5.

Zoarium consisting of thin expansions, which are highly contorted and often superposed. The layers are sometimes only 2 millimeters thick, but they may attain a thickness of 5 millimeters or more at certain points or over small areas. The sheets are contorted or are folded over or even elevated into nodes. By the superposition of consecutive layers, which may or may not be in contact, the zoarium attains a thickness of 20 millimeters or perhaps considerably more. The largest example seen is about 50 millimeters across.

Monticules, apart from prominences due to contortions of the zoarium, are absent. So also are maculæ of the usual character—that is, depressed granular areas which are noncelluliferous. There appear, however, to be areas of closely arranged and areas of more widely separated apertures, though probably these are conditioned by the irregular growth of the zoarium and have no constant relation to one another. The zoecia are subcircular in section, though they possess a strongly marked lunarium, which occupies about a third of

one side, and as a rule they appear to be more or less regularly arranged in quincunx. Some of the zoecia are elongated, and the lunarium is on either the long or the narrow side. In some areas they are about 0.2 millimeter across and are separated by intervals of one and one-half to two times their own diameter. In places, however, they are larger and more closely arranged—0.3 millimeter in diameter, separated by one-half their own diameter or less. Perhaps their average size is 0.25 millimeter, and their average spacing is one to one and one-half diameters. The mesopores occur in one, or more often two, rows between adjacent zoecia, and where the latter are small some of the mesopores are fully as large as the zoecia. Diaphragms appear to be irregularly developed. They are curved and very delicate and are irregularly arranged. They have been observed at less than a diameter, at one and one-half diameters, and at two diameters apart. In some zoecia they seem to be absent altogether.

This species differs from *F. fernglenensis* in its mode of growth, which is much more irregular and which produces zoaria made up of numerous superposed layers. The zoecia are also much smaller. According to Prof. Weller, about two zoecia and two interspaces occur in 2 millimeters, while in this type about four zoecia and three interspaces occupy the same distance.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CYSTODICTYA LINEATA Ulrich.

Two rather poor specimens appear to belong to the Fern Glen species that Prof. Weller identified as *Cystodictya lineata*. They agree with his description in all the characters which can now be determined.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CYSTODICTYA LINEATA var. MAJOR Ulrich?

Several rather poorly preserved specimens have been referred to this species. One of them is large and shows the manner of growth well but the more minute characters only indifferently. The stipes are 6 to 7 millimeters across and 1 millimeter or somewhat less in thickness. They are profusely branched, not only in the plane of the stipe but at an angle to the plane as well. The complanate branches occur in alternation on opposite sides of the main stipe, which has thus a sinuous course, branches on the same side being situated about 15 millimeters apart. The width is considerably increased in the proximity of branches that lie in the plane of the stipe, and

the thickness in the proximity of branches that lie oblique to that plane.

The specimen from which the foregoing data are derived is embedded in limestone, and, in breaking, the fracture has for the most part passed along the median plate. The apertures, where seen, are small, triangular or trefoil shaped, and are spaced about twice their own diameter apart. They occur in numerous rows, with apparently no longitudinal grooves or other surface markings.

The scarcity of material, together with its poor preservation, has prevented the determination of some important measurements, and some of the statements made above are subject to revision.

In a general way this form suggests *Cystodictya lineata* var. *major*, but more perfect specimens will probably show it to be new.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

EUACTINOPORA QUINQUERADIATA Ulrich.

This species is rather common in the St. Joe limestone. Different specimens show different numbers of rays or arms, though five is the usual equipment. Thus seven have five arms, three have four arms, and one has six arms. The rays are of the long, slender type, as in *quinqueradiata*, whether the number be four or five or six.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CHEILOTRYPA? sp.

This type is represented by a fragment of a cylindrical stem 7 millimeters long and slightly over 1 millimeter in diameter. The apertures are situated at relatively wide intervals. Their arrangement is not certainly determinable from the specimen, but they appear to be developed in longitudinal rows without any constant lateral relationship. The intervals are about two diameters longitudinally and one diameter or more laterally, but this is not clearly shown. The surface surrounding the apertures is marked by irregular, discontinuous, longitudinal striæ.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

FENESTELLA HERRICKANA Ulrich?

