OKLAHOMA GEOLOGICAL SURVEY

Governor Robert L. Williams, State Superintendent R. H. Wilson,
President Stratton D. Brooks, Commission.

C. W. Shannon, Director.

BULLETIN NO. 24.

PART I.
GEOLOGY OF A PORTION OF NORTHEASTERN OKLAHOMA.

PART II.
PALEONTOLOGY OF THE CHESTER GROUP IN OKLAHOMA.

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NORMAN
July, 1915.

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PART I.

THE GEOLOGY OF A PORTION OF NORTHEASTERN OKLAHOMA.

LOCATION AND AREA.

The area covered by this report is that part of northeastern Oklahoma in which the surface rocks are of Mississippian age or older, and includes approximately the region north of Arkansas River and east of Grand* River. All of Delaware, and parts of Adair, Sequoyah, Cherokee, Muskogee, Wagoner, Mayes, Craig and Ottawa counties

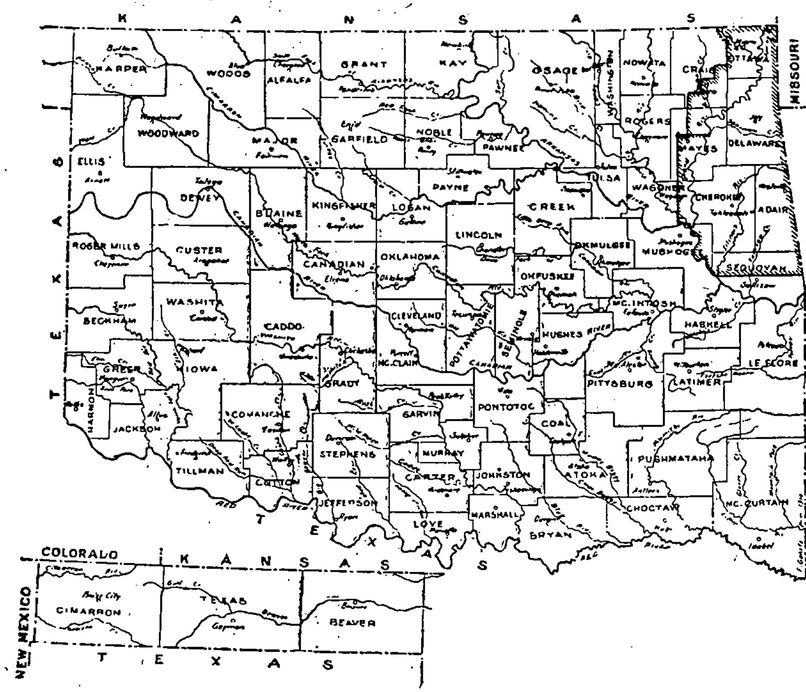

Fig. 1. Sketch map of Oklahoma showing area covered by this report.

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*According to a ruling of the United States Board of Geographic Names the name Neosho is applied to this stream. This ruling, however, conflicts with long established usage and in this report the stream below the confluence of Neosho and Spring rivers is called Grand River. In quotations from publications of the United States Geological Survey the name Neosho applies to the entire stream, but the name Grand is inserted in brackets when the portion of the stream below the confluence of Spring and Neosho rivers is meant.

are included. Of the 30-minute quadrangles of the United States Geological Survey, parts of the Vinita, Wyandotte, Pryor, Siloam Springs, Muskogee, and Tahlequah quadrangles lie in the area.

In fig. 1 the lined portion indicates the portion of the State considered.

NATURE OF REPORT.

The primary object of the field work upon which this report is based was the interpretation of the stratigraphy of the Mississippian system, and especially that of the Chester group. In the study of the Mississippian rocks in the Vinita quadrangle, it was found that the Chester rocks were so different from those of the Muskogee quadrangle, the nearest region which had been mapped, that correlations were very uncertain. The Pryor quadrangle lying between the Muskogee and Vinita quadrangles was practically unknown stratigraphically, and the major part of the work was the tracing of the formations of the Chester group across this quadrangle.

The solution of the Chester problem necessitated a large amount of traveling through the area, and in the course of the work considerable information was accumulated in regard to the older rocks and also in regard to the lowermost Pennsylvanian rocks and their relation to the Chester.

This report, then, deals principally with the stratigraphy of the Chester formations and the relation of these rocks to the overlying Pennsylvanian. The discussions of the older formations are admittedly incomplete but are believed to contain enough new material to justify their inclusion in most cases, especially since the distribution of these rocks in the Siloam Springs quadrangle, about which practically nothing has previously been published, is shown with some degree of accuracy.

The Chester rocks are richly fossiliferous, and the determination of the faunas is an important element in their correlation, and in checking the conclusions drawn from the field work on the stratigraphy. Collections were made from the Chester in 55 localities, and the collections have been studied at the University of Chicago under the direction of Dr. Stuart Weller. The results of the paleontologic studies constitute Part II of this report. The subjects of physiography, structure, and economic geology (with the exception of the lead and zinc deposits) were studied only incidentally in connection with the stratigraphy. The observations on these subjects are included in the hope that they may be of service to those interested in the region, but without any claim to completeness.

The field work on which the report is based was as follows:

In the autumn of 1911, the writer, assisted by Jerry B. Newby,

made a reconnaissance of the region and investigated the lead and zinc fields near Miami. The results of this work were published as Bulletin No. 9 of the Oklahoma Geological Survey. In the early summer of 1912, three weeks were spent in company with D. W. Ohern in work on the Chester group in the Pryor and Vinita quadrangles, and later in the summer, seven weeks were spent with Jerry B. Newby in mapping the Chester in the southern part of the quadrangle. In April, 1914, the writer, assisted by Thomas Jackson, studied the sections as exposed in the Muskogee and Tahlequah quadrangles. Later in the summer the mapping of the Chester formations in the Pryor quadrangle was completed, and the study of these formations was carried on through the Vinita and Wyandotte quadrangles to the Kansas line. Nearly three months were spent in this work, in which George D. Morgan was assistant.

During this summer Dr. Stuart Weller accompanied the writer in a trip around the margin of the area.

Acknowledgment should be made to the assistants mentioned above, to Chas. N. Gould, D. W. Ohern, and C. W. Shannon under whose administrations the Survey work was carried on, to Dr. George H. Girty of the United States Geological Survey for the comparison of material, to K. F. Mather for collections from the Fayetteville and Pitkin formations near Fayetteville, Ark., and for the determination of the Morrow fauna, and especially to Dr. Stuart Weller of the University of Chicago under whose direction the faunal studies have been made and who also co-operated in the field work.

PREVIOUS WORK IN THE AREA.

The first paper published on the geology of the region—except some incidental references—was by N. F. Drake* in 1898.

In this paper Drake discusses the stratigraphy and structure of the Ozark region as well as that of the coal fields, and gives a sketch map on which the Mississippian-Pennsylvanian contact is shown approximately as accepted today. Correlations were made with the Arkansas section which has been so extensively revised since that time that the correlations have little value now. His conclusions in regard to the stratigraphy will be noted in connection with the discussion of that subject.

Topographic maps of all the quadrangles on the scale of 1:125,-000 and with 50-foot contour interval are available. The map for

*Drake, N. F., A Geological Reconnaissance of the Coal Fields of Indian Territory: Contributions to Biology from the Hopkins Seaside Laboratory (Leland Stanford Jr. University), No. 14, also in the Proc. Am. Phil. Soc., vol. 36, No. 156.

the Wyandotte quadrangle was made in 1906 and 1907, and the Vinita quadrangle was resurveyed in 1911 and 1912. The Pryor, Siloam Springs, Muskogee and Tahlequah quadrangles were surveyed before 1900 and consequently the culture, except in the hillier regions, is completely out of date.

The Tahlequah and Muskogee quadrangles were mapped geologically by Joseph A. Taff for the United States Geological Survey and the folios published in 1904 and 1905 respectively.

The Wyandotte quadrangle was mapped by C. E. Siebenthal about 1907, but the folio has not been issued at the time this is written (Jan. 1915). The Vinita quadrangle was mapped by D. W. Ohern in 1911 under co-operative agreement between the United States and Oklahoma Geological Surveys. No results of this work have been published, but a bulletin on the economic geology of this quadrangle and the Nowata, adjoining it on the west, has been in the press of the Federal Survey for some time and should soon be issued.

As a result of his work in the Wyandotte quadrangle and reconnaissance trips in the adjoining region, Siebenthal published in 1908 a short paper on the *Mineral Resources of Northeastern Oklahoma* in Bulletin 340 of the United States Geological Survey. This paper gave in some detail the development of the lead and zinc resources up to 1907 and included a consideration of the petroleum, natural gas, and other mineral resources, and a brief statement of the stratigraphy and structure.

In 1912, the writer published a preliminary report on the lead and zinc resources of the State as Bulletin No. 9 of the Oklahoma Geological Survey, as the result of field work in 1911. Very little work on the stratigraphy was done in the preparation of this report, and Siebenthal's conclusions as to the stratigraphy and structure as stated in the paper mentioned in the previous paragraph were accepted.

Brief mention of the region has been made in various other bulletins of the Oklahoma Geological Survey, but the stratigraphy has received practically no attention except in the papers already mentioned.

PHYSIOGRAPHY.

TOPOGRAPHY.

The greater part of the region is in the Springfield plain, with smaller portions in the Prairie plains to the west and the Boston Mountain plateau to the south.

The Springfield plain is a subdivision of the Ozark region, which

includes the St. Francis Mountains in southeastern Missouri, the Salem plain, the Springfield plain, and the Boston Mountain plateau. The areas and relations of these sub-divisions and their relation to the Arkansas valley and the Prairie plains are shown in fig. 2.

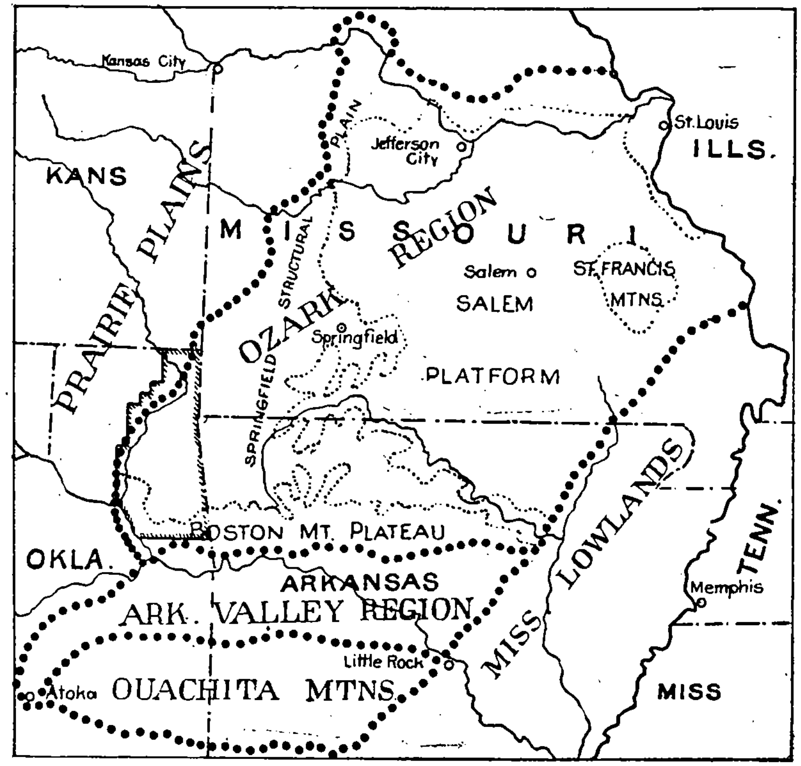


Fig. 2.—Diagram showing the relations of the Ozark region to surrounding physiographic provinces: also principal divisions of the Ozark region (after Taff).

