V

MISSISSIPPIAN FAUNA

By

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THE MISSISSIPPIAN FAUNA OF KENTUCKY

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INTRODUCTION

The Mississippian System was named for the Mississippi Valley where it was first studied and the stratigraphic succession worked out, mainly in Illinois, Iowa, and Missouri. The standard section is as follows:

CHESTER SERIES	UPPER CHESTER GROUP	Kinkaid limestone Degonia sandstone Clore limestone Palestine sandstone Menard limestone Waltersburg sandstone Vienna limestone Tar Springs sandstone
	MIDDLE CHESTER GROUP	Glen Dean limestone Hardinsburg sandstone Golconda limestone Cypress sandstone
	LOWER CHESTER GROUP	Paint Creek limestone Yankeetown chert Renault limestone Aux Vases sandstone
IOWA SERIES	MERAMEC GROUP	Ste. Genevieve limestone St. Louis limestone Salem limestone Warsaw limestone
	OSAGE GROUP	Keokuk limestone Burlington limestone Fern Glen limestone
	KINDERHOOK GROUP	Sunbury shale Berea sandstone Bedford sandstone and shale

In Kentucky all of the strata between the New Albany shale below and the Coal Measures or Pennsylvania above belong to the Mississippian System.

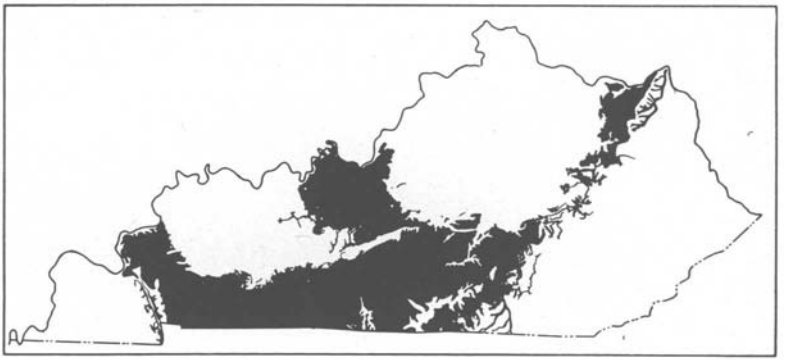


Fig. 28. Map of Kentucky showing outcrop of Mississippian rocks.

The seas which occupied the interior of North America, including the area which is now Kentucky, during the Mississippian period were transgressions from the Gulf of Mexico and except for those of the Kinderhook were broadly extensive. The clastic materials which were contributed during the first half of the period were largely derived from a land area lying to the east. On the other hand, the sands of the Chester series which are in part of continental and not margin origin, were brought in from the Ozark region and land to the north of the Chester embayment.

STRATA OF KINDERHOOK AGE

In northeastern Kentucky the New Albany shale is succeeded in ascending order by the Bedford shale, Berea sandstone, and Sunbury shale. The lower part of the Bedford shale is fossiliferous at some localities in Kentucky and has yielded a fauna with strong Devonian affinities. The Berea sandstone is unfossiliferous in Kentucky but many well characterized Mississippian species have been obtained from it in Ohio. The Sunbury is black and fissile and closely resembles the New Albany shale in character. A species of *Lingula*, another of *Orbiculoidea*, and a large variety of conodonts are the only fossils known from it.

These formations become thinner southward from the Ohio River and are not known beyond Irvine in Estill County. At this locality the Sunbury is separated from the New Albany

by only a few inches of strata representing the Bedford-Berea interval and south of here the two black shales come in contact and are indistinguishable. It is not known whether or not the Sunbury is represented in the upper part of the New Albany in other parts of Kentucky.

STRATA OF OSAGE AGE

NEW PROVIDENCE SHALE. Outcrops of the New Providence shale completely encircle the Bluegrass region and form the Knobs and the escarpment known as Muldraugh's Hill and also extend southward along the crest of the Cincinnati anticline. Near Lebanon a sandstone appears in the middle of this formation and to the eastward and northward it thickens until it has replaced the upper half of the formation. The two-fold division of the New Providence in eastern Kentucky corresponds to the Cuyahoga formation below and the Logan formation above both of which are typically represented in Ohio.

At some localities where thin limestone layers are present in the New Providence shale a large number of fossils may be collected. One of the most famous collecting localities is Buttonmould Knob, 12 miles south of Louisville. Collections from this and other localities have yielded a very large fauna. Most of the species range throughout the formation as they are present in collections made at various horizons from top to bottom. The New Providence fauna is rich in bryozoans and corals and at some localities many species of crinoids are represented. Brachiopods are present in considerable numbers although the variety of forms present is not so great while the molluscs, generally are a rather inconspicuous and unimportant part of the fauna as a whole. The brachiopods are the most important species for correlation purposes and clearly show that the New Providence is of Fern Glen age. A few species are present whose range is restricted in other regions to beds either somewhat higher or somewhat lower than the Fern Glen and it is possible that a portion of the Kinderhook and lower Burlington may be represented in the New Providence. Among such species are *Schuchertella lens* (Pl. XXXIII figs. 8a, b) and *Athyris hannibalensis* (Pl. XXXIII, fig. 10) which are

restricted to the Kinderhook in the Mississippi Valley and *Brachythyris suborbicularis* (Pl. XXXIII, fig 1) and *Pustula alternata* (Pl. XXXIII, fig 11) which are not known from below the lower Burlington of this same region. Some of the more important species indicating the contemporaneity of the New Providence and Fern Glen are *Ptychospira sexplicatu* (Pl. XXXIII, figs. 3a-c), *Spirifer vernonensis* (Pl. XXXIII, fig. 4) and *S. fernglenensis* (Pl. XXXIII, fig. 6). Certain other species which characterize the New Providence have not been obtained in other areas. Among these are *Rhipidomella oweni* (Pl. XXXIII, figs. 2a, b), *Strophalosia cymbula* (Pl. XXXIII, figs 5a, b), *Chonetes shumardarnus* (Pl. XXXIII, figs, 7a, b) and *Spiriferina subelliptica* (Pl. XXXIII, fig. 9). The fauna of the New Providence gives no indication that this formation includes any beds of upper Burlington age.

BEDS OF KEOKUK AGE. The New Providence shale is succeeded by a series of sandy and shaly beds on the western and southern borders of the Bluegrass region which in the vicinity of Louisville have been divided into the Kenwood sandstone below, the Rosewood shale in the middle, and the Holtsclaw sandstone above. To the south and west of the Bluegrass this series of beds becomes more calcareous and passes into a cherty limestone that has been correlated with the Ft. Payne chert of Alabama. No beds of Keokuk age are known in eastern Kentucky north of Mt. Vernon. At some localities an uncomformity is believed to separate these beds from the underlying New Providence. The absence of upper Burlington faunas from Kentucky is an indication that there may be a hiatus in the midst of the Osage Group.

While the Keokuk beds have not produced as great a variety of fossils as the New Providence still the faunas are quite similar in general aspect. The brachiopods play a relatively more important part in these later Osage beds, and the bryozoans and corals are less well represented and crinoids are of much rarer occurrence. Many of the species are identical with those found in the New Providence but others which continue up into higher horizons make their first appearance here. Among these are *Productus*

wortheni (Pl. XXXIV, fig. 1), *Syringothyris textus* (Pl. XXXIV, fig 2), *Spirifer keokuk* (Pl. XXXIV, fig. 4), *S. rostellatus* (Pl. XXXIV fig. 7) and *Orthotetes keokuk* (Pl. XXXIV, fig. 9). Other species which are confined exclusively to the Keokuk beds and therefore are of greater significance are *Rhynchopora beecheri* (Pl. XXXIV, figs. 5a, b) and *Spirifer crawfordsvillensis* (Pl. XXXIV, fig. 3).

In the western Kentucky counties where the Osage beds again make their appearance from beneath the younger formations they constitute a thick series of very cherty limestones. Fossils are not abundant in these strata and collections are difficult to obtain so that in this region it is not practicable to subdivide the Osage Group.

MERAMEC GROUP

WARSAW-SALEM LIMESTONES. In the Mississippi Valley two formations are recognized, the Warsaw and the Salem, between the Keokuk and the St. Louis. They are distinguished not so much by their fossils as by their lithologic character. The Salem does carry a distinctive fauna but it is made up of forms which are seldom found in any except oolitic limestone and is of little value in the recognition of the Salem where it is not oolitic and therefore capable of being separated by its lithologic features. While it is thought that the Salem has been recognized at several places in Kentucky it is best in a general discussion to consider these two formations as a single unit.

The Warsaw-Salem formation overlies beds of Keokuk age and it is possible that they are separated by a slight unconformity. It outcrops along the western side of the Bluegrass region and occupies considerable areas in south-central Kentucky. East of the Bluegrass it extends as far north as Berea but has not been recognized beyond. It also comes to the surface in limited areas in the western counties of the State.

The Warsaw-Salem contains coarsely crystalline crinoidal beds, earthy yellowish argillaceous limestone, more or less shale and, particularly in eastern Kentucky, some locally conspicuous sandstone members. Geodes are present at many places.

The fauna of the Warsaw-Salem is rather distinct from that of the Keokuk and a fairly sharp transition takes place particularly in southern Kentucky. The large spiriferoids of types found in the underlying beds are not abundant, corals are not as common as at some Keokuk localities and crinoids are seldom to be obtained. Among the characteristic fossils of the Warsaw-Salem are the brachiopods *Spirifer washingtonensis* (Pl. XXXV, fig. 4), S. *lateralis* (Pl. XXXV, fig 3) and S. *keokuk* (Pl. XXXIV, fig. 4). The last species occurs also in the Keokuk but is not as abundant as in these higher beds. Two species which are an unfailing guide to this formation and occur at no other horizon are the crinoid *Talarocrinus simplex* (Pl. XXXV, figs. 9a, b) and the blastoid *Metablastus wortheni* (Pl. XXXV, fig. 8). The bryozoan genus *Archimedes* (Pl. XLI, figs. 1a-6, Pl. XLIII, fig. 7) occurs for the first time in Kentucky, in the Warsaw-Salem. However it is not nearly so abundant as in the later Chester faunas. One of the species which is locally very common in these strata is the brachiopod *Productus magnus* (Pl. XXXV, fig. 1). It is unknown in the typical Warsaw but occurs in great numbers in beds of similar age in southeastern Missouri and on the whole the Kentucky fauna rather closely resembles that of this region to the west.