Two specimens which stand very close to *F. herrickana* in their specific relationship and perhaps are identical with it are included under this caption.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

FENESTELLA sp. a.

A large but very poorly preserved frond which has much the structure and proportion of *Polypora* sp. but which is nevertheless apparently a true *Fenestella*.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

FENESTELLA sp. b. and c.

The *Fenestellas* in my collection from the St. Joe limestone are rather few in number, fragmentary, and more or less eroded or weathered. Besides the types distinguished above are two others, clearly distinct from those as from each other, but so poorly preserved as not to justify the effort to identify them.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

POLYFORA sp.

This type is represented by a single fragment showing only one side. The construction is on a small scale, nine branches occurring transversely and six fenestrules longitudinally in a distance of 5 millimeters. The fenestrules are elliptical, about twice as long as wide. The apertures occur in two rows, increased to three a short distance below the bifurcation of a branch. *P. biseriata* is a related form.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

BRACHIOPODA.

LEPTENA ANALOGA Phillips.

This type is represented by a single specimen, which in spite of its very fragmentary condition can hardly be assigned to any other species than *L. analoga*.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CHONETES ILLINOISENSIS Worthen.

A single specimen in a poor state of preservation, whose probable reference is determined by its very fine liration.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

PRODUCTELLA CONCENTRICA Hall.

This characteristic Chouteau form was not found by Prof. Weller in the Fern Glen fauna nor has it before been recorded from the St. Joe limestone. It is, however, rather abundant in the St. Joe limestone at St. Joe and presents a typical development of the species.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

PRODUCTELLA PYXIDATA Hall?

This is a species of moderate size and convexity, of which the surface is marked by fine concentric striæ, fine irregular concentric wrinkles, and numerous small, rather obscure tubercles of rounded shape, from which small spines doubtless proceeded.

P. pyxidata, which this form most closely resembles, is found, when a large series of specimens is examined, to present several modifications. One type is nearly smooth; another is marked by fine concentric wrinkles; another has in addition small spine bases; and still another has the spine bases more or less extended into somewhat irregular intermittent costæ.

The specimens from St. Joe are only four in number, one large and three small, and none of them is in very satisfactory condition. They do not, of course, exhibit the complete range of variation shown by *P. pyxidata*, but they closely resemble the second and third mutations mentioned above, and it would be difficult to name satisfactory characters for their discrimination.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

PRODUCTUS LEVICOSTA White.

This species is represented by a diminutive and probably very young specimen, but the identification is believed to be fairly safe.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

PRODUCTUS SAMPSONI Weller.

This species is a small representative of the *cora* group. It was recognized by Prof. Weller in the Fern Glen fauna but was described by him from specimens found in the Chouteau limestone. In my St. Joe collections it is represented by two specimens of whose specific identity there can be little doubt. The species is also common in the Cuyahoga shale of the Waverly group of Ohio.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

RHIPIDOMELLA BURLINGTONENSIS Hall.

This is doubtless the species called *Rhipidomella michelinia* by Prof. Weller, the correct spelling of the name being *Rhipidomella michelini*. Prof. Weller does not state that the observations which found no difference between European specimens of *R. michelini* and *R. michelini* var. *burlingtonensis* were made by himself, nor that the European specimens were authentically identified, so that I am provisionally employing the American name, which may, however, be superseded in the manner indicated by Prof. Weller.

The St. Joe specimens suggest that the species is not uncommon, but they are so imperfect that I have been unable to satisfy myself that some do not belong to Schizophoria, perhaps to *Schizophoria swalowi*. The largest is somewhat over 25 millimeters long.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CAMAROPHORIA SIMULANS n. sp.

Plate II, figures 10–10c, 11–11b.

Shell rather large, subovate to subpentagonal. Length and breadth about equal, the latter possibly a little in excess. Ventral valve moderately convex; dorsal valve inflated. The two valves are plicated medially into a strong fold and sinus, which is either narrow and rounded or broad and more quadrate. The ventral beak is small and strongly incurved.