The surface of the Springfield plain in Oklahoma slopes to the west, southwest, and south from the northeastern part of the area. The greatest elevation on the ridges in the northeastern corner of the State is about 1150 feet, while that of the streams in the southeastern part of the area is about 600 feet. The maximum elevation of the hills above their bases is about 400 feet and the average about 250 feet.

The Springfield plain is a rather deeply dissected plateau. It consists of broad flat areas which in Oklahoma are often wholly or partly treeless and are known as prairies. Several of these prairies are given local names which are shown on the topographic maps of the Siloam Springs and Vinita quadrangles. These vary in size from 4 to 5 square miles, to the Cowskin prairie in the Vinita quadrangle, which has maximum dimensions of about 15 by 8 miles. These prairies and flat areas are separated by narrow, steep-sided stream valleys, from which branch narrow canyons, indenting the flat areas for short distances, usually less than a mile. Narrow flat-topped ridges extend out from the prairies between the canyons.

Locally the plateau is more maturely dissected and a very rough, broken topography results. Most of these areas of hilly topography are along streams, and the hills are due to the formation of tributary canyons. However, in these areas the canyons are more numerous and are longer than elsewhere. That the presence of a large stream is not necessary for the development of the hills is shown by the Seneca Hills. Examples of such areas are the Seneca Hills south of Wyandotte and southwest of Seneca, Mo., in the Vinita quadrangle; the Spavinaw Hills along the creek of that name in the Siloam Springs and Pryor quadrangles; and the region along Illinois River and south and east of that stream in the Siloam Springs quadrangle. The three areas mentioned are along large anticlines, and it seems that the structure has had some effect on the development of the mature topography. The structure, while pronounced, is not sufficiently sharp to produce any marked shattering or breaking of the rock, although the brittle chert is probably filled with incipient fractures which make it more subject to the erosive effects of the run-off. The explanation is probably to be found in the effect of the steeper dip carrying the beds below ground water level, so that they become saturated to within a short distance of the surface. This will cause a somewhat greater surface run-off and so produce greater erosional effects.

Along the southern margin of the Springfield plain is a narrow belt of hilly topography due to the outcrop of the Chester formations. Most of the hills are capped by the limestones or sandstones of the lower Pennsylvanian formations, the Morrow and Winslow. On the western margin of the plain, the Chester formations are thin and the basal Pennsylvanian strata are shale or shaly sandstone, so the Prairie plains come directly to the margin of the Springfield plain.

DRAINAGE.

The surface drainage of most of the Ozark area in Oklahoma probably was developed on the shales of the Pennsylvanian system when they extended far to the east of their present outcrop. At present outliers of the upper Mississippian and lowermost Pennsylvanian rocks are found in sink holes in the Joplin district twenty

to thirty miles from the main body of those formations, and it seems safe to presume that they originally extended considerably to the east of any present outcrop. With the removal of the Pennsylvanian and upper Mississippian rocks, the stream courses were superimposed on the resistant Boone chert. The streams flow in meandering courses which were developed on the softer rocks, but have been able to cut only very narrow valleys in the Boone formation. One of the best examples of the superposition of the drainage is the course of Grand River in the Vinita and Pryor quadrangles. Neosho River leaves the Pennsylvanian shales to unite with Spring River, and the Grand—formed by the confluence—flows in a narrow, meandering valley between high hills of Boone chert. In the Pryor quadrangle the river has practically its entire course on the chert, although a very slight readjustment would cause it, to flow on the soft shales of the Chester group and Pennsylvanian system, in some places less than a mile to the west.

The entire region lies in the drainage basin of Arkansas River.

Much the larger part of the drainage is carried into the Arkansas through Grand River and its tributaries. Grand River is formed by the confluence of Neosho and Spring rivers, south of the center of the Wyandotte quadrangle. Spring River enters Oklahoma from Kansas and flows south to its confluence with the Neosho. The latter stream also enters from Kansas but has a general southeasterly course. From the confluence of the Spring and Neosho, the Grand flows southwest and south joining the Arkansas at Ft. Gibson. Its course is very near the margin of the Boone chert, except in the extreme lower part of its course where it flows on Pennsylvanian rocks.

The principal tributaries of the Grand from the east, named from north to south, are: Lost Creek, Cowskin River with Buffalo Creek an important tributary, Honey Creek, Drowning Creek, Spavinaw Creek, Salina Creek, Spring Creek, Clear Creek, Fourteen-mile Creek, and Ranger Creek. With the exception of the last two named, these streams flow on the Boone chert and are swift-flowing streams, with gravel bottoms and exceptionally clear, pure water. They flow in narrow valleys between high hills of the chert.

From the west, Grand River receives the waters of Cabin Creek —of which Little Cabin, Locust Creek, Whiteoak Creek, and Mustang Creek are important tributaries—Rock Creek, Wolf Creek, Pryor Creek, Choteau Creek, Brush Creek, and Flat Rock Creek. The majority of these streams have the greater portion of their courses on the Cherokee and Fayetteville shales, and, in contrast with the tributaries of the Grand from the east are generally sluggish and muddy, flowing in channels only slightly depressed below the general level of the country and with steep mud banks.

The southern and southeastern portions of the area are drained into the Arkansas through Bayou Manard, Greenleaf Creek, Illinois River, Vian Creek, Sallisaw Creek, and Lee Creek as well as many smaller streams. With the exception of Illinois River these streams have their courses principally on the Morrow and Winslow formations, consisting principally of sandstone, shale, and limestone, and are intermediate in character between the clear, rapid streams of the Boone chert area, and the muddy sluggish streams on the Cherokee shale.

Illinois River rises in Arkansas and crosses the State line a few miles south of Siloam Springs. It flows nearly west for a few miles and then turns to the south and continues in a course a little west of south to its junction with the Arkansas near Gore. Its principal tributaries are Flint Creek, and Barren Fork River which has Tyner Creek and Courthouse Creek as tributaries. These streams have the principal part of their courses on the Boone chert and are clear, rapid-flowing streams.

In the Boone chert area, underground drainage is very important. The limestone layers in the formation are removed by solution, and the chert is broken by settling into the cavities which are left. The flat-topped hills and the slopes are covered to a depth of several feet by residual chert fragments which form an excellent reservoir for the water falling on them and serves to prevent rapid surface run-off. Springs, many of them of large volume, are common throughout the Boone area. In general they are the mouths of underground streams. Sink holes are numerous, but no large caverns are known in Oklahoma, although there are some of considerable size in the Boone formation in southwestern Missouri. The development of the characteristic Boone topography with the broad flat-topped hills and narrow canyons more or less choked by residual chert fragments is due in large measure to the importance of the underground drainage.

Terrace deposits along Grand River indicate a slight elevation of the region in recent times. These terraces have a maximum width of 4 or 5 miles, and the higher portions are from 50 to 100 feet above the level of high water. The larger terraces are in the southern part of the Pryor quadrangle, and in the northeastern part of the Muskogee. Considerable areas of terrace gravels are mapped by Taff to the east of Grand River in the Muskogee quadrangle. These gravels are on top of the hills at an elevation of more than 150 feet above the streams. The recent elevation of the area is thus greater toward the south.

STRATIGRAPHY.

GENERAL STATEMENT.

The greater part of the area is underlain by rocks of Mississippian age, of which the most important by far is the Boone formation. In the deeper valleys the streams have cut through the Boone formation into older Paleozoic rocks. The younger Chester formations outcrop as a narrow belt or fringe around the Boone area and appear in outliers capping the hills within the outer portion of the area. In the Tahlequah quadrangle narrow outcrops of the Chester formations between larger outcrops of the Boone are the result of faulting. The Pennsylvanian formations lie immediately above the Chester group and are the highest exposed in this portion of the State. Igneous rocks are confined to a small granite dike at the village of Spavinaw in the northeastern part of the Pryor quadrangle.

The stratigraphic column of the region covered by this report is as follows:

Table of correlations for northeastern Oklahoma.

	Formations.	*Approximate eastern equivalents*
Pennsylvanian system	*Winslow formation* in southern part of area,	
	Cherokee formation in northern part.	Lower Allegheny Upper Pottsville
	Morrow formation in southern part of area.	Lower Pottsville
Unconformity, slight in southern part of area, but representing very late Mississippian, all of Pottsville, and part of Allegheny time in northern part of area.		
Mississippian system	*Pitkin formation* in southern part of area. *Fayetteville formation* (with the Wedington sandstone member in the southeastern part of area). *Mayes formation.*	Chester
Unconformity representing most of Warsaw and all of Salem, St. Louis and Ste. Genevieve time.		
	Boone formation (with the St. Joe limestone member at the base).	Lower Warsaw Keokuk Burlington Kinderhook, in part.

Unconformity representing most or all of Kinderhook time.

Devonian (?) system	*Chattanooga shale* (with Sylamore sandstone member at base in south-eastern part of area).	Ohio shale

Unconformity representing late Silurian and nearly all of Devonian time in the southeastern part of area.

Silurian system	*St. Clair marble* in the southeastern part of area.	Part of Niagaran.

Unconformity representing late Ordovician and early Silurian time.

Ordovician system	*Tyner formation.*	Trenton-Lorraine
	Burgen sandstone.	St. Peter

In the discussion of the stratigraphy, each formation is considered separately beginning at the base of the section.

ORDOVICIAN SYSTEM.

BURGEN SANDSTONE.

The Burgen sandstone outcrops only in the valley of Illinois River in the northern part of the Tahlequah and southern part of the Siloam Springs quadrangle. It is massive, white to brown, fine to medium grained sand, poorly cemented. It is brought to the surface by an anticline along Illinois River northeast of Tahlequah, where it forms bluffs about 100 feet in height. Folding carries the formation down to the north, and it passes beneath the surface just north of the line between the Tahlequah and Siloam Springs quadrangles, but soon rises again and outcrops along the river from a point a little north of east of Moodys to the vicinity of the pronounced bend of the river north of Whitmire, where it again dips below the surface. In the vicinity of Whitmire the top of the Burgen reaches an elevation of between 50 and 75 feet above Illinois River.

The Burgen sandstone has an exposed thickness of about 100 feet with the base not shown. It has no determinable fossils, but on account of its stratigraphic position is correlated by Taff with the Saccharoidal sandstone lying above the Yellville formation in north Arkansas. The Saccharoidal sandstone is generally correlated with the St. Peter sandstone of the Mississippi valley.

The extent of the Burgen to the north, west, and south beneath the younger formations can not be stated definitely. Ordovician rocks reappear on Spavinaw Creek in the northeastern part of the Pryor quadrangle. From some small exposures of greenish shale,

the Tyner formation, which immediately overlies the Burgen on Illinois River, is believed to be present in this locality, but the rocks beneath are siliceous limestones or dolomites, and there is no such massive sandstone as the Burgen. While there is no doubt that the Ordovician limestones and dolomites and the related sandstones extend far to the west and southwest, it can not be said that the Burgen itself extends very far from its outcrop. The name Burgen was given by Taff and is taken from the name of a hollow northeast of Tahlequah.

TYNER FORMATION.