The typical Salem fauna is not known in Kentucky although a few of its members occur locally. This fauna is a peculiar one in which small gastropods and pelecypods play a most conspicuous part. It usually occurs in oolitic limestone associated with large numbers of the foraminifera *Endothyra baileyi* (Pl. XXXV, fig 7). Many of the species of this fauna are reminiscent of Devonian ancestors and it recurs with only slight modification at several later horizons notably the Ste. Genevieve, lower Chester and even well up in the Pennsylvanian.

ST. LOUIS LIMESTONE. In western Kentucky the St. Louis outcrops extend from Hardin County southward to Green River and thence southwestward to the Tennessee line. Farther west they enter the State again in Trigg County and extends northwestward toward the Ohio River. In eastern Kentucky they extend northward from the Tennessee line to the vicinity of Frenchburg beyond which they are absent. The St. Louis

everywhere overlies beds of Warsaw-Salem age except in eastern Kentucky north of Berea where it overlaps onto older strata.

The St. Louis is usually rather sharply distinct lithologically from its adjacent formations. Its massive, dense, or fine grained limestone beds aid in distinguishing it from the crinoidal, more coarsely crystalline and argillaceous beds of the Warsaw-Salem and the oolitic beds of the Ste. Genevieve.

The most important guide fossil to the St. Louis is the massive colonial coral *Lithostrotion canadense* (Pl. XXXVI, figs. la, b). It is known in Kentucky only in this formation although in southeastern Missouri it occurs in the upper part of the Salem limestone. Another species *L. proliferum* (Pl. XXXVII, figs. la, b) is also rather common in the St. Louis although it does range upward into the lower Ste. Genevieve. Good collections are difficult to obtain from the St. Louis limestone both an account of its dense and massive character and the fact that it is usually covered by deep residual soil. Its fossils however are often to be obtained as casts in the chert which strews the surface of its zone of outcrop. In most places however the St. Louis may be readily recognized by the corals mentioned above and its lithologic character. A large number of the characteristic Warsaw-Salem species have never been observed in the St. Louis.

STE. GENEVIEVE LIMESTONE. The Ste. Genevieve limestone everywhere overlies the St. Louis. In western Kentucky it occupies a more or less wide belt about the western coal field. In eastern Kentucky it outcrops in a much narrower zone completely across the State. In western Kentucky the Ste. Genevieve succeeds the St. Louis conformably but along its eastern outcrop an unconformity is at least locally present and north of Frenchburg where the St. Louis is absent the Ste. Genevieve lies unconformably upon older beds.

Throughout much of its extent the Ste. Genevieve is more or less oolitic and this character is an important one in differentiating it from the St. Louis. Some beds of the Ste. Genevieve are notably sandy this being particularly true of its

northern outcrops in eastern Kentucky. In the western counties of the State a thin but persistent sandstone member, the Rosiclare, is present in the upper part of the formation.

Fossils are usually difficult to obtain from this massive limestone formation and its fauna has never been thoroughly studied. The coral *Lithostrotion proliferum* (Pl. XXXVII, figs. la, b) which occurs abundantly in some parts of the St. Louis persists into the lower beds of the Ste. Genevieve. On the other hand the crinoid *Platycrinus penicillus* (Pl. XXXVIII, figs. 2a-c) which is commonly present almost everywhere in the Ste. Genevieve and is the most reliable means of differentiating it from the overlying Chester, also occurs in the upper St. Louis. Another important guide fossil which is known from no other formation is the brachiopod *Pugnoides ottumwa* (Pl. XXXVIII, figs. 5a, b). In the middle part of the Ste. Genevieve occur a number of corals which seem to be entirely restricted to this horizon. Among these are *Michelinia subramosa* (Pl. XXXVIII, fig. 6) and *Lithostrotion harmodites* (Pl. XXXVIII, figs. 8a-c). This latter species is a colonial form which usually occurs in large heads sometimes as big as a bushel basket. A number of long range forms which are common in some of the lower formations did not survive the Ste. Genevieve. One of the most characteristic of these is *Rhipidomella dubia* (Pl. XXXVIII, figs. 3a-c). In some of the oolitic beds there is a recurrence of the peculiar Salem fauna characterized by many small gastropods and pelecypods.

CHESTER SERIES

Everywhere within the upper Mississippi and Ohio Valleys the Chester series unconformably overlies the Iowa series. This is the most important break within the Mississippian System and marks a change in conditions followed by shallower, less extensive and oscillating seas. The Chester outcrops completely encircle the western coal field of Kentucky to the east and south, and occur along a narrow belt beneath the Pennsylvanian strata upon the east side of the Cincinnati anticline.

The Chester faunas possess an aspect entirely different from those of the lower Mississippian formations. Their most conspicuous character generally consists in the abundant pres-

ence of bryozoans belonging to the genus *Archimedes* (Pl. XLI, figs. la-6, Pl. XLIII, fig. 7) and blastoids of the genus *Pentremites* (Pl. XXXV, figs. l0a, b, Pl. XXXVII, figs. 5a, b, Pl. XXXVIII, figs. 9a.-c, Pl. XL, figs. 5a, b 9a-llb, Pl. XLI, figs. 8a, b 12a-13, Pl. XLII, figs. 8-9b, Pl. XLIII, figs. 2a, b, Pl. XLIV, figs. 2, 3 5a, b). Although they do occur in lower beds, wherever, in Kentucky, species belonging to either of these genera are common it is fairly certain that the strata are of Chester age. The peculiar Salem fauna recurs with only slight modifications at several horizons in the Chester particularly in the lower part where the beds are notably oolitic at some localities and also in the Middle Chester where oolites however are seldom present.

LOWER CHESTER GROUP

AUX VASES SANDSTONE. This formation which occurs at the base of the Chester series in the typical section of southwestern Illinois, is absent in Kentucky.

RENAULT LIMESTONE. The Renault is the basal formation of the Chester series throughout Kentucky and everywhere directly overlies the Ste. Genevieve limestone and the typical Chester fauna appears in it for the first time. It has yielded its most extensive fauna in western Kentucky where its lower part is notably shaly. Farther eastward however where the formation is composed of massive limestone extensive collections are much more difficult to obtain.

The Renault is equivalent to the upper and greater portion of Ulrich's Ohara member of the Ste. Genevieve and to the lower half of Butts' Gasper limestone as described in Meade and Breckenridge counties.

The Renault is easily distinguished from the underlying Ste. Genevieve limestone by the presence of the bilobed bases of the several species of the crinoid *Talarocrinus* (Pl. XL, figs. 3, 6-7b) and the absence of the stem segments and cups of *Platycrinus penicillus* (Pl. XXXVIII, figs 2a-c). These fossils are fairly common and are almost always to be found when a careful search is made.

The fauna of the Renault and that of the Paint Creek limestone have much in common but there are four species which so far as known are restricted to the lower shaly phase of the Renault in western Kentucky. These are the coral *Amplexus geniculatus* (Pl. XL, figs. la-c), the brachiopod *Spiriferina subspinosa* (Pl. XL, figs. 2a, b) and the crinoids *Talarocrinus buttsi* and *Globocrinus unionensis* (Pl. XL, figs. 8a, b). Of these *T. buttsi* only has been collected from the Renault farther east where this formation has lost its shaly character. The base of this crinoid is subconical and narrowly bowl-shaped and thus differs from the other species of this genus which have disk-shaped bases with a deeply impressed suture separating the two plates. These other species occur in the upper part of the Renault and are also widely distributed in this formation geographically. *Pentremites* with the "pyriformis" type of elongated bases (Pl. XL, figs 5a, b) make their first appearance in the Renault and at many places bases of the bryozoan *Lyropora* (Pl. XLI, fig. 10) are abundant. One strange feature of the Renault fauna is the rarity of bryozoans of the genus *Archimedes* (Pl. XLI, figs. la-6, Pl. XLIII, fig 7) which are so conspicuous in most of the higher Chester limestones.

BETHEL SANDSTONE. In Kentucky the formation which occupies the position of the Yankeetown chert in the typical Mississippi Valley section is known as the Bethel sandstone. This formation thins out to the eastward from the western Kentucky counties and upon the south side of the coal field has not been recognized beyond Todd County. It appears however at its proper position on the northeast side of the coal field where it has been called the Sample sandstone. Along the south side of the western Kentucky coal field and also in eastern Kentucky where the Bethel sandstone is absent, the Paint Creek limestone rests directly upon the Renault. Where this situation prevails it is usually impracticable to separate these limestones which may here be appropriately combined to form the Renault-Paint Creek formation.

PAINT CREEK LIMESTONE. The Paint Creek limestone everywhere overlies the Bethel sandstone and where this is absent overlaps and directly succeeded the Renault. It is equivalent to the whole of the Gasper in the western Kentucky coun-

ties but represents only the upper portion of this formation as it is interpreted by Butts in Meade and Breckinridge counties.

The Paint Creek fauna has much in common with that of the Renault. Species of *Talarocrinus* (Pl. XL, figs. 3, 6-7b) with bilobed bases are also present in this formation although they are generally not as numerous. The bryozoans *Cystodictya labiosa* (Pl. XLI, figs. 7 a, b), *Glyptopora punctipora* and *Lyropora* (Pl. XLI, fig. 10) are common to both formations. The *Pentremites* show a very great expansion in the Paint Creek and are present in both greater numbers and variety. Additions to the fauna which are not present or are rare in the Renault include several species of the crinoid genus *Pterotocrinus* which are usually represented by the wing plates (Pl. XLII, figs. 2b-d, Pl. XLIII, figs. 3-4b, Pl. XLIV, fig. 7) and a great variety of the bryozoan genus *Archimedes* (Pl. XLI, figs. la-6, Pl. XLIII, fig. 7). One species, *A. compactus* (Pl. XLI, fig. 4) is rather characteristic of this fauna although it does occur rarely at higher horizons. *Chonetes chesterensis* (Pl. XLI. figs. lla, b) is the most important of the brachiopods as this species is unknown in any other formation except the Glen Dean in which it occurs rarely. Another noteworthy feature is the much greater abundance of *Spiriferina spinosa,* (Pl. XXXIX, figs. 3a-c) over *S. transversa* (Pl. XXXIX, figs. 2a-c). *Camarotoechia purduei* is a rare brachiopod which is known in Kentucky only from the Paint Creek limestone.