The surface is possibly devoid of costæ. None of my specimens show any lateral ribs. In one the fold also appears to be unplicated. In another, however, the sinus shows traces of very obscure ribs, about four in number, which may possibly be due to internal markings, though I think not.

This species is externally very unlike any of the Mississippian types of Camarophoria. On the other hand, it closely simulates *Shumardella missouriensis* of Shumard (typical). *S. missouriensis*, however, is a true rhynchonellid, whereas the present form certainly has the dental plates united internally into a spondylium and hence is a true pentameroid.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CAMAROTÆCHIA METALLICA White?

I am here including two specimens only—a larger, 8 millimeters long, and a smaller, 6 millimeters long. Both appear to be mature or nearly mature. The smaller, which is the more perfect, has five plications on the fold and five lateral ones; the other appears to have

more numerous mesial ribs, perhaps six. The ribs are strong and angular and the fold and sinus are well developed, especially in the larger example.

The relationship which these specimens bear to *Camarotœchia cooperensis* is perhaps debatable, but they appear to represent a distinct species by reason of their smaller size and more angular ribs. These characters and the arrangement of the costæ indicate a form closely resembling *C. metallica*.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CAMAROTŒCHIA aff. CAMAROTŒCHIA COOPERENSIS Swallow.

Included here are a few very small specimens which somewhat suggest the form identified as *C. metallica*?, but they differ in having the plications much less angular as well as differently arranged. One specimen 6 millimeters in length, which is about the average size, has six plications on the fold and five or six lateral ones. The low convexity and partly developed fold and sinus indicate that they are young specimens, and their general aspect suggests that they are the young of some species of the *cooperensis* type. The shell structure does not appear to be punctate.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CAMAROTŒCHIA n. sp. ?

This type is represented by a single specimen which has an elongated subtriangular shape suggestive of *Rhynchotetra caput-testudinis*, but the presence of two dental plates in the ventral valve makes clear that it belongs to a different genus, while the presence of a median septum in the dorsal valve indicates that the genus is probably *Camarotœchia*. This is a small and probably a young shell, having a length of 7 millimeters and a greatest width of 6 millimeters, the latter measurement lying close to the front. The fold and sinus are rather poorly developed. The plications are relatively large and rounded and can be traced to the beak on both valves. Four of them occupy the fold and four occur on each of the lateral areas of the dorsal valve. The surface is also marked by rather fine, regular, indistinct concentric striae.

This is probably a new species, but the fact that I have only a single specimen, which, moreover, appears to be immature, makes it inadvisable to introduce a new name at this juncture.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

RHYNCHOPORA sp.

It is sometimes very difficult to detect the critical shell structure of Rhynchopora. Most specimens which come up for examination are more or less exfoliated, and in some it is possible to find a showing of punctate structure only about the margin. Thus, however much one may be on guard, the possibility of confusing this type with the structurally similar Camarotæchia is always imminent.

Two large shells having much the external appearance of *Camarotæchia cooperensis* exemplify these statements in the St. Joe collection. They exhibit unmistakably the punctate structure, though only in a few small areas, and hence they belong to the genus Rhynchopora.

One retains both valves and the other only the dorsal valve, and neither is in very good preservation. The shape is highly gibbous and transverse, the plications coarse and rounded. Of these five occur on the strongly elevated fold and five, perhaps six, on each of the sides.

Only two species of Rhynchopora are at present known from the Mississippian, *R. beecheri* and *R. pustulosa*. So great a range of variation is shown by the specimens which Gregor includes under *R. beecheri* that apparently my shells might be regarded as belonging to that species. Gregor's figures, however, show a smaller form, with much finer, more angular, and more numerous plications. It is clear that my specimens can not be regarded as typical *R. beecheri*, even if included in that species at all. They perhaps resemble *R. pustulosa* a little more nearly, but are larger, more gibbous, and more numerous plicated.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

SHUMARDIELLA MISSOURIENSIS var.

Shumard figured two specimens of what he described as a single species, *Rhynchonella missouriensis*. The smaller he regarded as a young example of the larger. As is well known, the larger shell differs from the smaller not only in size and in the strength of the plications, but also in being covered by fine, radiating liræ, and Meek and Worthen introduced for it the specific name *striaticostata*, restricting the term *missouriensis* to the smaller species. At the same time typical *missouriensis* does appear to undergo modifications which cause it to approach at least *striaticostata*¹ in the character of external form.