The Tyner formation succeeds the Burgen with apparent conformity. It outcrops along Illinois River in the same region as the Burgen sandstone outcrop previously described, and to the east and southeast; also in Baumgartner Hollow and in the valley of Barren Fork to the east and southeast. No special investigation of the Tyner was made in the preparation of this report, so Taff's description of the formation in the Tahlequah quadrangle is given in full.

Greenish or bluish shale, brown sandstone, calcareous, cherty sandstone, and limestone, abundant in the order named, constitute the Tyner formation. For 75 to 80 feet above the base the formation consists of greenish and relatively soft fissile clay shale with a few beds of brown and yellow, fine-grained sandstone. These interbedded sandstones are usually less than 3 feet in thickness. At the top of the shale there is generally a bed consisting of sandstone in the lower part with calcareous sandstone or siliceous cherty limestone above. This bed is lithologically variable along its outcrop, a sandstone occurring in places above the cherty layer. It varies in thickness also below an extreme of 8 feet 10 inches, and is believed to be absent in places. A bluish limestone succeeds the cherty layers and continues to the base of the Devonian black shale, its thickness ranging from a thin layer to massive beds aggregating 20 feet. These descriptions apply to the district of the Illinois Valley northeast of Tahlequah. In this district fossils have been found in the cherty limetsone and associated calcareous sandstone. Some fossils of common occurrence in these beds are listed below. The determinations of fossils and the discussions of age, classification, and correlations of the formations based upon them are by Dr. E. O. Ulrich.

Camarocladia rugosa Ulrich.
Orthis tricenaria Conrad.
Liospira americana Billings.
Lophospira sp. of the type of perangulata.
Hormotoma gracilis var.
Leperditia, near L. fabulites Conrad.
Leperditia n. sp. (about 5 mm. in length).
Ceraurus pleurexanthemus Greene.

This association of species indicates lower Trenton or Black River age.

In Baumgartner Hollow and along the banks of the Barren Fork Valley only the upper part of the formation is exposed and its thickness does not exceed 20 feet. In these exposures the upper part of the formation consists of, interbedded brown sandstone, calcareous sandstone, and bluish or greenish shale. The thin sandstone and shale exposed on Barren Fork and Tyner Creek and probably in Baumgartner Hollow are believed, both from the character of the rocks and from the fossils, to be stratigraphically above the limestones at the top of the formation on Illinois River. Some fossils collected from thin, sandy beds in this locality are listed below.

Psiloconcha inornata Ulrich.
Psiloconcha sinuata Ulrich.
Psiloconcha cf. subovalis Ulrich.
Rhytimya sp. undet.
Whiteavesia sp. undet.

These fossils appear to be of Lorraine age, and therefore are considerably higher in the Ordovician than the fauna from the limestone.

The variability in the thickness and the absence of the upper beds of the formation in places are due to erosion preceding the deposition of the overlying Chattanooga shales.

The Tyner formation occurs in but three places in the Tahlequah quadrangle, and these are near the northern border, in the Illinois and Barren Fork valleys and in Baumgartner Hollow. This is the first description of the formation, and its name is that of a small creek along which it is exposed near the northern border of the quadrangle.

In the outcrop of Ordovician at Spavinaw, a small exposure of green shale was noted which indicates the presence of the Tyner formation. No exposures of the base or top of the formation were noticed in this locality, and the thickness can not be stated. In the log of a well near Vinita "green copper ore" is reported below the "black slate" (Chattanooga) so it would seem that the Tyner maintains its identity at least to that distance beneath the younger rocks.

SILURIAN SYSTEM.

ST. CLAIR MARBLE.

This formation is present at the surface only in the southeast part of the Tahlequah quadrangle. To the north it is absent, either through non-deposition or by erosion, and the Chattanooga shale rests directly on the Tyner formation.

Taff's description of the St. Clair is as follows:

This rock is a pinkish white and, in most parts, coarsely crystalline

marble. Only the upper part is exposed and the beds are thick and massive. The marble is even textured, but in parts it contains small, irregular cavities about which the rock is more coarsely crystalline. This characteristic renders the rock locally weak and, in such parts, unfit for the finer uses to which marbles are adapted.

The St. Clair marble is found in the bottom and lower slopes of several small valleys in the south-central part of the quadrangle. The streams in these valleys have worn down through the overlying strata into the marble, but have not cut through it. As it occurs in the bottoms of the valleys, subject to the direct wear of the streams, fresh exposures are common. At four of the localities the marble is cut off by faults and the part on the southeast side is thrown down to a depth of more than 100 feet below the surface. The exposures showing the thickest beds of the marble are in the large area opposite the station of Marble on the Kansas City Southern Railroad. Here a small tributary of Sallisaw Creek has cut a deep gorge, exposing about 100 feet of the marble, and prospect drills have penetrated nearly an additional 100 feet without reaching the base of the formation. The outcrop extends from this gorge northeastward a distance of 3 miles along the fault bordering Sallisaw Creek Valley. A small area is exposed in Illinois River a few feet above low water opposite Cookson. Here the rock is light gray or nearly white and the beds are thinner than elsewhere.

The St. Clair marble has yielded a considerable number of fossils from the upper part of the formation. The fossils indicate that the formation is of Niagara age and that its upper part at least is equivalent to the St. Clair limestone of northern Arkansas, with which the marble is correlated. It is correlated also by Dr. E. O. Ulrich, who has studied the formation and determined its fossils, with the Lockport limestone of New York and the Osgood limestone of Indiana.

The following list of fossils occurring in the upper part of the marble indicates the Niagara age of the rocks:

Caryocrinites sp. nov.
Callicrinus corrugatus Weller.
Pisocrinus gemmiformis Miller.
Stephanocrinus osgoodensis Miller.
Dalmanella elegantula (Dalman).
Plectambonites cf. transversalis (Wahlenberg).
Strophonella striata Hall.
Atrypa nodostriata Hall.
Cypricardinia arata Hall.
Orthoceras cf. medullare Hall.
Gyroceras? elrodi White.

DEVONIAN (?) SYSTEM.

CHATTANOOGA SHALE.

The Chattanooga shale is tentatively regarded as belonging to the Devonian system.* The formation consists of hard, fissile, carbonaceous and bituminous, black shale. Locally there is a sandstone member at the base known as the Sylamore sandstone.

The Chattanooga is exposed in several of the deeper stream valleys of the region in the Tahlequah, Siloam Springs, Pryor and Vinita quadrangles. It is limited both above and below by unconformities so that the thickness is variable. The formation is massive in fresh exposures, but on weathering breaks into approximately rectangular blocks, due to cross joints which are 2 to 3 feet apart in each direction.

The principal outcrops of the Chattanooga are shown on the geologic map (Pl. I). All the areas mapped as pre-Mississippian contain Chattanooga shale and except for the narrow belts of Ordovician rocks and of St. Clair marble previously described, all the areas so mapped are Chattanooga.

As has been said, the thickness of the Chattanooga is variable. In the Tahlequah quadrangle Taff reports the thickness in the Illinois and Barren Fork valleys at approximately 40 feet, and in the vicinity of Marble at 20 feet for the black shale, and 20 to 30 feet for the Sylamore sandstone. Northwest of Bunch, both the black shale and the Sylamore sandstone are absent, and the Boone formation rests on the St. Clair marble.

Along Illinois River, about two miles north of the south line of the Siloam Springs quadrangle, the black shale is 60 feet thick, and between 30 and 40 feet, disregarding the Sylamore sandstone, at the confluence of Flint Creek and Illinois River. In the Pryor quadrangle, the shale shows a thickness of almost 100 feet at Spavinaw, and of more than 40 feet with the base not exposed in the valley of Clear Creek near the south line of the quadrangle. In the Vinita quadrangle, in a bluff of Cabin Creek, about 40 feet is shown with the base not exposed. In the Wyandotte quadrangle Siebenthal* reports that: "In the east bluff of Neosho [Grand] River, 3 miles above the mouth of Cowskin River, the thickness is 26 feet; on Buffalo Creek it is 20 feet, at Southwest City, 50 feet, and at the mouth of Honey Creek 83 feet."

*Recent work by Ulrich in southeastern Missouri seems to show that a black shale, thought to be equivalent to the Chattanooga, lies above the Glen Park, the basal formation of the Mississippian, and that the Glen Park is equivalent to the Sylamore sandstone. These conclusions were presented in a paper read at the 1914 meeting of the Geological Society of America. In the absence of definite correlations, however, it seems best to treat the Chattanooga of Oklahoma as belonging to the Devonian.

The Sylamore sandstone member is present locally at the base of the Chattanooga shale, in the eastern part of the Tahlequah and southeastern part of the Siloam Springs quadrangle. In the Tahlequah quadrangle it is exposed in the vicinity of Marble and on the east side of Illinois River near the north boundary of the quadrangle. It is described by Taff as a ferruginous sandstone, sometimes appearing conglomeratic due to lumps of material harder than the body of the rock, and also to nodules of clayey material probably derived from the underlying Tyner formation. In the vicinity of Marble the member reaches a thickness of 30 feet.

In the bluff on the west side of Illinois River, about 2 miles north of the line between the Tahlequah and Siloam Springs quadrangles, a thickness of 5 feet of the Sylamore sandstone is shown immediately below the black shale. The slope below the exposed sandstone is covered for 16 feet and below that are 4 feet of shaly sandstone. If this belongs to the Sylamore, the total thickness is 25 feet. To the north the sandstone dips beneath the river and does not appear at the mouth of Flint Creek. It rises again to the north along that creek and shows a thickness of 15 to 20 feet, with the base not exposed, a short distance south of Flint Post-Office, from which place it again dips below the surface to the north.

In the western exposures of the base of the Chattanooga, at Spavinaw and along Spring Creek in the Pryor quadrangle, the Sylamore sandstone is absent.

MISSISSIPPIAN SYSTEM.

GENERAL STATEMENT.

Formations of the Mississippian system occupy by far the greater portion of the area under consideration and nearly all of the work in preparation for this report was in connection with them. From the base up the formations represented are (1) the Boone formation,** including shales and shaly limestone of Kinderhook age in the

*Siebenthal, C. E., Bull. U. S. Geol. Survey, No. 340, 1907, p. 189.

**The use of the term "formation" in connection with these rocks is questionable since a variety of rocks representing several epochs is included. However, the rocks have been mapped and described as the Boone formation in the Tahlequah and Muskogee quadrangles, and it is thought best to follow the United States Geological Survey in the matter.

southeastern part of the area, and a considerable thickness of limestone and chert of Burlington, Keokuk, and lower Warsaw age; (2) the Mayes formation separated from the Boone by a great unconformity; (3) the Fayetteville formation (with the Wedington sandstone member near the middle of the formation in the southeastern part of the area); and (4) the Pitkin limestone around the southern and southwestern part of the area. The Mayes, Fayetteville, and Pitkin formations make up the Chester group. Each of these formations is discussed in turn, commencing with the Boone formation.

BOONE FORMATION.

General Statement.

The Boone is much the thickest of the Mississippian formations and, on account of its thickness and its resistant nature, the outcrop covers three-fourths or more of the area covered in this report. As a whole the Boone formation consists of chert and limestone with limestone predominating near the base over most of the region. The formation gives rise to a rough topography, with narrow steep-sided valleys and canyons separated by relatively broad, flat-topped hills and ridges.

Area of Outcrop.