MIDDLE CHESTER GROUP

CYPRESS SANDSTONE. The Cypress sandstone is one of the most persistent sandstones of the Chester series. It completely encircles the western coal field upon the south and east and everywhere directly overlies the Paint Creek limestone in western Kentucky. It has not been definitely identified however in eastern Kentucky east of the Cincinnati anticline although it may be represented by a 10-foot sandstone which occurs at about the proper horizon 12 miles southeast of Monticello.

GOLCONDA LIMESTONE. The Golconda limestone overlies the Cypress sandstone and its outcrops extend around the

southern and eastern sides of the western coal field. It has not been certainly recognized east of the Cincinnati anticline but it may be represented by a thin marly shale bed which overlies the Renault-Paint Creek formation and is in turn succeeded by a limestone with the typical Glen Dean fauna.

Most of the species of the Golconda fauna are common long ranging Chester forms but certain new ones are introduced here for the first time and a consideration of these together with certain previously mentioned species which did not survive after the Paint Creek make the recognition of this formation easy. The most important new species is *Camarophoria explanata* (Pl. XLII, figs. 7a-d), a common and widely distributed brachiopod which is a certain index to beds younger than the Paint Creek. A number of other species are restricted to this formation so far as is known. These include the crinoid *Pterotocrinus capitalis* (Pl. XLII, figs. 2a-d), the blastoids *Pentremites obesus* (Pl. XLII, fig. 1) and *P. platybasis* (Pl. XLII, figs 9a, b), the brachiopod *Rhynchopora perryensis* and the bryozoan *Archimedes lativolvis.* The wing plates of *Pterotocrinus capitalis* (Pl. XLII, figs. 2b-d) are common at many localities in the western counties of Kentucky although they are unknown farther east. *Pentremites obesus* (Pl. XLII, fig. 1) while usually not abundant is a very conspicuous form as it is one of the largest known species of this genus. Species of *Archimedes* (Pl. XLI, figs. la-6, Pl. XLIII, fig. 7) are very abundant and the crinoid *Agassizocrinus* whose peculiar base (Pl. XLI, figs 9a, b) is easily recognized becomes common for the first time.

An interesting feature of the Golconda fauna is the occurrence of a considerable variety of molluscan species. While this aspect of the fauna is reminiscent of the Salem practically all of the species are new and the great majority of them have never been described.

HARDINSBURG SANDSTONE. The Hardinsburg like the Cypress is a very persistent sandstone formation. It is everywhere present at its proper horizon around the borders of the western coal field but apparently is not developed in eastern Kentucky.

GLEN DEAN LIMESTONE. The Glen Dean limestone everywhere overlies the Hardinsburg sandstone. East of the Cincinnati anticline it is recognized by its characteristic fauna from the Tennessee line northward to Carter County.

The most important fossil of the Glen Dean limestone is the bryozoan *Prismopora serrulata* (Pl. XLIII, fig. 1). While this species is not restricted to this formation it is usually much more abundant in it than in any other. It also occurs in the Golconda and Vienna limestones and a few specimens have been observed in the Menard but during Glen Dean time this species flourished in great luxuriance and some shaly partings in the limestone are crowded with specimens. *Archimedes laxus* (Pl. XLIII, fig. 7) is another bryozoan which while also present in the Golconda is much more abundant in the Glen Dean. On the whole the abundance of these two species is a much better guide to the Glen Dean in the western Kentucky counties than farther eastward about the extremity of the western coal field. The blastoid *Pentremites spicatus* (Pl. XI,IV, fig. 3) is rather characteristic of the Glen Dean and the crinoids *Pterotocrinus bifurcatus* (Pl. XLIII, fig. 3) and *P. acutus* (Pl. XLIII, figs. 4a, b) are so far as known confined to this formation but they are ordinarily not abundant and in some areas are rare or entirely absent. In addition to the forms previously mentioned the Glen Dean has yielded a very large fauna which is particularly rich in bryozoans and of course many of the species are the common widely ranging Chester forms.

UPPER CHESTER GROUP

The upper Chester group is well developed in all its members in the western Kentucky counties but to the eastward the several formations lose their individuality and grade laterally into a series of strata largely composed of shale. This shale is known in western Kentucky as the Leitchfield formation while east of the Cincinnati anticline it has been referred to the Pennington shale which receives its name from a locality in Virginia.

Limestone layers occurring at various horizons in the Leitchfield shale are more or less fossiliferous but the upper

Chester faunas as a whole are so similar that it has not as yet proved practicable to correlate them with any of the several formations which are known farther to the west.

TAR SPRINGS SANDSTONE. This sandstone overlies the Glen Dean limestone throughout its whole extent. It pinches out to the eastward however and is not known as a continuous formation beyond Bowling Green on the south side of the western coal basin although it also occurs in the vicinity of Cloverport in Breckenridge County. East of these limits it is patchy, very shaly or entirely absent.

VIENNA LIMESTONE. The Vienna limestone succeeds the Tar Springs sandstone. In the western Kentucky counties the limestone which constitutes its lower portion carries a great deal of chert in thin layers by which character it may be recognized. But where to the east this cherty limestone is replaced by shale and the overlying Waltersburg sandstone is absent, this formation cannot be separated from the Menard.

Paleontologically the Vienna limestone is known to have little that is diagnostic. As stated above *Prismopora serrulata* (Pl. XLIII, fig. 1), the bryozoan that is so abundant in the Glen Dean, also occurs in this formation. On the other hand the pelecypod *Sulcatopinma missouriensis* (Pl. XLIV, fig. 1) which is one of the most striking members of the Menard fauna appears for the first time in the Vienna but is rare. On the whole the Vienna has not yielded a very large fauna due principally no doubt to its poor exposures and limited extent.

WALTERSBURG SANDSTONE. The Waltersburg sandstone overlies the Vienna. This sandstone however is not recognized beyond the western Kentucky counties and when it is absent the Vienna and Menard limestones cannot be satisfactorily separated.

MENARD LIMESTONE. The Menard limestone directly overlies the Waltersburg in that part of western Kentucky where it is recognizable. Beyond, it rests upon strata of Vienna age and farther on loses its identity in the Leitchfield shale.

The Menard carries a considerable fauna and where it is advantageously exposed many fossils may be secured. Among these the blastoid *Pentremites fohsi* (Pl. XLIV, fig. 2) which

is nearly as large as the Golconda species *P. obesus* (Pl. XLII, fig. 1) and the crinoid *Pterotocrinus menardensis* (Pl. XLIV, fig. 7) have never been found at any other horizon. The partial or complete substitution of *Composita subquadrata* (Pl. XLIV, figs. 4a-c) and *Eumetria costata* (Pl. XXXIX, figs. 8a, b) in place of the common Lower and Middle Chester species C. *trinuclea* (Pl. XLIII, figs. 5a, b) and *E. vera* (Pl. XXXIX, figs. 7a, b) and the introduction of the typical *Spirifer increbescens* (Pl. XLIV, fig. 6) are particularly characteristic of this limestone of the upper Chester group. These three species which appear here for the first time are large and the *Eumetria* and *Spirifer* are more coarsely ribbed than their closely related predecessors. The presence of the pelecypod *Sulcatopinna missouriensis* (Pl. XLIV, fig. 1) sometimes in considerable numbers is another character of this fauna which may serve in its identification.

PALESTINE SANDSTONE. The Palestine sandstone overlies the Menard limestone and is well developed in the western Kentucky counties but to the eastward it pinches out or becomes an indistinguishable member of the Leitchfield shale.

CLORE LIMESTONE. The Clore limestone which succeeds the Palestine is characteristically developed in the western Kentucky counties but loses its identity to the eastward.

The Clore limestone has nowhere yielded large collections of fossils. Most of the species that have been collected are common Chester forms but the presence of *Spirifer increbescens* (Pl. XLIV, fig. 6) and *Composita subquadrata* (Pl. XLIV, figs. 4a-c) are clearly indicative of its Upper Chester position. The only species of any particular significance however is the slender branching byrozoan *Batostomella nitidula* (Pl. XLIV, fig. 8). While this species may occur at other horizons it is very common upon the surfaces of some of the Clore limestone layers and prolific colonies must have existed in the sea when these beds were being formed.

DEGONIA SANDSTONE. The Degonia sandstone which overlies the Clore has not been recognized beyond the western counties of Kentucky.

KINKAID LIMESTONE. This formation succeeds the Degonia sandstone and is the uppermost member of the Chester series. It is recognized as a distinct formation only in the western Kentucky counties.

The Kinkaid limestone has in general not yielded faunas of any great diversity and the species which have been obtained are not distinctive. It is not known to possess any paleontological characters which would serve to certainly distinguish it from the other upper Chester limestones.

PRE-PENNSYLYANIAN UNCONFORMITY

A very important unconformity separates the Mississippian and Pennsylvanian systems. Channels were cut in the Mississippian rocks and locally a considerable thickness of strata was removed. In western Kentucky the lowest formation upon which the Pennsylvanian beds have been observed to rest is the Cypress sandstone. In eastern Kentucky the Pennsylvanian in a general way overlaps successively older beds in a northerly direction. The lowest formation with which it is known to come in contact is the Logan (upper New Providence).

BIBLIOGRAPHY

For a fuller description of the stratigraphy of the Mississippian system in Kentucky the reader is referred to the following reports by Charles Butts;

Descriptions and Correlations of the Mississippian Formations of Western Kentucky: Kentucky Geol. Survey, 1917.

The Mississippian Series of Eastern Kentucky: Kentucky Geol. Survey, series 6 vol. 7, 1922.

In consulting these reports however the reader should remember that they are the result of reconnaissance and not detailed studies and certain of the author's correlations particularly of the lower Chester formations have been somewhat invalidated by more detailed surveys of later date.

For accurate descriptions of the Mississippian stratigraphy of certain smaller areas that have been studied in detail and extended faunal lists for the various formations the following reports by Stuart Weller may be consulted;

The Geology of Hardin County: Illinois State Geological Survey, Bulletin 41, 1920.

Geology of the Golconda Quadrangle: Kentucky Geological Survey, series 6 vol. 4, 1921.

Geology of the Princeton Quadrangle: Kentucky Geological Survey, series 6 vol. 10, 1923.

Geology of the Cave in Rock Quadrangle: Kentucky Geological Survey, series 6 vol. 26, 1927.