¹ Prof. Weller has introduced the names *Paraphorhynchus* and *Shumardiella* for the generic types represented, respectively, by *P. striaticostatum* and *S. missouriensis*.

A very fragmentary specimen from the St. Joe limestone looks as if it might be part of a typical specimen of *striaticostata*, except that it shows no traces of radiating liræ. It probably belongs to one of the modifications of *S. missouriensis* or to a variety closely related to them.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

DIELASMA? sp.

This type is represented by a single small specimen which nevertheless appears to be mature. The length is 12 millimeters and the shape ovate. This is clearly not the very large species which Prof. Weller described as *Dielasma fernglenensis*, but its specific relations are not determinable from the data at hand.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

SPIRIFER GRIMESI Hall.

This species is represented by three determinable specimens, besides several others so imperfect and poorly preserved that their specific relations are a matter of uncertainty. Aside from its shape and costation this species is distinguished by having the ribs overlain by very fine, regular, radiating liræ, not to be discerned without a lens. Concentric markings there are, too, in the shape of very delicate, sublamellose growth lines, but these are more closely arranged and delicate than the radiating liræ, and in fact are rarely preserved, so that most specimens appear to possess the radiating striæ only.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

SPIRIFER PECULIARIS Shumard.

The original of this identification is a small Spirifer having a sub-pentagonal or subrhombic shape, highly convex valves, and rounded cardinal angles. The fold and sinus are moderately elevated and are wider than the lateral plications, which are broad and not strongly defined. About five occur on either side of the fold, which seems to have toward the front a faint median sulcus, but which is otherwise unplicated. The surface, though exfoliated, shows traces of rather fine, regular, concentric striæ.

I have been somewhat doubtful where to place this rather well preserved specimen, the species chiefly involved in the question being *S. fernglenensis*, *S. chouteauensis*, and *S. peculiaris*. A specimen from Fern Glen, which seems to be a representative example of *S. fernglenensis*, presents a very different appearance, having a more

transverse shape and coarser, more strongly defined lateral costæ. I have also compared this shell with several specimens from the Chouteau limestone which I do not hesitate to identify as *Spirifer peculiaris*, and it seems to me that it may very well be a young example of that species. But the Chouteau specimens are very suggestive of the form which Prof. Weller has described from the same formation as *Spirifer chouteauensis* and which he says has often been mistaken for *S. peculiaris*. The differentiating characters mentioned by the author do not appear to me very reliable, but I notice that he does not ascribe to *chouteauensis* the concentric striæ which are a feature of *S. peculiaris*, of my specimen from the Chouteau limestone, and probably of the specimen from the St. Joe limestone here under consideration.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

SPIRIFER sp.

Under this title are included a number of imperfect specimens which show neither the fine, radial striæ of *S. grimesi* nor the concentric lamellæ of *S. vernonensis*, though in a few the preservation is such that one would expect some trace of sculpture to be retained. There may be, in fact, more than a single species among these shells, but at present there is no way to distinguish them satisfactorily.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

SYRINGOTHYRIS CARTERI Hall.

It has always been difficult to distinguish species satisfactorily among representatives of the genus *Syringothyris*, and I have not been able to satisfy myself as to the affinities of the three not very perfect specimens found at St. Joe. The largest of these when complete had a width of about 60 millimeters; the length of the dorsal valve must have been about 45 millimeters, and the height of the ventral area about 30 millimeters. The area is gently concave and must have been rather strongly inclined forward. The costæ are large, few, and ill defined.

Since the chief distinguishing character of the Fern Glen species *Syringothyris sampsoni* mentioned by Prof. Weller is the height of the area, it is probable that the present form is not *S. sampsoni*, for the height of its area is only about half as great. It seems to be rather more in agreement with *S. carteri* than with any other species, though many of its characters are not well shown. It resembles *S. halli* in the inclination of the area (though this relation is obscured by crushing in the best preserved example), but it is much larger.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

RETICULARIA COOPERENSIS Swallow.