The outcrop of the Boone formation in Oklahoma includes practically all of Delaware and Adair counties, the eastern and southern portions of Ottawa, the extreme southeastern part of Craig, the eastern half of Mayes, and all except the southwestern fourth of Cherokee County. In terms of quadrangles the outcrop includes all of the Siloam Springs quadrangle except for small areas of older rocks in the deeper valleys, the southeastern two-thirds of the Wyandotte, a small area in the southeastern part of the Vinita, the eastern half of the Pryor, considerable areas in the northeastern fourth of the Muskogee, and the most of the northern half of the Tahlequah quadrangle.

Stratigraphy.

Kinderhook beds.—At the base of the Boone formation in the northern part of the Tahlequah and southern part of the Siloam Springs quadrangles, along Illinois River, there are locally shales and shaly limestones which belong to the Kinderhook group. In sec. 36, T. 18 N., R. 22 E., these beds, according to Taff, consist of dull blue and earthy fossiliferous limestone in the lower part, followed above by thicker and harder limestone beds, the thickness of the whole being 6 feet. A few miles to the north of this locality the Kinderhook beds are well exposed in the west bluff of Illinois

River, known locally as Eagle Bluff. There the beds consist of dark gray and green shales with thin lenses and nodules of limestone. The thickness of the beds differs greatly in short distances along the bluff, the variations observed being from 5 or 6 to 40 feet or possibly a little more. To the north and northwest the Kinderhook beds probably are absent. They may, however, be represented by a bed of green clay shale, about 1 foot thick, which lies between the Chattanooga shale and the thick limestones forming the lower part of the Boone formation in the Spavinaw region in the Pryor quadrangle and along Cabin Creek in the southeastern part of the Vinita quadrangle. This thin shale layer has yielded no fossils but has the stratigraphic position of the Kinderhook shale along Illinois River and a marked lithologic resemblance to it.

The great variation in the thickness of the Kinderhook beds along Eagle Bluff is due to their lying on the uneven surface of the Chattanooga shale and also to their being separated from the overlying limestones of the Boone by an unconformity. In one locality along Eagle Bluff the limestone was observed dipping to the north and truncating a thickness of 13 feet of level-lying Kinderhook beds in a distance of 75 yards.

In a preliminary paper* the writer correlated these beds with the Fern Glen formation of southeastern Missouri. Further study of the fossils shows that the correlation is rather with the Chouteau limestone of southwestern and central Missouri, a somewhat lower horizon. The study of the fauna has not been completed but the following species may be listed with certainty:

Amplexus brevis Weller.
Cyathaxonia arcuata Weller.
C. minor Weller.
Cladoconus sp.
Cystodictya lineata Ulrich.
Schizophoria sedaliensis Weller.
Chonetes logani N. & P.
Productella concentrica Hall.
Productus fernglenensis Weller.
P. blairi Miller.
P. sampsoni Weller.
Rhynchopora rowleyi Weller.
Spirifer latior Swallow.
Brachythyris peculiaris Shumard.
Spiriferina subelliptica McChesney.
Cliothyridina proutii Swallow.
Athyris lamellosa L'Eveille.

*Jour. Geol., vol. 22, No. 6, 1914, pp. 616-617.

In addition there is a large undescribed *Productus* known to occur also in the Chouteau limestone of Missouri; a large *Spirifer* of the shape of *S. grimesi* Hall but belonging to the group to which *S. vernonensis* Swallow and *S. shephardi* Weller belong; a *Brachythyris* near *B. chouteauensis* Weller; as well as several other species including corals, crinoids, bryozoans, gastropods, and a trilobite. It is hoped to include a detailed study of this fauna in a subsequent paper on the fauna of the Boone formation.

St. Joe limestone member.—At the base of the Boone formation in most of the localities where it is exposed, is a considerable thickness of limestone nearly free from chert, which is correlated with the St. Joe limestone member of the Boone formation of Arkansas. In the Tahlequah quadrangle the limestone is absent locally, and the chert member rests on the Chattanooga shale. Taff describes the outcrops of the St. Joe limestone in the Tahlequah quadrangle as follows:

The base of the Boone formation is exposed in twelve localities, and in four of these limestone was found beneath the chert. Of the known occurrences of limestone beneath the chert two were found bordering the small areas of the Chattanooga shale in Barren Fork Valley south of Westville. In the smaller area in the west side of sec. 34, T. 17 N., R. 26 E., the limestone is about 5 feet thick. At the other locality, 3 miles down the stream, it is 10 to 15 feet thick. At these places it consists of fine-textured and dense, white to pinkish, even-bedded limestone. Light-colored crinoidal limestone beds 10 to 15 feet thick occur at the base of the Boone formation in the south bank of Barren Fork at the road crossing in the NW. 1-4 sec. 13, T. 17 N., R. 23 E. No fossils were collected from this limestone at the three localities named, but its position in the formation and its lithologic character strongly indicate that it should be correlated with the basal St. Joe member of the Boone formation exposed in the northern part of the Fayetteville quadrangle and farther east in northern Arkansas.

The fourth locality referred to by Taff in the above paragraph is the outcrop of the Kinderhook beds which has been described under that heading.

The St. Joe limestone is not exposed in the Muskogee quadrangle, but is reported as 20 feet of light gray limestone at the base of the Boone formation in the log of a well at Ft. Gibson.

As noted by Taff the St. Joe member does not exceed 15 feet in thickness in the Tahlequah quadrangle, and is absent locally. To the north and west it is present wherever its horizon is exposed, and reaches a much greater thickness. Along Illinois River in the Siloam Springs quadrangle, the St. Joe member is about 30 feet thick and consists of thick-bedded crinoidal limestone. Farther to the northwest, the limestone becomes thicker and the lower part is of dense, thin-bedded or flaggy and nodular limestone without fossils. In the northwesternmost exposure, along Cabin Creek in the Vinita quadrangle, the limestone is almost 100 feet thick, of which half or more is of the dense non-crinoidal limestone.

The St. Joe limestone contains a Burlington fauna, but only rarely are the fossils at all abundant or well-preserved. From collections along the west side of Illinois River in the south part of the Siloam Springs quadrangle several species have been identified which show the limestone to be of lower Burlington age. The study of these faunas is not completed.

Chert member.—The great part of the Boone formation consists of interstratified chert and limestone, which may be called the chert member. In fresh exposures the limestone is seen to be fairly plentiful, sometimes forming half or even more of the member. In most of these cases the limestone and chert are in alternating beds about a foot thick, but in some places the chert is present as lenses and nodules in the limestone. Good exposures are uncommon, and the greater part of the outcrop is covered to a depth of several feet with soil containing chert, or with loose, angular chert fragments from which the limestone has disappeared.

The cherts in the lower part of the member are very dense and almost pure white in color. As a rule, those in the upper part are more porous and of a yellow or brownish color. It is, however, impossible to separate the member into mapable units in view of the small number of good exposures.

The lower cherts contain few fossils, but enough to show that they are of Burlington age. The more porous cherts in the upper part are quite fossiliferous locally and contain a lower Warsaw fauna. Taff lists the following species from this portion of the formation in the Tahlequah and Muskogee quadrangles:

Amplexus fragilis White and St. John.
Glyptopora keyserlingi Prout.
Fenestella multispinosa Ulrich.
Polypora maccoyana Ulrich.
Hemitrypa proutana Ulrich.
Pinnatopora striata Ulrich.
Spirifer logani Hall.
Reticularia pseudolineata Hall.
Productus setigerus Hall [P. wortheni?]
Orthotetes keokuk Hall.
Capulus equilaterus Hall.

Collections were made from these cherts near Stilwell in the

Tahlequah quadrangle, and near Miami in the Wyandotte quadrangle. These collections have not been studied carefully, but the fauna is undoubtedly of early Warsaw age.

The total thickness of the Boone formation in Oklahoma varies considerably. Outcrops of the bottom and top are as a rule separated by considerable distances, and estimates of the thickness are at best approximations. The range in thickness is probably from about 100 feet in the southern part of the area, to about 350 feet farther north.

POST-BOONE UNCONFORMITY.

As shown in the discussion of the Boone formation, the upper part of that formation is early Warsaw in age. No fossils indicating an age younger than early Warsaw have so far been found in the Boone in Oklahoma, and the only place where it seems that younger beds may be present in the formation is in the extreme northeastern corner of the area, where Siebenthal* reports the Short Creek oolite in the northeastern part of the Wyandotte quadrangle. It is reported** that fossils indicative of late Warsaw age have been found above this bed of oolite in Missouri, but so far as the field work for this report shows, the statement may be made that the uppermost beds of the Boone in Oklahoma are lower Warsaw.

The beds lying immediately above the Boone formation are limestones and shales of Chester age. There is consequently an unconformity representing most of Warsaw and all of Salem, St. Louis, and Ste. Genevieve time.

In the southern part of the area this unconformity is not noticeable stratigraphically. In fact, the basal Chester limestones were mapped by Taff in the Tahlequah quadrangle as belonging to the Boone. In the Muskogee quadrangle the difference in the age of the faunas was noted, and the limestone was mapped with the Fayetteville formation, although the relations of the limestone and the Boone were apparently conformable.

To the north, however, the unconformity becomes conspicuous, and the upper surface of the Boone exhibits its irregularity even in short exposures of the contact. In the vicinity of Pryor, Mayes County, pronounced hills of Boone chert rise through the overlying Chester formations, and form many inliers. Some of the larger of these inliers are shown on the accompanying geologic map (Pl. 1). The westernmost of these is the hill about one-half mile east of the town of Pryor, on which the stand-pipe is erected. The top of this hill is nearly level with the base of the Pennsylvanian rocks a fraction of a mile distant. An excavation in the side of the hill shows the chert to be well-bedded and undoubtedly in place. There is no indication whatever of the Chester formations ever having passed over these hills of Boone chert, but on the other hand, so far as can be seen they lie against the chert in a nearly horizontal position.

*Bull. U. S. Geol. Survey, No. 340.

**Personal communication from H. A. Buehler.

Farther north, in the extreme northern part of the Pryor and in the Vinita and Wyandotte quadrangles, the unconformity is again less pronounced, and the inliers of Boone are absent.

Basal conglomerate was noticed in the overlying formation in a few localities which are described in connection with the discussion of the Mayes formation.

CHESTER GROUP.

GENERAL STATEMENT.

The Chester group outcrops in a belt somewhat interrupted by folding and faulting, around the margin of the Boone chert outcrop, and as outliers surrounded by the chert. The outcrop of the whole group is narrow over most of its area, seldom reaching more than a mile in width, and as a general rule forming only a narrow belt on the slopes of the hills between the Boone chert at their bases and the Pennsylvanian rocks at their summits. In the central part of the Pryor quadrangle and northeastward through the Vinita and Wyandotte quadrangles the outcrop reaches a width of 6 or 8 miles, on account of the low dip of the rocks and the level topography. The narrow outcrops along the southern and southeastern margins of the area are wooded, while the broad outcrop on the western and northwestern margins is a nearly flat prairie.

The principal problem in connection with the preparation of this report has been the determination of the stratigraphy of the Chester and this subject is treated more fully than the others considered in the report. This is especially true of the Mayes formation which is here recognized as a distinct formation for the first time.

MAYES FORMATION.

Definition.—The name Mayes formation is here proposed for the basal formation of the Chester group. Its base is the unconformity separating the Chester from the Boone formation, and is limited above by the thick bed of black shale of the Fayetteville formation. In the Tahlequah quadrangle it includes the limestones mapped by Taff as the upper part of the Boone formation, but discussed as the lower limestone bed of the Fayetteville, and in the Muskogee quadrangle, the equivalent beds mapped with the Fayetteville and discussed as the lower limestone bed of that formation. The name is from Mayes County where the formation attains its maximum thickness and areal extent, and where its various phases are best shown.