Also the following report by James Marvin Weller;

The Geology of Edmonson County: Kentucky Geological Survey, series 6 vol. 28, 1927.

And the following report by Charles Butts;

The Geology of Jefferson County: Kentucky Geological Survey, series 4 vol. 3, pt. 2, 1915.

And the following reports by A. H. Sutton;

Geology of the Southern Part of the Dawson Springs Quadrangle, in Kentucky: Kentucky Geological Survey, series VI, vol. 31, part III. 1929.

A Reconnaissance Survey of the Geology of Northern Hardin County, (Kentucky): Kentucky Geological Survey, series VI, vol. 37, part III. 1931.

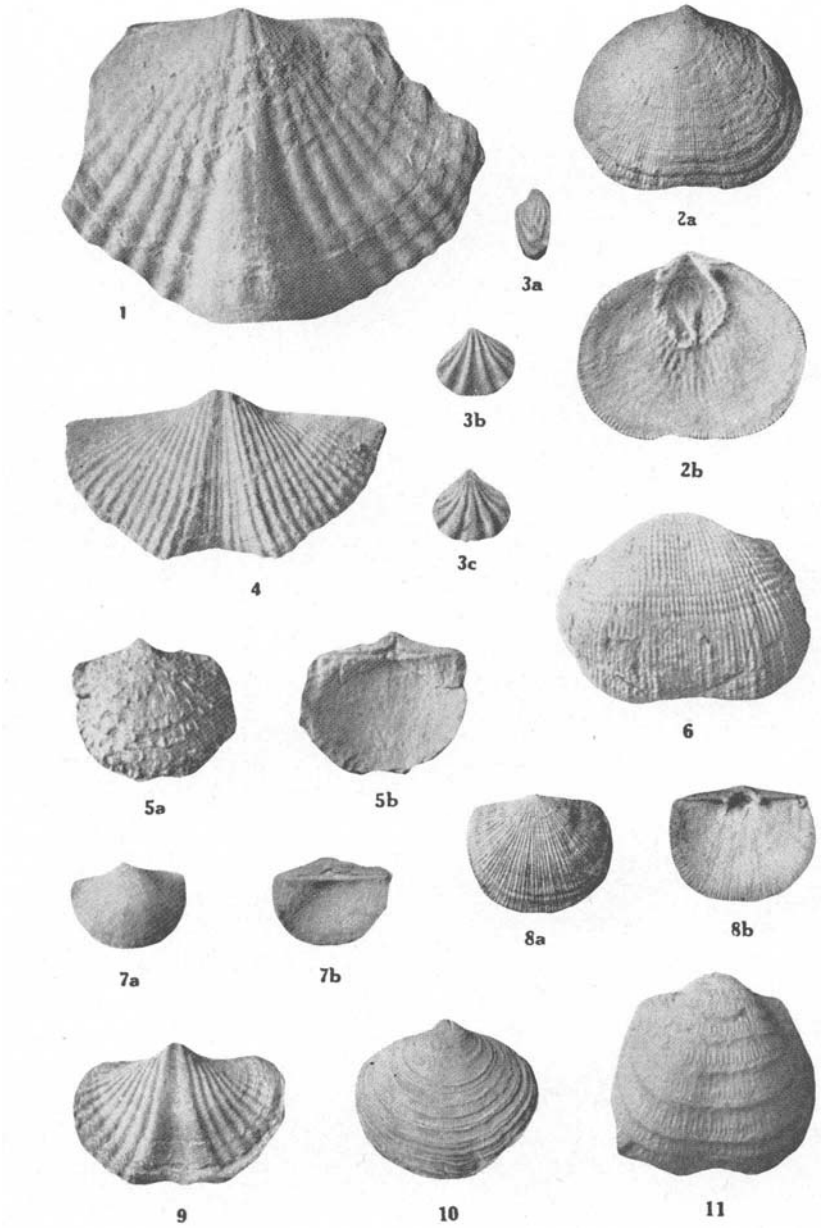
Explanation of Plate XXXIII

FOSSILS OF THE NEW PROVIDENCE SHALE.

Figure	
1	*Brachythyris suborbicularis* (Hall). Lower Burlington to Keokuk.
2a, b.	*Rhipidomella oweni* Hall and Clarke. Confined to the New Providence.
3a-c	*Ptychospira sexiplicata* (White and Whitefield). Fern Glen.
4.	*Spirifer vernonensis* Swallow. Fern Glen and Lower Burlington.
5a, b.	*Strophalosia cymbula* Hall and Clarke. Confined to the New Providence.
6.	*Productus fernglenensis* Weller. Fern Glen and Lower Burlington.
7a, b.	*Chonetes shumardanus* De Koninck. Confined to the New Providence.
8a, b.	*Schuchertella lens* (White). Kinderhook.
9	*Spiriferina subelliptica* (McChesney). Confined to the New Providence.
10.	*Athyris hannibalensis* (Swallow) Kinderhook.
11.	*Pustula alternata* (Norwood and Pratten). Burlington, Keokuk and Warsaw.

All figures after Stuart Weller.

PLATE XXXIII



Fossils of the New Providence—
Mississippian.

Explanation of Plate XXXIV

FOSSILS FROM FORMATIONS OF KEOKUK AGE.

Figure

1. *Productus wortheni* Hall. Keokuk and Warsaw.
2. *Syringothyris textus* (Hall). Keokuk and Warsaw.
3. *Spirifer crawfordsvillensis* Weller. Keokuk.
4. *Spirifer keokuk* Hall. Keokuk and Warsaw.

5a, b. *Rhynchopora beecheri* Greger. Keokuk.

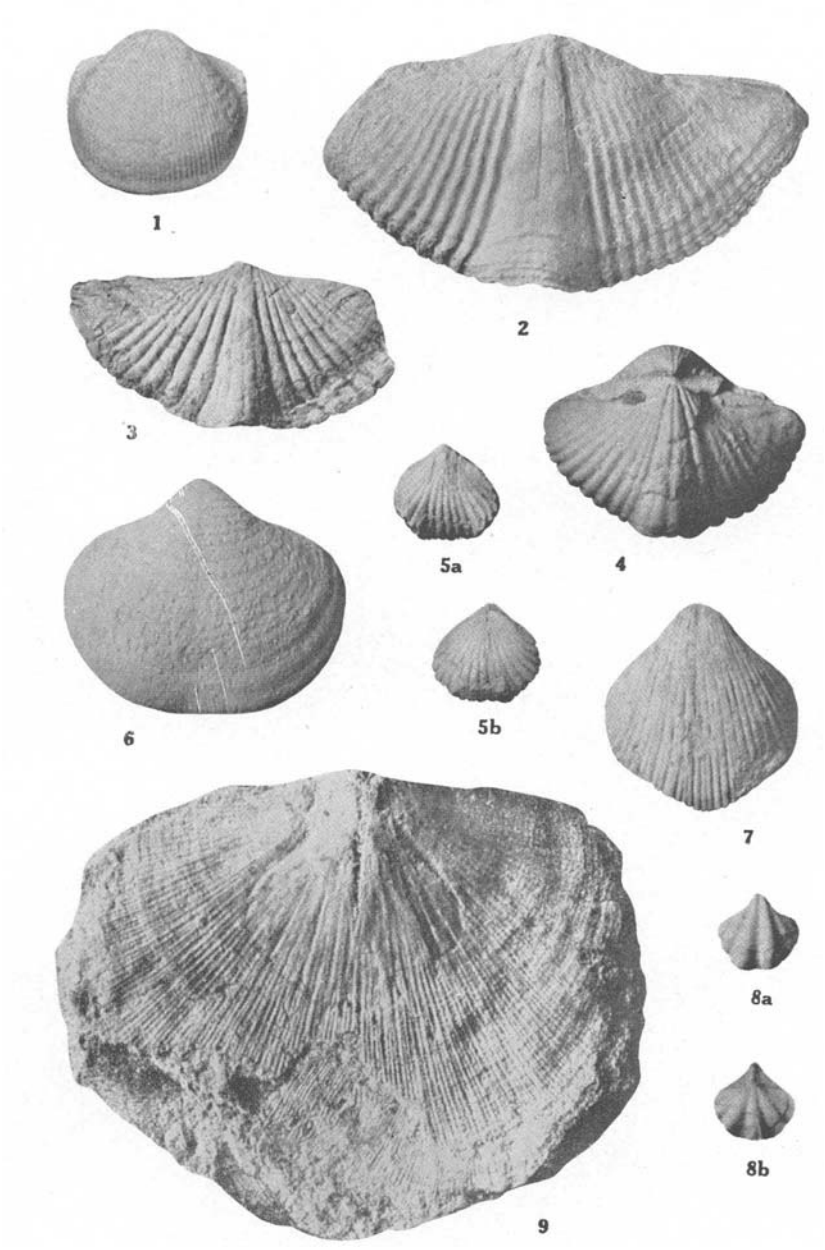
6. *Reticularia pseudolineata* (Hall), Burlington, Keokuk and Warsaw.
7. *Spirifer rostellatus* Hall. Keokuk and Warsaw.

8a, b. *Cyrtina burlingtonensis* Rowley. Fern Glen, Burlington and Keokuk.

9. *Orthotetes keokuk* (Hall). Keokuk and Warsaw.

All figures after Stuart Weller.