A ventral valve from one of the collections undoubtedly belongs to a species of Reticularia and is at present indistinguishable from *R. cooperensis* from the Chouteau limestone. In a second collection, probably made at the same place, there are three small spiriferoid ventral valves which are also referred to the same species, but three small dorsal valves are included with more doubt. If specimens are exfoliated and imperfect, especially dorsal valves, it is often impossible to distinguish satisfactorily Reticularia, Clithyridina, and sometimes Athyris and Composita. Yet, though some doubt surrounds the identification of individual specimens, my material is sufficiently perfect to show the presence of three out of the four genera, and to permit a reasonably accurate determination of the species.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

AMBOCÆLIA MINUTA White.

This species is represented by a single rather well preserved specimen. The dorsal valve is nearly flat, subquadrate or subcircular, slightly wider than long. The size is small, the width being only 4 millimeters. The ventral valve is moderately elevated, suberect, somewhat projecting behind the hinge line. A gentle sinus is developed in both dorsal and ventral valves.

The specific differentiation among the Ambocælias is very slight, and the validity of some of the species that have been described from the Carboniferous is open to question. The genus appears to be more common in the Pennsylvanian than in the Mississippian and more common in the lower Mississippian than in the upper. From the early Mississippian we have *A. levicula*, *A. minuta*, and *A. parva*. The present specimen differs from *A. levicula* in having much shallower sinuses, and it differs from *A. parva* in not having the sinus of the ventral valve narrow and groovelike. It differs from *A. arcuata* in being relatively broader. The most numerous points of agreement appear to lie with *A. minuta*, than which, however, it seems to be considerably larger.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

ATHYRIS HANNIBALENSIS Swallow.

This species is represented by several rather well preserved specimens which agree exactly with *Athyris hannibalensis* from Louisiana, Mo. The shape is subpentagonal or subrhomboidal, slightly wider than long, and the surface is crossed by a number of distantly and regularly disposed lamellæ.

This species is rather clearly the same that is found in the Fern Glen fauna and that Prof. Weller identifies as *Athyris lamellosa*. So far as my observations go, however, this type can be distinguished from the more transverse one occurring at the higher horizon which is usually referred to *A. lamellosa*. This view is apparently shared by Prof. Weller, as he does not include *A. hannibalensis* in the synonymy, but it is the narrow not the broad form that he refers to L'Éveillé's species. Typical *lamellosa* as depicted in L'Éveillé's figures is a broad type more like the Keokuk and Waverly variety, and if *lamellosa* occurs in this country at all it is to these that the name should be applied, unless, indeed, the whole series of forms is to be merged in a single species.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

CLIOTHYRIDINA ROISSYI Weller non L'Éveillé.

Plate II, figures 7-9.

A single small, lenticular athyroid (length and breadth 9 millimeters) shows a surface covered with fine, closely arranged lamellæ, from which presumably proceeded fringes of spines. A second specimen from the other collection is too exfoliated to retain any of the surface characters, but it has a similar subcircular shape, though more transverse, and a size nearly twice as great.

These shells without much question belong to the species which Prof. Weller calls *Cliothyris roysii*, the correct or at all events the authentic spelling of which is *Spirifer roissyi*. Typical *roissyi*, as figured by L'Éveillé, is a quite different sort of shell, being much more strongly transverse and having a highly developed fold and sinus. In fact, L'Éveillé's figures of *roissyi* so closely resemble those of *Spirifer (Athyris) lamellosus* as to arouse the suspicion that they represent specimens belonging to the same species though differing somewhat in preservation and to a minor degree in shape. At all events it is not Prof. Weller's *C. roissyi* that resembles the authentic one, but a species which he, doubtless correctly, refers to *Cliothyridina prouti*. I do not know what name would best be employed for this species, but it is clearly not *roissyi*. Perhaps it only consists of young examples of the larger form, *C. incrassata* Hall.

As this species is so persistently misunderstood by American authors, and as the original work is difficult of access, I have reproduced (see Pl. II, figs. 7, 8, and 9) the original figures of L'Éveillé for comparison with our own forms.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

COMPOSITA? sp.