Character and thickness.—In the Tahlequah and Muskogee quadrangles the Mayes consists principally of dark gray to black limestone, locally argillaceous, which weathers to a drab or light gray color. The limestone beds are separated by thin bands of black shale and there is in most places a bed of shale up to 4 or 5 feet in thickness at the base. Much of the limestone is dense and non-fossiliferous, but some of the beds contain great numbers of well-preserved fossils.

The thickness shows considerable variation in this region. About a mile south of Tahlequah the formation is over 20 feet thick. The upper part consists of thick-bedded, black fossiliferous limestone (collection M 1). In the exposure southeast of Hulbert in the Muskogee quadrangle (NE. 1-4 sec. 25, T. 17 N., R. 20 E.) the limestone of the Mayes is not over 5 or 6 feet thick, but there may be 3 or 4 feet of shale separating it from the Boone chert. The limestone here is lighter colored than common and is extremely fossiliferous (collection M 2). Along Bayou Manard southeast of Ft. Gibson, the Mayes shows a thickness of 9 feet with the bottom of the basal shale not shown. Here also the limestones are filled with excellently preserved fossils (collections M 4 and M 5). In the south side of Fourteen-mile Creek north of Hulbert (sec. 2, T. 17 N., R. 20 E.) the Mayes consists of four beds of limestone averaging about 1 foot in thickness, separated by black slaty shales. The total thickness is between 15 and 20 feet. Two of the limestone beds are quite fossiliferous (collection M 3). Similar conditions and thicknesses are shown at the foot of the large hill in the north part of sec. 18 of the same township.

In the Pryor quadrangle the Mayes formation changes greatly in character and thickness as followed from south to north. For a distance of 8 or 10 miles the formation maintains the character which it exhibits to the south except that it is more predominantly limestone, the beds reaching a thickness of 3 to 4 feet, while the shales between the limestone layers become insignificant. The thickness increases somewhat but does not exceed 30 or 40 feet in T. 18 N., R. 19 E. A good exposure is found in a small quarry about 2 miles northeast of Yonkers (collection M 6).

In the lower part of the large hill in secs. 15 and 16, T. 19 N., R. 19 E., the Mayes formation shows a thickness of about 50 feet. The upper part is light-colored and, in part, thin-bedded (collection M 9). About 2 miles farther northwest in the bluff on the

west side of Grand River, in sec. 8 of the same township, the whole formation is exposed and gives the following section:

		Thickness feet.
	Fayetteville shale,—	
7.	Blue to black—weathering to a very light gray—dense, non-fossiliferous limestone with conchoidal fracture, in beds about 1 foot thick, separated by bands of black shale up to 6 feet thick	15
6.	Thick-bedded, pinkish, very hard crinoidal limestone, very fossiliferous (collection M 8c)	25
5.	Covered, probably shale	15
4.	Light yellow, fine-grained, thick-bedded limestone	17
3.	Gray siliceous limestone, breaking into thin plates with irregular surfaces, fossiliferous (collection M 8b)	5
2.	Black, slaty calcareous shale or shaly and sandy limestone, fossiliferous (collection M 8a)	15
1.	Grayish, dense, badly fractured limestone, non-fossiliferous	4
	Total	96

In this section Nos. 1, 2, and 3 are believed to represent the Mayes to the south, while the higher beds are believed to have come in at the expense of the Fayetteville shale. It is a question whether No. 7 should be placed with the Mayes or Fayetteville, the decision depending on whether all the limestone should be included with the Mayes or all the shale with the Fayetteville.

Similar sections are shown on the east side of Grand River in the vicinity of Locust Grove, but the exposures are not clear enough to permit of accurate measurements of the individual beds. The upper beds of the formation are exposed in cuts of the Missouri, Oklahoma, and Gulf Railroad about 3 miles southwest of Locust Grove. The limestones are black when fresh, and largely crystalline and crinoidal. The beds are 2 to 3 feet thick and are separated by bands of shale a few inches thick, which are quite fossiliferous (collection M 7). The Mayes formation maintains a thickness of approximately 100 feet for a distance of 10 or 12 miles to the north of the locality just described. To the east and southeast of the town of Pryor its outcrop covers many square miles in T. 21 N., Ranges 19 and 20 E. The region is a level prairie and the line between the Mayes and the overlying Fayetteville is difficult to trace. As a rule the Mayes lies very near the surface, being covered by at most 2 to 3 feet of soil and appearing at the surface over areas several acres in extent. It is in this vicinity that the unconformity between the Boone and the Mayes is best developed, and there are many inliers of Boone in the Mayes area.

North of the latitude of Pryor the Mayes formation thins by the disappearance of the lower beds and in the northern part of the Pryor quadrangle is but 30 to 40 feet thick. A good section is exposed in a small tributary of Cabin Creek in the west-central part of sec. 23, T. 23 N., R. 20 E. The formation is here about 40 feet thick, and may be divided into four approximately equal divisions: (1) the lowest 10 feet is a conglomerate with a matrix of dense, siliceous, light to dark blue limestone, with irregular chert fragments up to a foot in diameter, in the lowest layers. These pebbles or fragments decrease in number and size in successively higher layers, and the conglomerate grades into (2), light gray, siliceous, platy limestone with fossils (collection M 13); (3) is a soft, yellow, fine-grained sandstone, which is succeeded by (4) dense, blue, non-fossiliferous limestone in beds 8 to 10 inches thick. A very similar section is shown on Rock Creek. The platy siliceous limestone is shown in the creek at the road crossing on the line between secs. 32 and 33, T. 23 N., R. 20 E., and the conglomerate down the stream a few rods. The platy siliceous limestone is quite fossiliferous (collection M 12) with a fauna principally of pelecypods of which *Schizodus depressus* is the most abundant species.

The topmost beds of the Mayes farther up Rock Creek are thin, platy limestones, which are quite fossiliferous. Except for their platy nature these beds resemble very strikingly those at the top of the formation in the section in the bluff of Grand River southeast of Chouteau. The same fossils are present, with *Orthotetes kaskaskiensis* and fenestellid bryozoans abundant in both localities. An excellent exposure of these beds is in the SE. 1-4 sec. 23, T. 23 N., R. 19 E., in a small tributary of Rock Creek.

In the Vinita quadrangle the Mayes formation outcrops along Cabin and Little Cabin creeks, and some of their tributaries in the vicinity of Vinita, and in a belt along the north side of the Boone outcrop in the north part of T. 24 N., R. 21 E. The formation seems to have the same character as in the adjacent portion of the Pryor quadrangle. The sandstone bed was not observed, but careful search was not made for it. The upper beds are well exposed in Little Cabin Creek straight east from Vinita, where they are very fossiliferous (collection M 16).

In the Wyandotte quadrangle the Mayes formation is well shown in the syncline south of the Horse Creek anticline. Southwest of Bernice the Mayes is not over 20 feet thick, but along Grand River northwest of Bernice in secs. 13 and 14, T. 25 N., R. 23 E., it is about 50 feet thick. The lower 30 feet is of fairly thick-bedded limestone, in part crinoidal, with fossils of which *Productus coloradoensis* and *Spirifer arkansanus* are especially abundant (collection M 20). Above this limestone are about 6 feet of fine-grained yellowish sandstone, and above this 10 feet or a little more of extremely fossiliferous limestone (collection M 19).

On the north side of the Horse Creek anticline, between Afton and Fairland, the Mayes formation is very thin or is covered. The same is true from Ogeechee north along the west side of Neosho River almost to Miami. In the banks of the river near Miami the Mayes shows a thickness of 25 to 40 feet with a development similar to that in the northern part of the Pryor quadrangle,—siliceous limestone with chert fragments at the base, succeeded by a fine-grained sandstone and this by more limestone.

Southeast of Miami on the west slope of the hill at the northeast corner of sec. 3, T. 27 N., R. 23 E., the Mayes consists of about 60 feet of limestone capped by a bed of coarse sandstone. The limestone is partly siliceous and platy but the greater part is a coquina-like mass of comminuted fossils (collection M 21). This limestone is very porous and its removal locally by solution may account in part for the apparent thinness of the Mayes in part of this region. However, in many localities the distance between the Boone formation and the Pennsylvanian (?) sandstone is too small to permit the presence of so great a thickness of limestone.

The Mayes is shown in several outcrops in the vicinity of Lincolnville, but in most places is not more than 10 or 12 feet thick. North of Lincolnville, the Pennsylvanian is apparently in contact with the Boone formation and the Mayes formation was not observed.

Fauna and correlation.—The complete faunal list of the Mayes formation is given below.

In this list, as in those for the Fayetteville and Pitkin formations following, the number of collections in which the species occurs is denoted by the figure in parenthesis after the name of the species. The species denoted by an asterisk occur only in the one formation.

List of fossils from the Mayes formation (23 collections):

Corals.

Zaphrentis spinulosa E. & H. (4)
*Pachypora oklahomensis n. sp. (1)
Michelinia meekana Girty (1)

Blastoids.

Pentremites sp. (1)

Crinoids.

*Agassizocrinus sp. (3)

Crinoidea sp. (3)

Bryozoans (not complete).

Archimedes proutanus Ulrich (2)
*Archimedes confertus Ulrich (3)

Brachiopods.

*Lingula batesvillae Girty (3)
*Lingulidiscina newberryi var. moorefieldana Girty (4)
*Lingulidiscina newberryi var. ovata Girty (1)
*Rhipidomella arkansana Girty (2)
Orthotetes kaskaskiensis McChesney (12)
Chonetes oklahomensis n. sp. (3)
*Chonetes cherokeensis n. sp. (4)
*Chonetes sericeus Girty? (2)
*Productella hirsutiformis Walcott (1)
*Productella hirsutiformis var. batesvillensis Girty (1)
Productus inflatus McChesney (1)
Productus ovatus Hall (17).
*Productus ovatus var. latior n. var. (4)
*Productus coloradoensis Girty (4)
Productus arkansanus var. multiliratus Girty (1)
*Pustula moorefieldana Girty (1)
Pustula alternata N. & P. (2)
*Pustula subsulcata Girty (5)
*Pustula biseriata Hall? (1)
*Avonia oklahomensis n. sp. (1)
Diaphragmus elegans N. & P. (13)
Marginifera adairensis Drake (4)
Camarotoechia purduei Girty (9)
*Liorhynchus carboniferum Girty (8)
*Liorhynchus carboniferum var. polypleurum Girty (1)
*Moorefieldella eurekensis Walcott (6)
Dielasma shumardana Miller (8)
Dielasma compressa n. sp. (1)
Girtyella indianensis Girty (7)
Spirifer pellaensis Weller (2)
Spirifer leidyi N. & P. (8)
*Spirifer arkansanus Girty (3)
Brachythyris ozarkensis n. sp. (1)
Reticularia setigera Hall (10)
*Ambocoelia levicula Rowley? (2)
*Martinia glabra Martin? (2)
Spiriferina transversa McChesney (2)
Spiriferina spinosa N. & P. (2)
Eumetria verneuilana Hall (1)
Eumetria vera Hall (1)

Eumetria costata Hall (10)
Athyris cestriensis n. sp. (2)
Composita trinuclea Hall? (7)
Composita sp. (6)
*Composita cf. lewisensis Weller (1)
*Composita rotunda n. sp. (2)

Pelecypods.