PLATE XXXIV



Fossils of Keokuk Age—Mississippian

Explanation of Plate XXXV

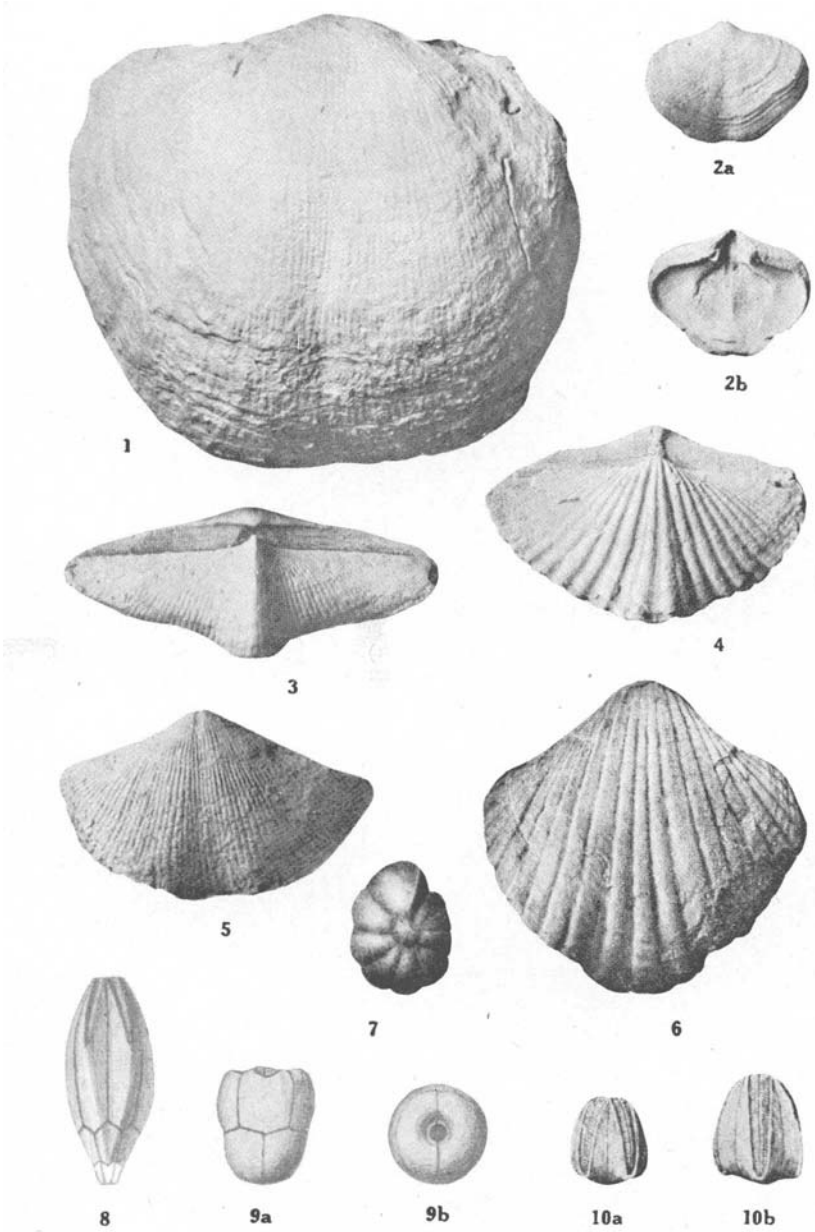
FOSSILS FROM THE WARSAW-SALEM LIMESTONE

Figure

1. *Productus magnus* Meek and Worthen. Upper Keokuk and Warsaw.
2a, b. *Athyris densa* Hall. Salem.
3. *Spirifer lateralis* Hall. Warsaw and Salem.
4. *Spirifer washingtonensis* Weller, Upper Keokuk and Warsaw.
5. *Spirifer tenuicostatus* Hall. Keokuk. Warsaw and Salem.
6. *Brachythyris subcardiformis* (Hall). Warsaw and Salem.
7. *Endothyra baileyi* (Hall). Salem to Pennsylvanian. Greatly enlarged.
8. *Metablastus wortheni* (Hall). Warsaw.
9a, b. *Talarocrinus simplex* (Shumard), Warsaw.
l0a, b. *Pentremites conoideus* Hall. Warsaw and Salem.

Fig. 7 after Whitfield, 8 after Worthen, 9 after Wachsmuth and Springer, 10 after Ulrich, all others after Stuart Weller.

PLATE XXXV



Fossils of the Warsaw-Salem—
Mississippian

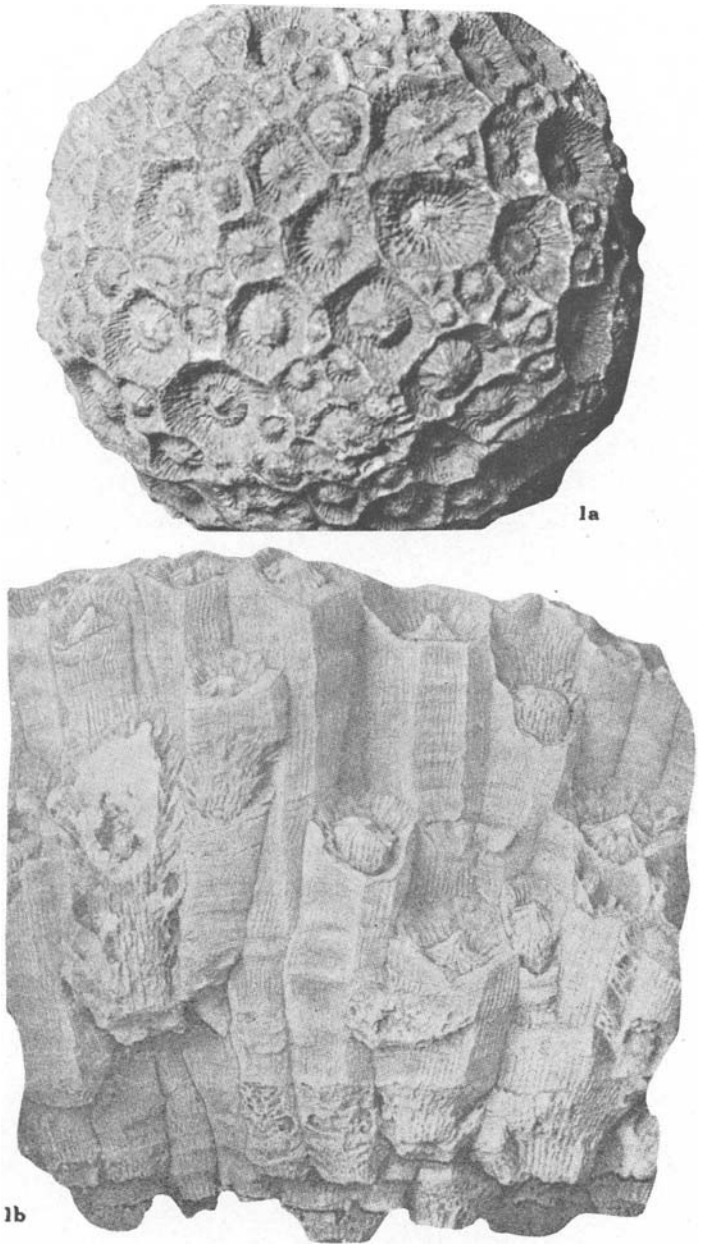
Explanation of Plate XXXVI

FOSSILS FROM THE ST. LOUIS LIMESTONE.

Figure

la, b. *Lithostrotion canadense* (Castelnau). Upper Salem and St. Louis. la, photograph by Savage, 1b, after Ulrich.

PLATE XXXVI



Fossils of the St. Louis—Mississippian

Explanation of Plate XXXVII

FOSSILS FROM THE ST. LOUIS LIMESTONE

Figure

1a, b. *Lithostrotion proliferum* Hall. St. Louis and lower Ste. Genevieve.

2a, b. *Productus marginicinctus* Prout. St. Louis.

3a-c. *Productus scitulus* Meek and Worthen. St. Louis.

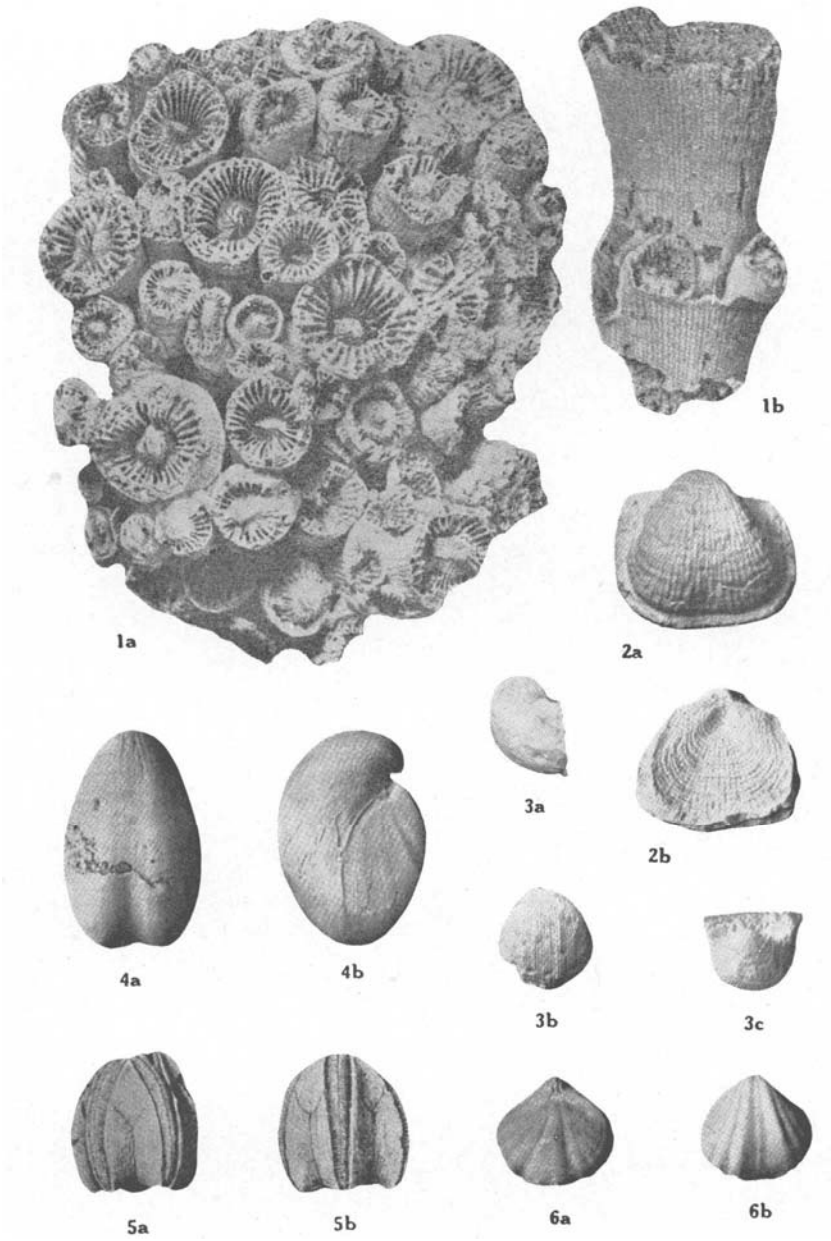
4a, b. *Dielasma sinuata* Weller. Keokuk to St. Louis.