Under this head I am including a very small, rather slender ventral valve only about 4 millimeters long. The shell substance appears to be impunctate, so that it is not a terebratuloid. The surface is exfoliated and the sculpture destroyed, but the shape is much more like that of *Composita* than *Athyris* or *Cliothyridina*, both of which genera are known in the same beds. It resembles *Composita madisonensis* var. *pusilla*, but is much smaller and has a stronger sinus.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

GASTROPODA.

PLATYCERAS NASUTUM Miller?

This species is represented by two mature, fairly perfect specimens and by three others which are smaller and more fragmentary. The extreme antero-posterior dimension is 27 millimeters. The small apex is closely coiled on itself, making perhaps a complete volution, below which the expansion is very rapid (varying, however, in different specimens) and the curvature slight (about one-half turn). The conspicuous feature of the configuration is an angulation or ridge running down the anterior side. In one specimen this is emphasized by a groove extending lengthwise to the left of the angulation, and in both specimens it is indicated by strong flexures of the growth lines, which produce an emargination of the peristome at the ridge and a slight projection each side of it. The growth lines are sinuous on both sides of the ridge, indicating small, ill-defined costæ which are scarcely perceptible as elevations. Rather strong, regular incremental striæ are present.

These shells agree with *P. nasutum* in some important particulars, such as the ridge down the anterior side and the emargination and sinus at the anterior margin. They differ from it chiefly in having the aperture less elongated than that of the type specimen (a difference of no great moment as the two St. Joe specimens differ markedly from one another) and in displaying flexures of the growth lines and obsolete plications not mentioned in the description of *P. nasutum*. The St. Joe specimens resemble *P. paralius* as figured by Prof. Weller from the Fern Glen limestone, fairly well in size and shape, and particularly in the fine obscure costæ and the correlated denticulations at the margin, but differ in having a less regularly circular or oval aperture and especially in developing a plication down the anterior side and the emargination going with it.

Horizon and locality.—St. Joe limestone member of the Boone limestone, St. Joe, Ark.

PLATE I.

PLATE I.

PRODUCTELLA PATULA (p. 13).

FIGURE 1. Dorsal view of a specimen retaining both valves.

- 1a. Ventral view of same.
- 1b. Side view in outline.
2. External mold of a dorsal valve.

Lower part of the Boone limestone, St. Joe, Ark.

PRODUCTELLA CONCENTRICA (p. 11).

FIGURE 3. A small ventral valve, $\times 4$.

- 3a. Same in outline, natural size.
- 3b. Side view in outline, natural size.

Lower part of the Boone limestone, St. Joe, Ark.

CHONETES ORNATUS VAR. ARKANSANUS (p. 11.)

FIGURE 4. A ventral valve, $\times 4$.

- 4a. Same in outline, natural size.

Lower part of the Boone limestone, St. Joe, Ark.

PRODUCTELLA MILLESPINOSA (p. 14).

FIGURE 5. A typical ventral valve.

- 5a. Same, $\times 2$.
- 5b. Side view, $\times 2$.
- 5c. Same in outline, natural size.

Lower part of the Boone limestone, St. Joe, Ark.

PRODUCTELLA SEMICOSTATA (p. 12).

FIGURE 6. A characteristic specimen with both valves in conjunction, broken in two along the plane of the dorsal valve. This figure shows the ventral valve (with the two parts in contact) viewed from above, $\times 2$.

- 6a. Same in outline, natural size.
- 6b. Side view in outline.
- 6c. Anterior view, $\times 2$.
- 6d. The visceral area of the dorsal valve, as an external mold, exposed by the removal of the "cap," natural size.
7. A malformed ventral valve, $\times 2$.
- 7a. Same in outline, natural size.
- 7b. Side view in outline.
- 7c. Anterior view, $\times 2$.

Lower part of the Boone limestone, St. Joe, Ark.

RHYNCHOPORA PINGUIS (p. 15).

FIGURE 8. Ventral view of the typical specimen.

- 8a. Dorsal view.
- 8b. Side view.
- 8c. Anterior view.

Lower part of the Boone limestone, St. Joe, Ark.