*Solenomya sp. (1)
*Solenopsis nitida Girty? (2)
Sphenotus cherokeense n. sp. (2)
*Spenotus oklahomense n. sp. (4)
Edmondia crassa Girty (2)
Edmondia crassa var. suborbiculata Girty (1)
Leda vaseyana McChesney (4)
*Cypricardinia moorefieldana Girty (3)
*Parallelodon multiratus Girty (1)
*Pinna consimilis Walcott (1)
*Pinna arkansana Weller ? (1)
Caneyella vaughani Girty ? (1)
Myalina compressa n. sp. (3)
Schizodus depressus Worthen (2)
Schizodus insignis Drake ? (1)
*Deltopecten batesvillensis Weller (6)
*Deltopecten tahlequahensis n. sp. (1)
Aviculopecten eurekensis Walcott (1)
*Aviculopecten mayesensis n. sp. (4)
*Aviculopecten ozarkensis n. sp. (1)
*Aviculopecten sp. 1 (1)
*Aviculopecten sp. 2 (1)
*Streblopteria similis Walcott (4)
Allorisma walkeri Weller (2)

Gastropods.

Bellerophon sp. (5)
*Pleurotomaria sp. 1 (2)
*Pleurotomaria sp. 2 (1)
*Pleurotomaria sp. 3 (2)
*Murchisonia? sp. (1)
*Bembexia nodomarginata McChesney (2)
*Bulimorpha canaliculata Hall? (1)
*Straparollus spergenensis Hall? (1)
Straparollus planidorsatus M. & W. (1)
Sphaerodoma subcorpulenta Whitfield (1)
*Orthonychia mayesense n. sp. (3)
Platyceras subrotundum n. sp. (1)

Cephalopods.

*Orthoceras eurekensis Walcott? (1)
*Glyphioceras kentuckiensis Miller (1)

Trilobites.

Griffithides pustulosus n. sp. (4)

The Mayes formation can be correlated definitely with the Moorefield shale and Batesville sandstone horizons of Arkansas. The Moorefield fauna, characterized by such species as *Productus coloradoensis*, *P. ovatus var. major*, *Camarotoechia purduei*, *Liorhynchus carboniferum*, *Moorefieldella eurekensis*, *Spirifer arkansanus*, *Cypricardinia moorefieldana*, *Deltopecten tahlequahensis*, etc., is developed in the southern part of the area in limestones usually black and bituminous, showing a strong lithologic resemblance to the Spring Creek limestone member of the Moorefield shale. With the exception of one locality northeast of Bernice (locality M 20), most of the typical Moorefield species named above were not collected from the Mayes north of the middle of the Pryor quadrangle.

The limestone beds to the north, especially the light-colored, siliceous, platy phase, show a fauna more nearly related to the Batesville fauna as described by Weller.* *Schizodus depressus*, *Allorisma walkeri* (occurring also in the Pitkin limestone) and other pelecypods with *Lingula batesvillae* and *Spirifer leidyi* are abundant in these beds.

From the association of the two faunas in the central part of the Pryor quadrangle, and especially in the excellent exposure in the bluffs of Grand River southeast of Chouteau, it is believed that the beds containing the Moorefield fauna die out to the north, while those with the fauna more nearly related to the Batesville come in and thicken in that direction. The relations are shown in the diagrammatic sections on Plate II.

In correlation with other regions, a striking resemblance is noted to the fauna of the Lower Carboniferous of the Great Basin region described by Walcott** from the Eureka district of Nevada. The identical species include *Moorefieldella eurekensis*, *Pinna consimilis*, *Streblopteria similis*, and *Aviculopecten eurekensis*, while several other species show close relationship, e. g., *Sphenotus quadriplicatum* n. sp. to *Sanguinolites salteri*, *Avonia oklahomensis* n. sp. is closely related to the species figured as *Productus lachrymosus* var. *limus* from the Devonian of the same region.

The Caney shale of southeastern Oklahoma contains several

*Weller, Stuart, Trans. N. Y. Acad. Sci., vol. 16, 1897.
**Walcott, C. D., Mon. U. S. Survey, vol. 8.

species of the Moorefield fauna and is almost certainly equivalent to the Mayes and perhaps to the higher Chester formations, the Fayetteville and Pitkin.

In the Mississippi valley the Moorefield and Batesville faunas have not been recognized and the interval is probably represented by one of the unconformities in the Chester section of southern Illinois and the adjacent portions of Missouri and Kentucky

FAYETTEVILLE FORMATION.

Definition.—The Fayetteville formation lies immediately above the Mayes formation in conformable relations, so far as can be observed, although the distribution of the Moorefield and Batesville faunas just referred to may indicate a slight unconformity in the south part of the area. The Fayetteville formation is limited above by different formations. In the southern part of the area the Pitkin limestone succeeds it conformably. To the north, on the west side of the area, the Pitkin limestone is absent and the Morrow formation rests on the Fayetteville. The Morrow in turn thins out and disappears and the Winslow (Cherokee) formation overlies the Fayetteville. (See fig. 3).

The formation consists typically of black shale with a limestone member near the top and, in the southeastern part of the area, with an important sandstone member near the middle. The limestones described by Taff as the lower limestone beds of the Fayetteville are considered here as belonging to the Mayes formation, and have been discussed in connection with that formation. The name is from Fayetteville, Ark., where the formation is typically developed.

Character and thickness.—In the Tahlequah quadrangle the Fayetteville as described by Taff consists of a lower shale member with limestone beds at the base, the Wedington sandstone member and an upper shale member. The limestone beds at the base of the lower shale member are considered here as the Mayes formation and have been described previously. The lower shale member, including the limestones, decreases in thickness from 110 feet in the northeastern part of the quadrangle to 20 feet in the southwestern. The *Wedington sandstone member* is about 40 feet thick in the northeastern corner of the quadrangle, but thins rapidly to the west and south and disappears before the western boundary of the quadrangle is reached. It consists for the most part of thin-bedded brown sandstone grading into the shale above and below, but is massive locally. The upper shale member is about 30 feet thick and in most places contains a thin limestone member 10 to 15 feet below the top. In the western part of the quadrangle the two members come together by the pinching out of the Wedington sandstone member, and the whole formation consists of black fissile clay shale with the limestone member, commonly 4 to 5 feet thick near the top. Small lenses of limestone occur locally at various horizons in the formation.

In the Muskogee quadrangle the Fayetteville formation has the same characteristics as in the western part of the Tahlequah. A mile east of Hulbert, at the end of the hill south of the road, the formation is nearly 50 feet thick with the limestone member about 5 feet thick near the middle of the formation. On the hills south of Bayou Manard the Fayetteville formation has a thickness of more than 100 feet. The limestone member is somewhat below the middle of the formation and is about 6 feet thick. Farther south, in the areas northeast of Gore, the formation is approximately 50 feet thick, and the limestone is about 20 feet below the top. In the extreme northern part of the quadrangle, in the hill in sec. 19, T. 17 N., R. 20 E., the Fayetteville is about 60 feet thick.

In the Pryor quadrangle the Fayetteville formation shows little change for several miles north of the line between the Muskogee and Pryor quadrangles. In the vicinity of Yonkers the formation varies from 70 to 90 feet in thickness, the lower shale from 10 to 20 feet, the limestone from 10 to 15 feet or a little more, and the upper shale from 30 to 50 feet. On the bluffs of Grand River southeast of Chouteau the lower shale is 28 feet thick; the limestone 12 feet; and the upper shale 35 feet. On the large hills 4 miles southwest of Locust Grove the entire formation is about 100 feet thick.

In this latitude and for some distance to the north a large part of the limestone of the Fayetteville is a dense, fine-grained, dark colored limestone, which weathers white and breaks up into small sub-cubical fragments. It is similar to the limestone at the top of the Mayes formation in the section on the bluff southeast of Chouteau. The fragments form a very noticeable white belt on the hill-slopes in the vicinity of Locust Grove.

In the northern part of the quadrangle the limestone member changes greatly in character. It consists of two parts, separated by calcareous shale. The lower limestone is probably the continuation of the limestone to the south, and has the dense blue limesstone phase fairly well developed. The upper limestone is thin-bedded, and platy, very hard, and typically ferruginous. Both limestones and the intervening shale are highly fossiliferous. The best development of this phase of the formation is on the hill slopes east and southeast of Adair. (Collection localities F 14, F 15, and F 16).

In the Vinita quadrangle, the development is similar to that just

described. The lower shale has an average thickness of 30 feet. The limestones with the intervening shale are of about the same thickness. Locally there is a third limestone above the other two. This is rather massive and thick-bedded, 5 to 6, locally 10 feet, thick. The upper shale is absent, having merged with the limestone member, or having been removed prior to the deposition of the succeeding Pennsylvanian beds. The formation is exposed in the valley of Locust Creek and in the region east and southeast of Todd (collection localities F 17 to F 21 inclusive).

In the Wyandotte quadrangle the Fayetteville formation is exposed in the syncline south of the Horse Creek anticline in the vicinity of Bernice. The development is very similar to that in the Vinita quadrangle. On the north side of the Horse Creek anticline the Fayetteville formation covers a considerable area in a belt 1 to 3 miles wide between Afton and Fairland, and in a wider belt extending south along the quadrangle line south and west of Afton To the north of Fairland the limestone member is not shown, the northernmost appearance observed being on the small mound a mile southeast of Fairland. Between Fairland and Miami the limestone was removed by erosion before the deposition of the basal Pennsylvanian beds, or else grades into shales and sandstones very similar to the Pennsylvanian. In the absence of the limestone member it is difficult to draw the line between the Fayetteville and Pennsylvanian. Southeast and east of Miami, however, heavy sandstones lie directly on the Mayes, and farther north on the Boone, so that the whole Fayetteville is absent north and east of Neosho River, or has graded into sandstones. The latter seems to be Siebenthal's interpretation as shown by his Mississippian-Pennsylvanian line (Pl. I.).

Fauna and correlation.—The complete faunal list of the Fayetteville formation is as follows:

List of fossils from the Fayetteville formation (22 collections).

Corals.

*Paleacis cuneata n. sp. (4)
Zaphrentis spinulosa E. & H. (8)
Michelinia meekana Girty (8)

Blastoids.

Pentremites sp. (1)

Crinoids.

Crinoidea sp. (1)

Bryozoa. (List not complete).

Cystodictya nitida Ulrich (4)

Cystodictya americana Ulr. (1)
Cystodictya labiosa Ulr. (4)
Rhombopora tabulata Ulr. (4)
Streblotrypa nicklesi Ulr. (4)
Streblotrypa subspinosa Ulr. (1)
Fenestella compressa Ulr. (1)
Fenestella serratula Ulr. (2)
Fenestella cestriensis Ulr. (3)
Fenestella elevatipora Ulr. (2)
Fenestella cf. triserialis Ulr. (3)
Archimedes invaginatus Ulr. (5)
Archimedes sublaxus Ulr. (1)
Archimedes proutanus Ulr. (4)
Archimedes distans Ulr. (1)
Polypora cestriensis Ulr. (4)
Polypora spinulifera Ulr. (1)
Thamniscus furcillatus Ulr. (1)

Brachiopods.