5a, b. *Pentremites cavus* Ulrich. Described from lower St. Louis but should probably be referred to Salem.

6a, b. *Brachythyris altonensis* Weller. St. Louis.

Figures 1 and 5 after Ulrich, all others after Stuart Weller.

PLATE XXXVII



Fossils of the St. Louis—Mississippian

Explanation of Plate XXXVIII

FOSSILS FROM THE STE. GENEVIEVE LIMESTONE.

Figure

1a, b. *Spirifer pellaensis* Weller. Ste. Genevieve.

2a-c. *Platycrinus penicillus* Meek and Worthen. Upper St. Louis and Ste. Genevieve. 2a view of basal plates, 2b, c stem segments.

3a-c. *Rhipidomella dubia* (Hall). Keokuk to Ste. Genevieve.

4a, b. *Menophyllum princetonensis* Ulrich. Ste. Genevieve.

5a, b. *Pugnoides ottumwa* (White). Ste. Genevieve.

6. *Michelinia subramosa* Ulrich. Ste. Genevieve.

7a, b. *Eumetria verneuiliana* (Hall). Salem to Lower Chester.

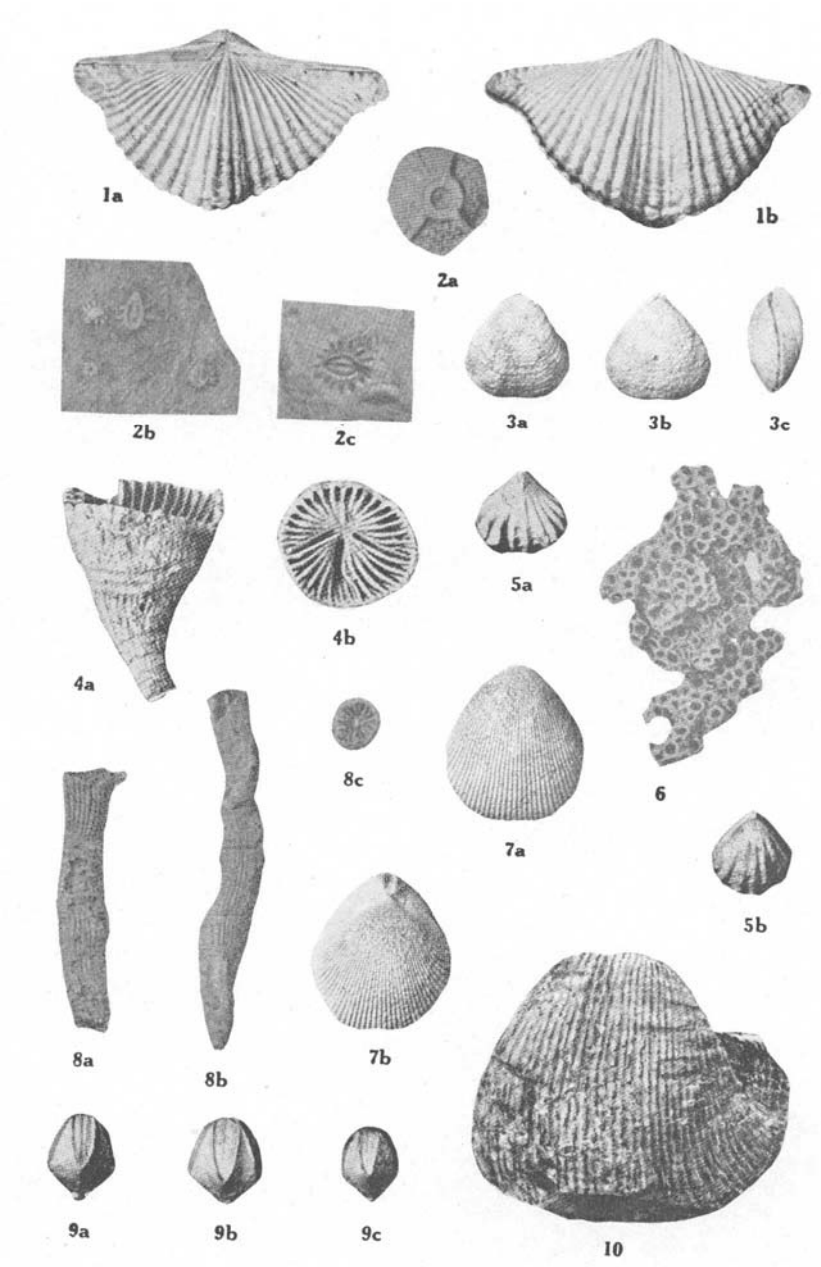
8a-c. *Lithostrotion harmodites* Milne-Edwards and Haime. Ste. Genevieve. Occurs in large colonies.

9a-c. *Pentremites princetonensis* Ulrich. St. Louis to Renault.

10. *Productus arkansanus* Girty: Chester, reported by Ulrich from Ste. Genevieve.

Figures 2, 4, 6, 8, and 10 after Ulrich, all others after Stuart Weller.

PLATE XXXVIII



Fossils of the Ste. Genevieve—Mississippian

Explanation of Plate XXXIX

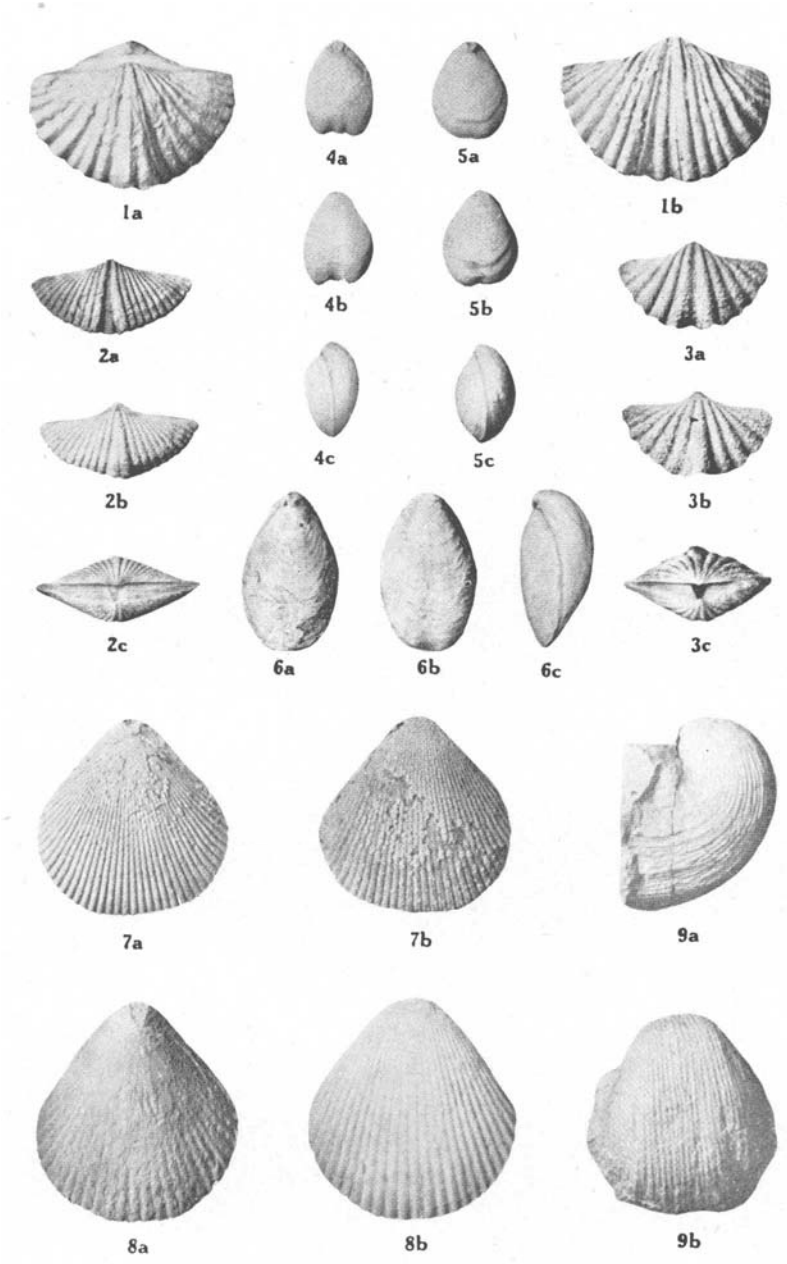
FOSSILS FROM THE CHESTER SERIES.

Figure

1a, b. *Spirifer leidyi* Norwood and Pratten. Ste. Genevieve and Chester.
2a-c. *Spiriferina transversa* (McChesney). Ste. Genevieve and Chester.
3a-c. *Spiriferina spinosa* (Norwood and Pratten). Ste. Genevieve and Chester.
4a-c. *Girtyella brevilobata* (Swallow). Ste. Genevieve and Chester.
5a-c. *Girtyella indianensis* (Girty). Ste. Genevieve and Chester.
6a-c. *Dielasma illinoisensis* Weller. Chester.
7a, b. *Eumetria* vera (Hall). Chester.
8a, b. *Eumetria costata* (Hall), Chester.
9a, b. *Diaphragmus elegans* (Norwood and Pratten). Ste. Genevieve and Chester.

All figure after Stuart Weller.