1



1a



1b



2



3

x 4



3a



4



3b



4a



5



5a

x 2



5b

x 2



5c



6

x 2



6a



6b



6c

x 2



6d



7

x 2



7a



7b



7c



8



8a



8b



8c

FOSSILS FROM THE BOONE LIMESTONE.
BRACHIOPODA.

PLATE II.

PLATE II.

SPIRIFER CABINATUS? (p. 17).

FIGURE 1. Dorsal view of the only specimen found.

- 1a. Side view in outline.
- 1b. Ventral view.

Lower part of the Boone limestone, St. Joe, Ark.

SPIRIFERINA aff. SPIRIFERINA SUBTEXTA (p. 18).

FIGURE 2. A ventral valve.

- 2a. Side view in outline.

Lower part of the Boone limestone, St. Joe, Ark.

CYPRICARDINIA RUGOSA (p. 20).

FIGURE 3. Right valve of a bivalved specimen, $\times 3$.

- 3a. Same in outline, natural size.

- 3b. Left valve of same, $\times 3$.

- 3c. Same in outline, natural size.

Lower part of the Boone limestone, St. Joe, Ark.

CARDIOMORPHA ORBICULARIS (p. 21).

FIGURE 4. A right valve, $\times 2$.

- 4a. Same in outline, natural size.

5. A small left valve provisionally referred to the same species, $\times 2$.

- 5a. Same in outline, natural size.

Lower part of the Boone limestone, St. Joe, Ark.

BRACHYMETOPUS? ELEGANS (p. 22).

FIGURE 6. A pygidium somewhat broken at the margin.

- 6a. The same, enlarged to two diameters and restored, $\times 2$.

Lower part of the Boone limestone, St. Joe, Ark.

CLIOTHYRIDINA ROISSYI (p. 41).

FIGURES 7, 8, 9. These are figures 18, 19, 20, respectively, of L'Éveillé's *Spirifer de roissyi* (Soc. géol. France Mém., vol. 2, 1835, pl. 2, figs. 18, 19, 20). They show a species quite distinct from the American shells commonly identified with this species, and one would not suspect that they represented a *Cliothyridina* at all. They suggest a *Composita* related to our *C. trinuclea*, and they so exactly resemble the figures of *Spirifer (Athyris) lamellosus*, given just below as to arouse suspicions that they represent only an exfoliated condition of the *Athyris*.

CAMAROPHORIA SIMULANS (p. 35).

FIGURES 10, 10a, 10b, 10c. Four views of one of the type specimens.

11, 11a, 11b. Three views of another of the type specimens. Fig. 11 is enlarged $1\frac{1}{2}$ times to show the spondylium.

St. Joe limestone member, St. Joe, Ark.