Lingulidiscina newberryi var. moorefieldana Girty ? (2)
*Crania chesterensis M. & G. (3)
Orthotetes kaskaskiensis McChesney (17)
Chonetes oklahomensis n. sp. (10)
Productus inflatus McChesney (11)
Productus ovatus Hall (12)
*Productus ovatus var. minor n. var. (6)
*Productus cherokeensis Drake (7)
Productus arkansanus Girty (6)
Pustula alternata N. & P. ? (5)
Avonia oklahomensis n. sp. (1)
Diaphragmus elegans N. & P. (8)
Marginifera adairensis Drake (1)
Camarophoria cestriensis n. sp. (3)
Camarotoechia purduei Girty (11)
Dielasma shumardana Miller (5)
Dielasma compressa n. sp. (3)
*Girtyella brevilobata Swallow (1)
Girtyella indianensis Girty (6)
*Girtyella indianensis var. exporrecta Girty (1)
Spirifer pellaensis Weller (14)
Spirifer leidyi N. & P. (3)
*Spirifer fayettevilleensis n. sp. (1)
Reticularia setigera Hall (8)
Ambocoelia levicula Rowley? (1)
Spiriferina transversa McChesney (3)
Spiriferina spinosa N. & P. (10)
Hustedia multicostata Girty (2)

Eumetria verneuilana Hall (1)
Eumetria vera Hall (4)
Eumetria costata Hall (3)
*Eumetria lata n. sp. (1)
Athyris cestriensis n. sp. (1)
Cliothyridina sublamellosa Hall (6)
Composita trinuclea Hall ? (13)
Composita sp. (2)

Pelecypods.

Leda vaseyana McChesney (1)
Myalina compressa n. sp. (3)
Schizodus depressus Worthen (2)
Schizodus chesterensis M. & W. (1)
Aviculopecten eurekensis Walcott (3)
Aviculopecten morrowensis Girty (2)
Aviculopecten pitkinensis n. sp. (2)
Aviculopecten sp. 2 (1)
Allorisma walkeri Weller (3)

Gastropods.

Bellerophon sp. (2)
Straparrolus planidorsatus M. & W. (2)
Holopea newtonensis Whitfield? (1)
Sphaerodoma subcorpulenta Whitfield (1)
Platyceras subrotundum n. sp. (2)

Cephalopods.

Orthoceras eurekensis Walcott? (2)
Cycloceras randolphensis Worthen (1)
Cycloceras sequoyahensis n. sp. (1)

Trilobites.

Griffithides sp.

The formation is continuous with the Fayetteville of Arkansas to the east, while the equivalent to the southwest probably is contained in the Caney shale. The Fayetteville and Pitkin formations probably are to be correlated with the Okaw and Menard formations of the Mississippi Valley Chester section.*

PITKIN LIMESTONE.

Definition.—The Pitkin limestone is conformable on the Fayetteville formation and unconformable beneath the Pennsylvanian beds—the Hale sandstone member of the Morrow formation in the

*Verbal communication from Stuart Weller.

southeastern part of the area, and the limestone of the Morrow to the west and north. The name Pitkin is that of a village in Arkansas.

Character and thickness.—For the Tahlequah quadrangle Taff's description is given in full.

The Pitkin limestone varies from rusty-brown, granular, earthy, and shaly strata at one extreme to fine-textured massive, bluish beds at the other. The characteristics first named are usually found where the formation is thinnest and in the upper and lower beds elsewhere. Blue clay shale locally occurs interbedded with the limestones.

In thickness the Pitkin limestone varies from a thin shaly layer to massive beds aggregating 70 feet. The changes in thickness are irregular, though there is a general increase toward the southwest. As instances of this variability the following instances are cited. In Walkingstick Mountain the formation consists of a thin bed of earthy limestone, while in the small mountain 3 miles west the strata are massive and make a section 40 feet thick. This limestone in the mountain east of Stilwell is 20 feet, while in the western and southwestern parts of the same township it is 40 to 60 feet thick. In T. 15 N., R. 24 E., the formation varies between 20 and 30 feet. The same is true for the northeastern part of the adjoining township (T. 15 N., R. 23 E.), but in the western and southwestern parts and in T. 15 N., R. 22 E., the thickness increases to more than 60 feet. In the vicinity of Bunch and elsewhere in T. 14 N., R. 24 E., the formation is usually 20 feet thick, while farther west, toward the border of the quadrangle, there is a general increase of the section, the thickness ranging from 40 to 60 feet.

The Pitkin limestone outcrops generally at the bases of hills and in steep slopes, bluffs, and escarpments, usually beneath sandstones. The talus from these overlying sandstone beds frequently conceals the edges of the Pitkin formation, so that a complete section can rarely be found. While the Pitkin limestone varies in thickness and locally becomes thin, it has been found at every place where its horizon reaches the surface. * * *

In the Muskogee quadrangle Taff states that the Pitkin varies little from 50 feet in thickness and consists of "light blue to brown, granular, earthy, slightly oolitic strata interbedded with fine-textured massive layers. The granular and oolitic types of rock are the more common, and may be said generally to characterize the formation. The thickness of the beds is variable, ranging from thin platy strata to beds 1 or 2 feet thick. The thinner strata are more argillaceous, and thin shale layers not uncommonly separate them."

In most of the Muskogee quadrangle the Pitkin and the limestone of the Morrow are in contact, and the separation must be made largely on the basis of fossils. The Morrow limestone is usually lighter colored and more crinoidal than the Pitkin, and it is often possible to make the separation on lithologic grounds if one is well acquainted with the formations.

The Pitkin limestone extends only a few miles north into the Pryor quadrangle. From a thickness of about 60 feet just south of the Pryor-Muskogee quadrangle line (on the hill in sec. 18, T. 17 N., R. 20 E.) it dwindles to about 10 feet in the vicinity of Yonkers, about 8 miles to the northwest, and has not been observed north of the line between Tps. 18 and 19 N.

The disappearance of the Pitkin limestone may be due in part to an actual thinning of the beds, but there is no change in the nature of the limestone, so the disappearance is credited rather to the greater development of the Mississippian-Pennsylvanian unconformity, i. e., the Pitkin is thought to have been removed before the deposition of the overlying Morrow formation.

In the early work in this region the Pitkin and Morrow limestones were not correctly differentiated and in the preliminary paper by the writer* the Pitkin is described as changing in character and extending north to about the latitude of Pryor, and possibly into the Vinita and Wyandotte quadrangles. The limestone extending to the north as far as Pryor is now known to be the Morrow limestone, while the uppermost limestone in the Vinita and Wyandotte quadrangles almost certainly belongs to the Fayetteville formation.

Fauna and correlation.—The complete faunal list for the Pitkin limestone in Oklahoma is as follows:

List of fossils from the Pitkin formation (10 collections).

Corals.

Zaphrentis spinulosa E. & H. (2)

Blastoids.

Pentremites sp. (1)

Bryozoans—not studied, *Archimedes* common.

Brachiopods.

Lingulidiscina newberryi var. moorefieldana Girty? (1)
Lingulidiscina newberryi var. ovata Girty (1)
Orthotetes kaskaskiensis McChesney (10)
Chonetes oklahomensis n. sp. (3)
Chonetes sericeus Girty? (1)

*Jour. Geol. vol. 22, No. 6, pp. 622-623.

Productus ovatus Hall (9)
Productus arkansanus Girty (6)
Pustula alternata N. & P. ? (1)
Diaphragmus elegans N. & P. (7)
Camarophoria cestriensis n. sp. (5)
Dielasma shumardana Miller (3)
Spirifer pellaensis Weller (6)
Spirifer leidyi N. & P. (3)
Reticularia setigera Hall (4)
Spiriferina spinosa N. & P. (3)
Hustedia multicostata Girty (2)
Eumetria vera Hall (2)
Eumetria costata Hall (3)
*Eumetria pitkinensis n. sp. (1)
Athyris cestriensis n. sp. (1)
Composita trinuclea Hall? (6)
Composita sp. (3)

Pelecypods.

Solenomya? sp. (1)
Sphenotus cherokeense n. sp. (6)
*Sphenotus quadriplicatum n. sp. (3)
*Sphenotus gibsonense n. sp. (1)
Edmondia crassa Girty (1)
Edmondia crassa var. suborbiculata Girty (1)
*Edmondia pitkinensis n. sp. (3)
*Nucula illinoiensis Worthen (1)
Leda vaseyana McChesney (3)
*Conocardium peculiare Girty (1)
*Leiopteria? sp. (1)
Myalina compressa n. sp. (2)
*Myalina longicardinalis n. sp. (1)
Schizodus depressus Worthen (1)
Schizodus chesterensis M. & W. (9)
Schizodus insignis Drake? (1)
*Schizodus sp. (1)
Deltopecten batesvillensis Weller (1)
Aviculopecten eurekensis Walcott ? (1)
*Aviculopecten keoughensis n. sp. (1)
Aviculopecten pitkinensis n. sp. (3)
Allorisma walkeri Weller (5)
*Allorisma arkansana Weller (1)

Gastropods.

Bellerophon sp. (4)
*Bellerophon pitkinensis n. sp. (1)
Straparollus planidorsatus M. & W. (1)

Holopea newtonensis Whitfield? (1)
Platyceras subrotundum n. sp. (6)
Sphaerodoma subcorpulenta Whitfield? (1)
*Strophystylus sp. (1)

Cephalopods.

Orthoceras eurekensis Walcott? (3)
Cycloceras randolphensis Worthen (2)
Cycloceras sequoyahensis n. sp. (1)
*Leuroceras? sp. (1)

Trilobites.

Griffithides pustulosus n. sp. (1)
Griffithides sp.

The conspicuous feature of the Pitkin fauna as distinguished from that of the Fayetteville is the abundance of pelecypods which occur at a definite horizon near the base of the limestone. *Archimedes* is much more abundant in the formation than would appear from the faunal list. The axes are often shown on the surface of the blocks of the thick-bedded limestone, but it is almost impossible to procure them except in fragments. In the shelly, thinner-bedded limestones where the other fossils are abundant, and from which the collections were made, *Archimedes* is rather rare.

The Pitkin limestone of Oklahoma is continuous with that of the Winslow quadrangle of Arkansas. As already noted, its equivalent to the southwest is probably in the Caney shale. In southwestern Missouri, its equivalent, if present, is in the Carterville formation of the Joplin district. In the Mississippi valley section, the Okaw and Menard formations probably represent the horizon of the Fayetteville and Pitkin of the southwestern Ozark section. The Menard formation is characterized by the presence of a large number of pelecypods some of them identical with those occurring in the Pitkin. Both the Fayetteville and Pitkin faunas differ from those of the Mississippi valley Chester in the abundance of *Chonetes* which is extremely rare in the Chester of Illinois and Missouri.

The Pitkin limestone can be pretty definitely correlated with the Maxville limestone of Ohio and through it with the Newman and Greenbrier limestones of the Allegheny region.

PENNSYLVANIAN SYSTEM.

GENERAL STATEMENT.

While the field work in preparation for this report had to do primarily with the determination of the stratigraphy of the Mississippian rocks, it was necessary to pay much attention to the lower Pennsylvanian, and especially to the unconformity at its base.

The formations concerned are the Morrow and Winslow on the southern and southwestern margins of the area, and the Cherokee on the western and northwestern margins. The following statements cover only points relating to the unconformity, and no attempt is made to give complete descriptions of the formations.

MORROW FORMATION.

In the Tahlequah quadrangle the Morrow consists of limestone with subordinate amounts of shale and sandstone and with an important sandstone member, the *Hale sandstone,* at the base. This sandstone thins irregularly from 110 feet in the northeastern corner to a thickness of a very few feet at the western border of the quadrangle. The great variation in thickness of the Pitkin limestone indicates unconformable relations between it and the Morrow formation, but the unconformity is by no means striking. In Arkansas, where the relations are similar to those in the Tahlequah quadrangle, the Morrow was for many years considered to be Mississippian.