PLATE XXXIX



Fossils of the Chester—Mississippian

Explanation of Plate XL

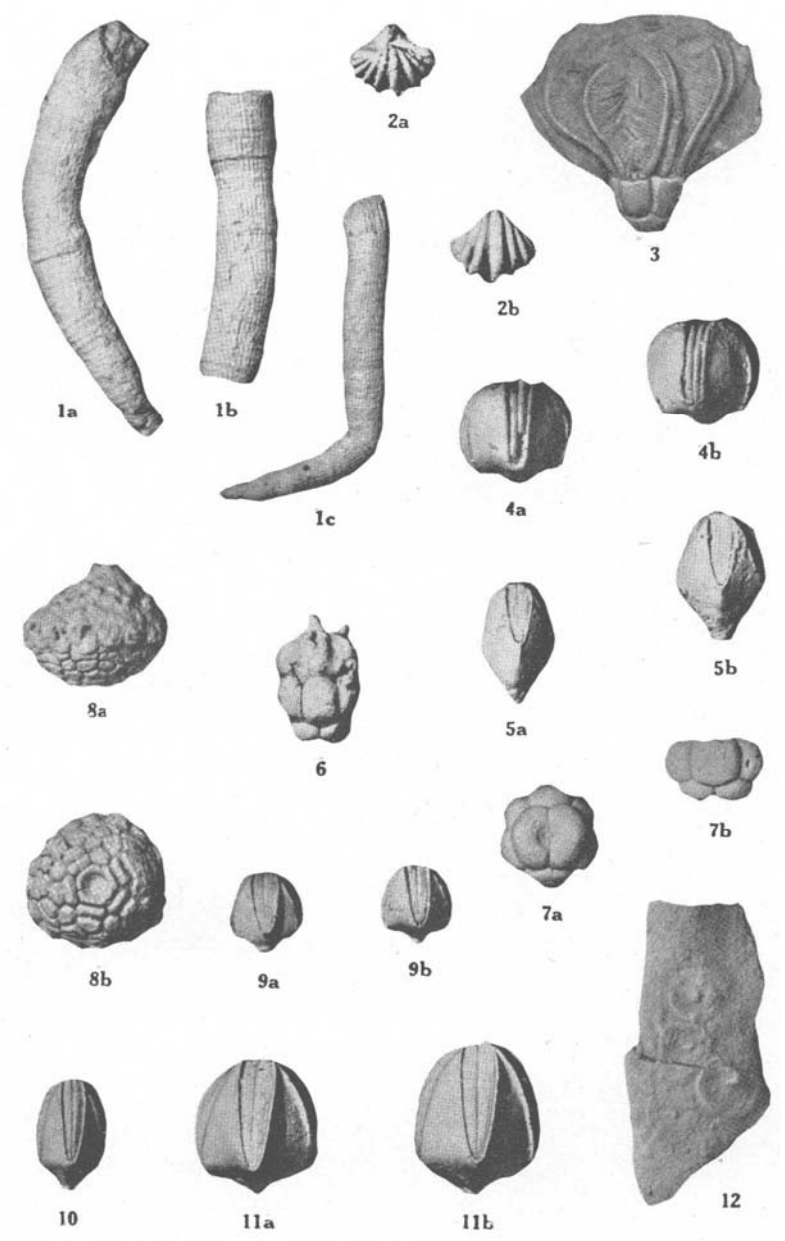
FOSSILS FROM THE RENAULT LIMESTONE.

Figure

la-c. *Amplexus geniculatus* Worthen. Renault.
2a, b. *Spiriferina subspinosa* Weller. Renault.
3. *Talarocrinus patei.* Miller and Gurley. Renault.
4a, b. *Mesoblastus glaber* (Meek and Worthen). Ste. Genevieve and Renault.
5a, b. *Pentremites buttsi* Ulrich. Renault.
6. *Talarocrinus ovatus* Worthen. Renault.
7a, b. *Talarocrinus inflatus* Ulrich. Renault.
Sa, b. *Globocrinus unionensis* (Worthen). Renault.
9a, b. *Pentremites pinguis* Ulrich. Renault.
10. *Pentremites pulchellus* Ulrich. Ste. Genevieve and Renault.
11a, b. *Pentremites godoni* (DeFrance). Renault and Paint Creek.
12. *Crania chesterensis* Miller and Gurley. Chester.

Figure 3 after Springer, all others after Stuart Weller.

PLATE XL



Fossils of the Renault—Mississippian

Explanation of Plate XLI

FOSSILS FROM THE PAINT CREEK LIMESTONE.

Figure

la, b. *Archimedes conferus* Ulrich. Paint Creek and Golconda.

2. *Archimedes meekanus* Hall. Paint Creek to Menard.

3. *Archimedes proutanus* Ulrich. Paint Creek to Glen Dean.

4. *Archimedes compactus* Ulrich. Paint Creek and Golconda.

5. *Archimedes swallovanus* Hall. Paint Creek to Menard.

6. *Archimedes distans* Ulrich. Paint Creek to Kinkaid.

7a, b. *Cystodictya labiosa* Weller. Renault and Paint Creek. 7b magnified 3½ diameters.

8a, b. *Pentremites symmetricus* Hall. Paint Creek.

9a, b. *Agassizocrinus* sp. Chester.

10. *Lyropora quincuncialis* Hall. Renault to Golconda.

lIa, b. *Chonetes chesterensis* Weller. Paint Creek, rarely in Glen Dean.

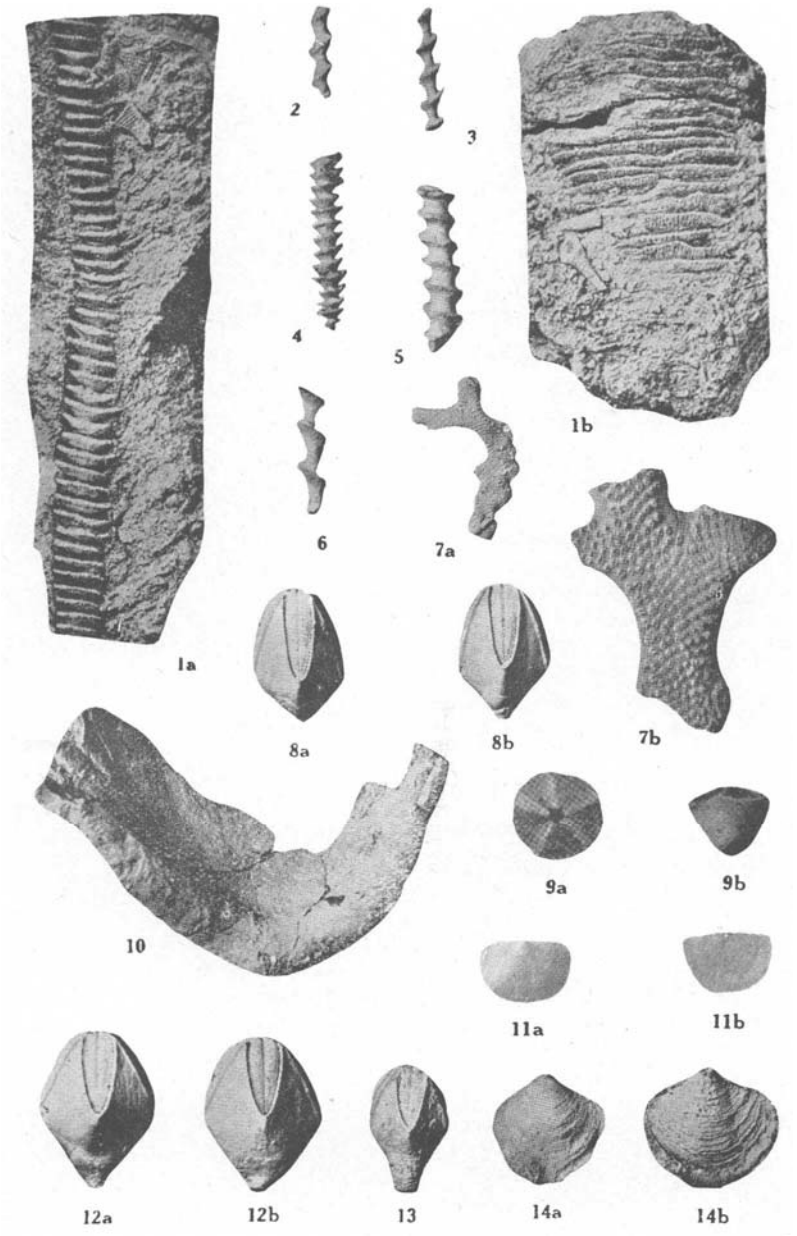
12a, b. *Pentremites pymmidatus* Ulrich. Paint Creek to Glen Dean.

13. *Pentremites gemmiformis* Hambach. Paint Creek.

14a, b. *Cleiothyridina sublamellosa* (Hall). Ste. Genevieve and Chester.

Figures 1 and 9, after Ulrich, all others after Stuart Weller.

PLATE XLI



Fossils of the Paint Creek—Mississippian

Explanation of Plate XLII

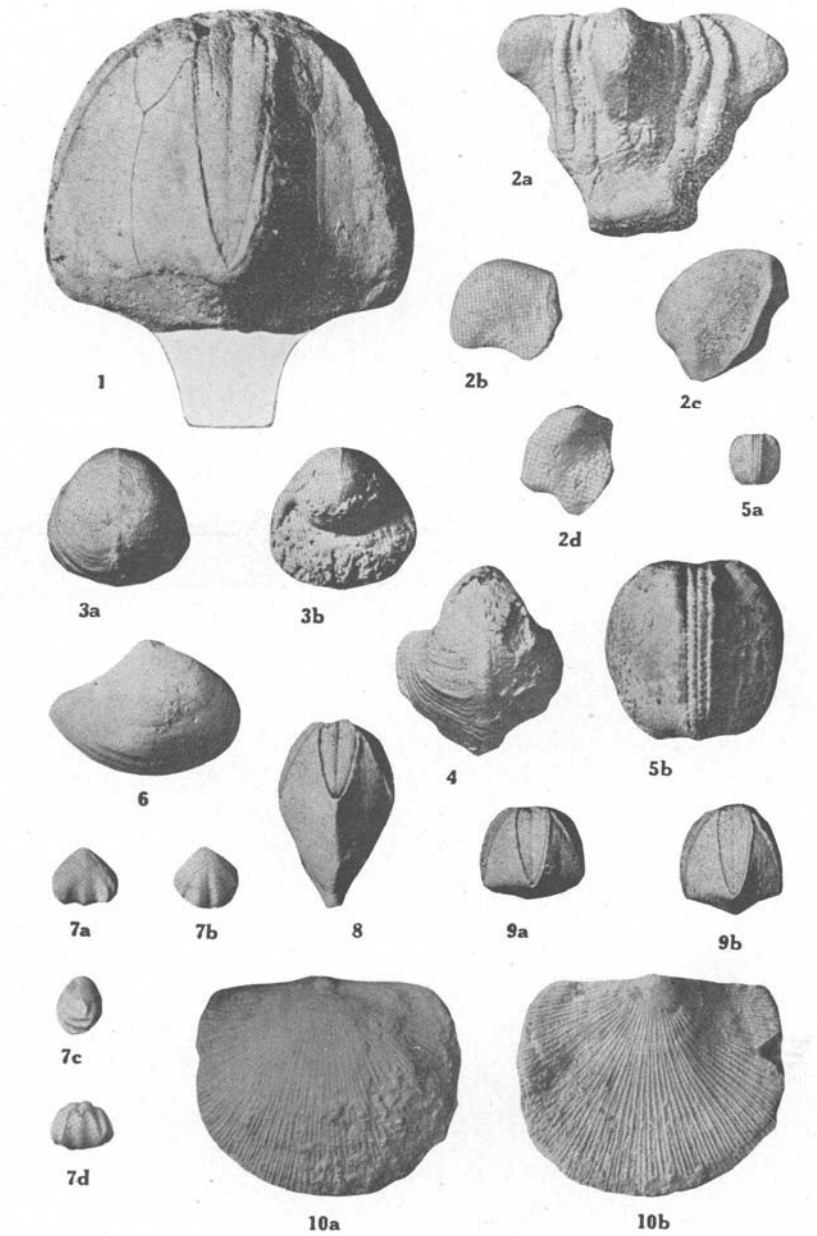
FOSSILS FROM THE GOLCONDA LIMESTONE.