1



1a



1b



2



3

x 3



x 3

3b



3c



2a



3a



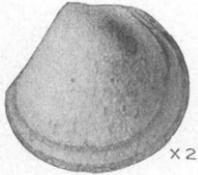
5a



6



4a



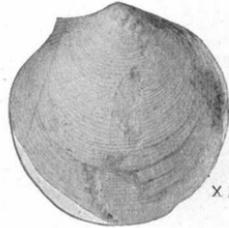
5

x 2



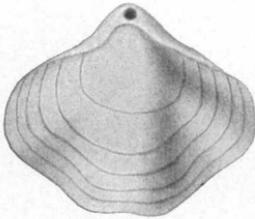
6a

x 2

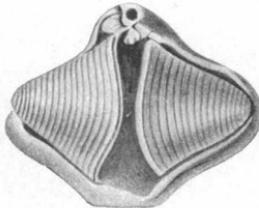


4

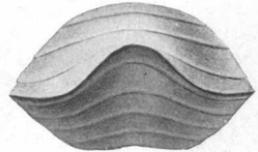
x 2



7



8



9



10b



10a



10



10c



11

x 1/2



11a



11b

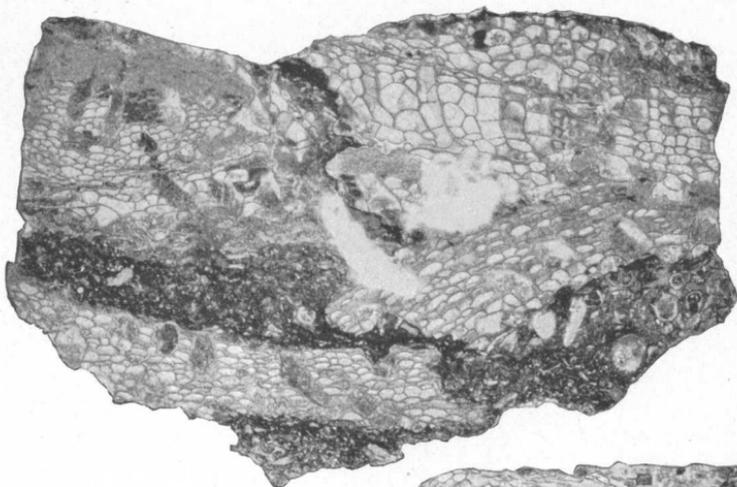
FOSSILS FROM THE BOONE LIMESTONE.
BRACHIOPODA, PELECYPODA, AND TRILOBITA.

PLATE III.

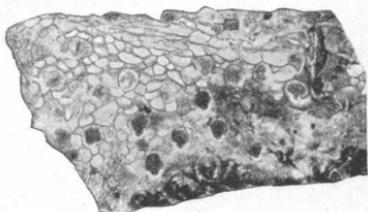
PLATE III.

FISTULIPORA RUBRA (p. 30).

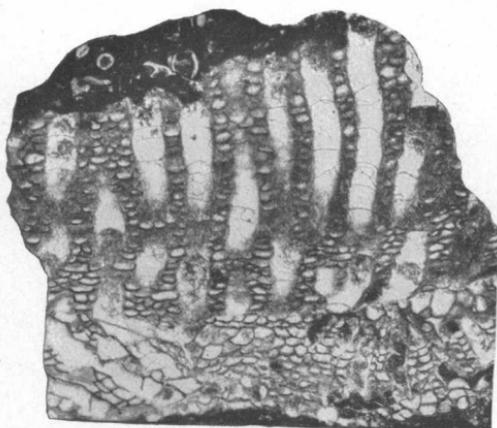
- FIGURES 1, 2, 3. Three sections cutting the cells longitudinally, $\times 10$. Owing to the contorted growth of these colonies it is very difficult to obtain sections which follow the zoecia for any distance.
- 4, 5. Two sections cutting the cells transversely, $\times 10$. Figures 1 and 4 are based on sections from one specimen, figures 3 and 5 from another, and figure 2 from a third.
- St. Joe limestone member, St. Joe, Ark.



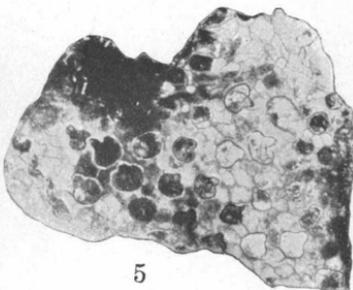
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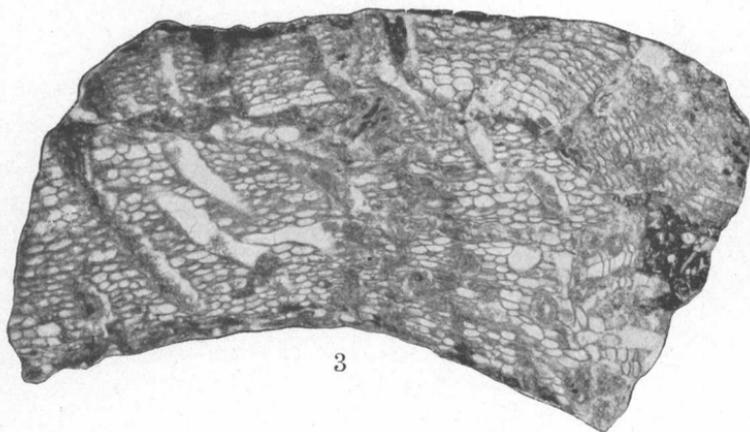
4



2



5



3

FOSSILS FROM THE BOONE LIMESTONE.
BRYOZOA.

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