Figure

1. *Pentremites obesus* Lyon. Golconda.
2a-d. *Pterotocrinus capitalis* (Lyon). Golconda.
3a, b. *Bellerophon chesterensis* Weller. Paint Creek and Golconda.
4. *Bucanopsis ornatus* Weller. Golconda.
5a, b. *Mesoblastus incurvatus* Weller. Paint Creek and Golconda. 5b magnified 3½ diameters.
6. *Leda chesterensis* Weller. Paint Creek and Golconda.
7a-d. *Camarophoria explanata* (McChesney). Golconda to Kinkaid.
8. *Pentremites okawensis* Weller. Golconda and Glen Dean.
9a, b. *Pentremites platybasis* Weller. Golconda.
l0a, b. *Orthotetes kaskaskiensis* (McChesney). Ste. Genevieve and Chester.

All figures after Stuart Weller.

PLATE XLII



Fossils of the Golconda—Mississippian

Explanation of Plate XLIII

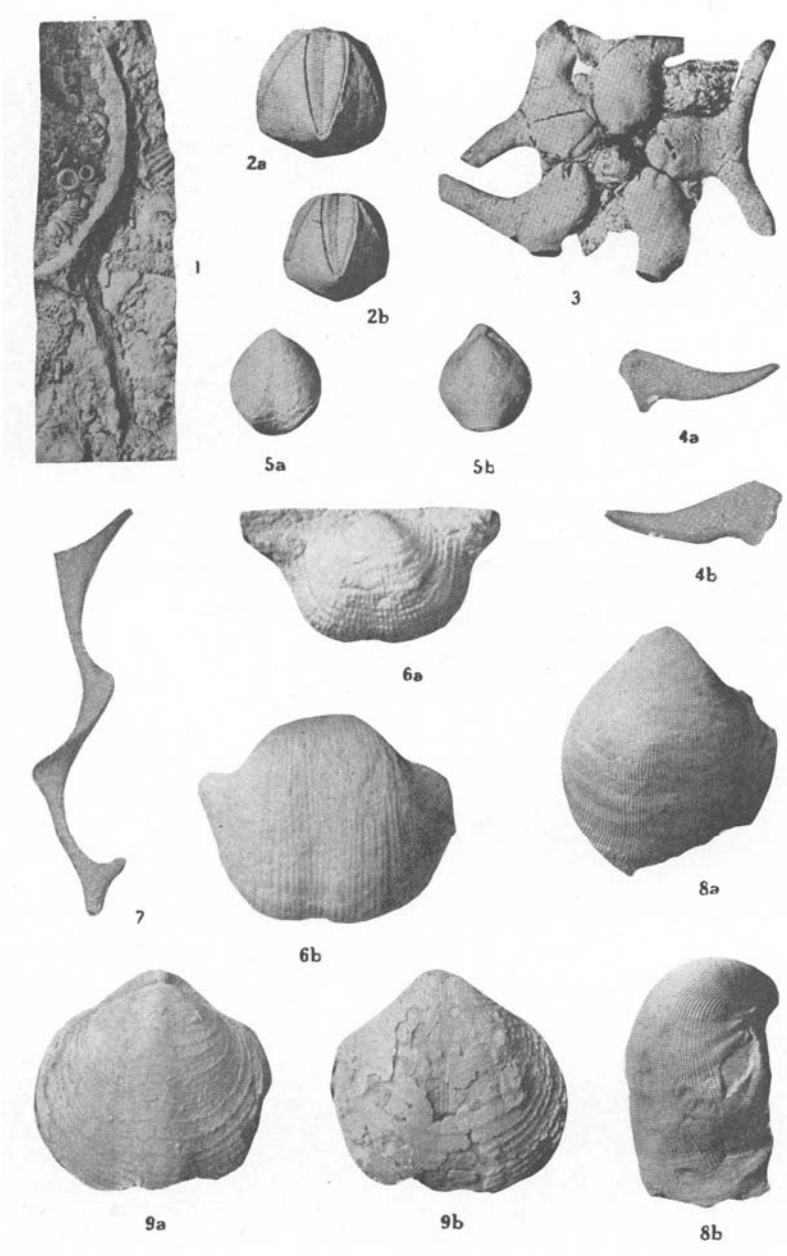
FOSSILS FROM THE GLEN DEAN LIMESTONE:

Figure

1. *Prismopora serrulata* Ulrich. Golconda to Vienna, particularly Glen Dean.
2a, b. *Pentremites brevis* Ulrich. Glen Dean.
3. *Pterotocrinus bifurcatus* Wetherby. Glen Dean.
4a, b. *Pterotocrinus acutus* Wetherby. Glen Dean.
5a, b. *Composita trinuclea* (Hall). Salem to Chester.
6a, b. *Productus inflatus* McChesney. Chester.
7. *Archimedes laxus* Hall. Golconda and Glen Dean.
8a, b. *Productus ovatus* Hall. Kinderhook to Chester.
9a, b. *Reticularia setigera* (Hall). Ste. Genevieve and Chester.

Figures 4 and 7 after Ulrich, all others after Stuart Weller.

PLATE XLIII



Fossils of the Glen Dean—Mississippian

Explanation of Plate XLIV

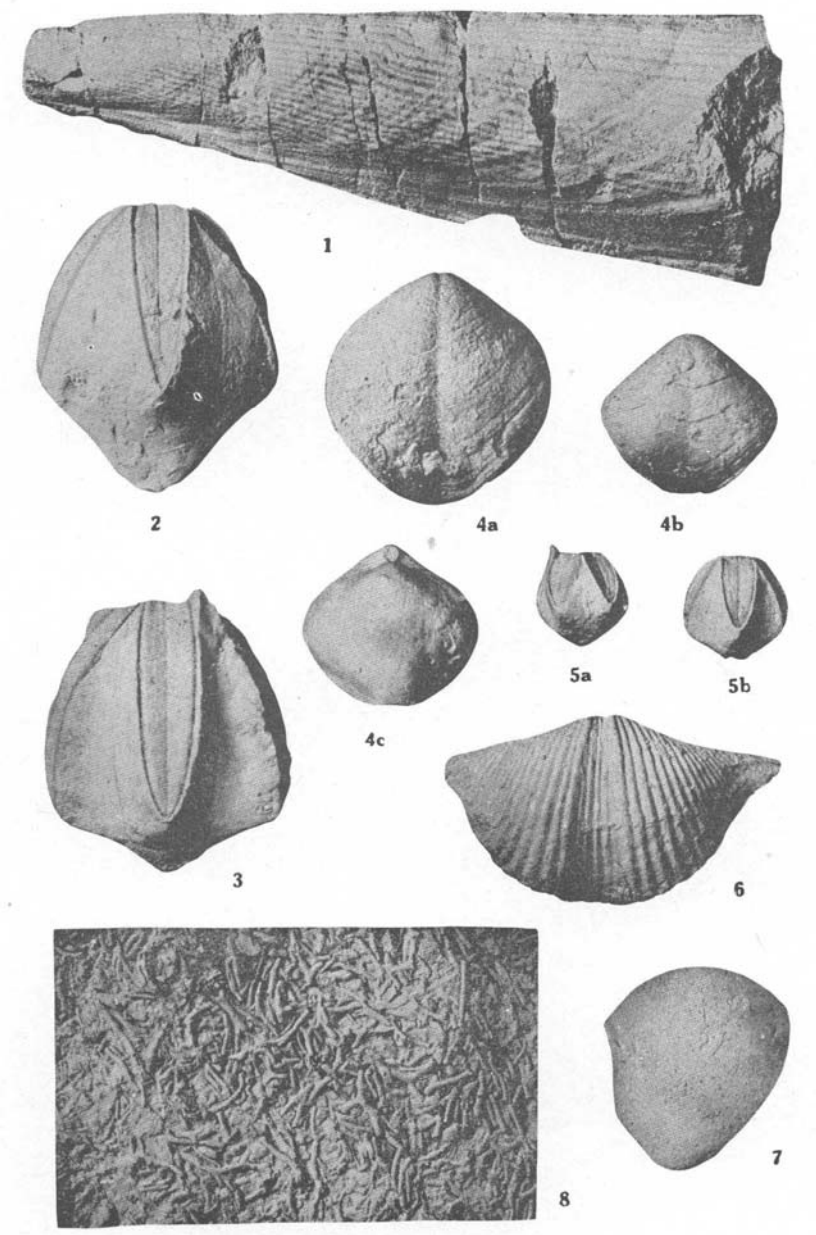
FOSSILS FROM THE UPPER CHESTER GROUP.

Figure

1. *Sulcatopinna missouriensis* (Swallow). Vienna to Kinkaid, particularly Menard.
2. *Pentremites fohsi* Ulrich. Menard.
3. *Pentremites spicatus* Ulrich. Glen Dean to Menard.
4a-c. *Composita subquadrata* (Hall). Vienna to Kinkaid.
5a, b. *Pentremites cherokeeus* Hall. Vienna and Menard.
6. *Spirifer increbescens* Hall. Upper Chester. A related form occurs in Lower and Middle Chester.
7. *Pterotocrinus menardensis* Weller. Menard.
8. *Batostomella nitidula* Ulrich. Chester. Particularly abundant in Clore.

All figures after Stuart Weller.

PLATE XLIV



Fossils of the Upper Chester—Mississippian