In the Muskogee quadrangle, the Hale sandstone appears locally near the eastern border of the quadrangle, e. g., south of Manard Post-office; but it is only a few feet thick and disappears to the northwest. The limestone of the Morrow formation is thus brought into contact with the Pitkin limestone and the two can be separated only by the fossil content and by a careful study of their lithologic characters. This relation holds for a short distance northwards into the Pryor quadrangle, where the Pitkin disappears, having apparently been removed by erosion before the deposition of the Morrow formation. The Morrow formation thins rapidly in this region and changes from nearly pure limestone to arenaceous limestone, partly thin-bedded and platy, and partly of beds up to 6 or 7 feet thick, which are highly cross-bedded and siliceous, and which grade into a coarse-grained, cross-bedded sandstone about the latitude of Locust Grove. This massive siliceous phase is the lower part of the formation, and is separated from the upper platy limestone by a distinct unconformity which is well shown in the bluff of Grand River just north of the Wagoner pumping plant. This unconformity increases to the north, cutting out the thick-bedded sandy phase of the Morrow, so that the thin-

bedded, platy limestone rests on the Fayetteville formation. This phase continues to the north for a few miles where it is cut out by the basal sandstones of the Cherokee (Winslow). Except in the block of the Seneca fault, the last exposure of the Morrow formation observed is on the hill in the NW. 1-4 sec. 31, T. 21 N., R. 20 E. This outlier is separated by some miles from the main body of the Morrow. In the Seneca fault block, limestone thought to be Morrow is exposed in the small creek 1 1-2 miles east and 1 1-2 miles south of Pryor, and again in the SE. 1-4 sec. 20, T. 22 N., R. 20 E. This exposure is almost certainly of Morrow limestone and is its northernmost known occurrence.

WINSLOW AND CHEROKEE FORMATIONS.

In the Tahlequah and Muskogee quadrangles the Morrow is succeeded with apparent conformity by the Winslow formation consisting of black shale and brown sandsone. Northward from the Muskogee quadrangle the lower Pennsylvanian thins very rapidly, and at the Kansas line is represented by only 400 to 500 feet of the Cherokee shale, which is continuous with the formation of that name in Kansas. In the Pryor quadrangle these rocks are continuous with the Cherokee on the north and with the Winslow (and overlying formations) to the south, so the name to be used is as yet uncertain.

Owing to the disappearance of the Morrow and the Pitkin formations the Pennsylvanian shales (Cherokee) rest on the Fayetteville shale in the northern part of the Pryor quadrangle, and in the Vinita and Wyandotte quadrangles. In the extreme northern part of the latter quadrangle, it is believed that the Fayetteville formation is absent and that the Cherokee shales rest on the Mayes formation and probably upon the Boone formation locally.

THE MISSISSIPPIAN-PENNSYLVANIAN UNCONFORMITY.

The relations of the Mississippian and Pennsylvanian rocks have been given in the preceding paragraphs, but it may be well to summarize the facts which bear directly on the contact between the two systems.

In the southeastern part of the area—Tahlequah quadrangle—the Hale sandstone member of the Morrow formation (Pennsylvanian) rests on the Pitkin limestone, with slight unconformity, the principal stratigraphic evidence of unconformity being the variation in the thickness of the Pitkin. To the west the Hale sandstone disappears, and in the Muskogee quadrangle the limestone of the Morrow rests on the Pitkin limestone. A short distance north the Pitkin disappears and the lower part of the Morrow soon follows, and before the middle of the quadrangle is reached the Morrow is absent from the section. In this region, then, the unconformity represents the interval of the Pitkin limestone (uppermost Mississippian) and the Morrow formation (lowermost Pennsylvanian) in addition to the interval represented by the unconformity between the Pitkin and the Morrow at the Arkansas-Oklahoma line. These relations continue practically unchanged through the northern part of the Pryor, across the southeastern portion of the Vinita, and almost across the Wyandotte quadrangle. In the northern part of this quadrangle the Fayetteville formation disappears and the Pennsylvanian system rests on the Mayes formation and, locally at least, on the Boone.

The unconformity between the Mississippian and Pennsylvanian therefore increases in importance to the west and north around the margin of the Ozark uplift. The great break between the Boone and the Cherokee shale in the extreme northern part of the Wyandotte quadrangle may be considered as the sum of a series of unconformities which are present to the southeast. The time interval represented is all of Mississippian time later than early Warsaw and at least that part of the early Pennsylvanian represented by the Morrow formation, and probably that of a considerable portion of the Pennsylvanian formations of the Arkansas trough.

The conditions as they are believed to exist are shown in the columnar section on Plate II, and also in the cross section (fig. 3).

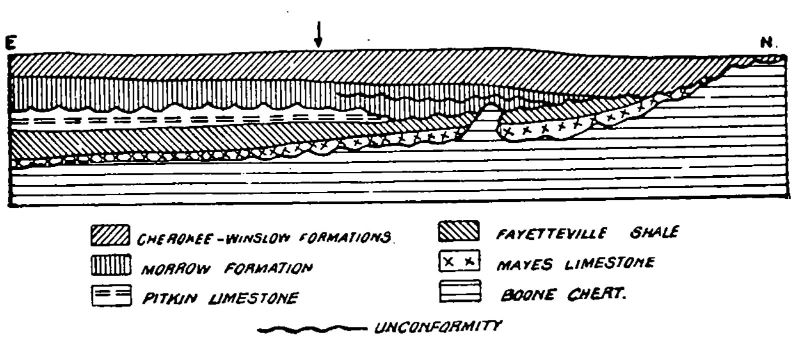


Fig. 3. Diagram showing conditions on the southwestern margin of the Ozark area after the deposition of the basal Pennsylvanian beds.

This section is intended to represent diagrammatically the stratigraphic relations on the margin of the Ozark uplift, after the deposition of the Winslow (Cherokee) formation. The direction of the

section is north-south in the portion of the figure to the right, and west-east in the portion to the left. The arrow indicates the turning point.

COMPARISON WITH EARLIER CONCLUSIONS.

It should be noted that the interpretation of the stratigraphy in the Vinita quadrangle does not agree with that of Siebenthal as given in his only published report.* He states that in the Vinita quadrangle the Chester group is represented by the Batesville sandstone, the Fayetteville shale with its Wedington sandstone member, and the Pitkin formation. The Batesville sandstone of his report is probably the Mayes formation of this paper. The Fayetteville shale is present in the west-central part of the quadrangle, but seems to disappear or to grade into sandstone a little southwest of Neosho River, south of Miami. Traced westward, the Wedington sandstone member of the Fayetteville formation enters the State from Arkansas, but thins out and disappears in the southeastern part of the Siloam Springs and northeastern part of the Tahlequah quadrangles, and there is nothing in the Wyandotte quadrangle which can be correlated with it. The Pitkin thins out and disappears by unconformity in the southern part of the Pryor quadrangle.

In the region west and southwest of Miami there are two sandstones in the lower part of the Cherokee shales which lie at about the same distances above the Boone, that the Wedington and Pitkin do far to the southeast. These sandstones, however, have all the appearance of the Winslow sandstones farther south, and they cross into the Vinita quadrangle outcropping near Vinita, considerably above the Mississippian rocks in that region. D. W. Ohern** reports the finding of Pennsylvanian fossils in the shale between the two sandstones. On the geologic map (Pl. 1) the lines in the Wyandotte quadrangle are those of Siebenthal, used by permission of the United States Geological Survey. Judging from these lines, the base of the lower of the two sandstones above mentioned is considered the base of the Pennsylvanian.

In a paper published in 1897, Drake*** discusses the stratigraphy of the entire region covered by this report. His work was of a reconnaissance nature but except in minor respects the writer agrees with his conclusions. The nomenclature of the formations

*Bull. U. S. Geol. Survey, No. 340, 1907.

**Verbal communication.

***Drake, N. F., Proc. Am: Phil. Soc., vol. 36, No. 156.

has been considerably changed since the time at which Drake wrote. The greater part of his Boston group—the Mayes, Fayetteville, and Pitkin (Archimedes) formations, are recognized as of Chester rather than Warsaw age, and the Morrow formation, included at that time in the Boston group as Mississippian, is recognized as of Pennsylvanian age.

Concerning the region in the Wyandotte quadrangle discussed in the second paragraph above, Drake says: "Between Fairland and Miami the strata that may be referred to this (Boston) group are gray shales, and possibly a little limestone. Northeast of Miami it seems probable that the horizon of the Boston group is overlapped by Coal Measures, shales, and sandstones, or if this is not the case the group is represented by gray clay shales and sandstones."

From his hasty work in the vicinity of Miami the writer was inclined to be in accord with the first of Drake's hypotheses. However, the work of Siebenthal, as shown on the geologic map, was of a much more detailed nature than the writer's, and his conclusions as shown by the mapping are accepted, and the base of the second sandstone above the Boone is taken as the base of the Pennsylvanian.

SUMMARY OF CONDITIONS OF SEDIMENTATION.

As shown by the summary of the stratigraphy given in the introduction to the section on stratigraphy, the sedimentation in the region of northeastern Oklahoma during the Paleozoic was interrupted often. The area seems to have been unstable and to have been subjected to repeated incursions and withdrawals of the sea. The sediments were derived for the most part from land to the north and northeast, the central part of the Ozark region or "Ozarkia."

The lowest rocks in the Oklahoma portion of the area represent the sedimentation of the early Ordovician. These rocks were deposited over very large areas, and their source is an open question. They cover practically the entire Ozark region, and the small areas in the St. Francis Mountains which possibly remained above the water can not be regarded as having furnished sufficient material for the rocks. The extent of these rocks to the west is problematic, and it is possible that there was a land area in that direction. The region to the southwest was almost certainly submerged, the thick Arbuckle limestone of the Arbuckle Mountains representing the deposition of the period. The greater part of the rocks of the Ordovician period in this region and in southern Missouri and northern Arkansas are limestones and dolomites which probably indicate clear water conditions some distance from the shore, or if near

shore, that the adjacent lands were low, yielding little sediment. Intercalated with the limestone and dolomites are white saccharoidal sandstones which probably were deposited near shore, or were worked over by an advancing sea.

About mid-Ordovician time there was a shallowing of the sea recorded by the shales and sandstones of the Tyner formation. Following this the sea was entirely withdrawn from the Oklahoma area and an erosion period of considerable length followed, during which the Tyner beds were eroded and possibly removed locally.

In the Niagaran epoch of the Silurian period the sea again covered part of the area, how large a part can not be said. In the waters of this sea limestone now forming the St. Clair marble was deposited. This formation occurs only in the extreme southeastern part of the area but it may have been deposited much farther to the north and west and removed by erosion before the succeeding beds were deposited. At most, however, the area was submerged a relatively short time and the submergence was followed by another withdrawal of the sea and an erosion period lasting through the remainder of the Silurian period and the greater part of the Devonian.

Near the end of the Devonian period the sea again advanced and there was deposited a thin formation of black shale, the Chattanooga. This formation is continuous with the black shales of the same age in Arkansas, Missouri, Tennessee, Indiana, and Ohio. The conditions which produced such uniform deposition over such large areas have not been satisfactorily explained.

Following the deposition of the black shale there was another withdrawal of the sea, and the Chattanooga shale was eroded to an uneven surface, and entirely removed in some places.

The advancing sea of the Kinderhook epoch of the Mississippian period reached only to the eastern margin of the area. It necessarily advanced first up the old valleys which had been eroded in the Chattanooga shale, and these were nearly filled with sediment before the higher surfaces of the black shale were covered. Consequently in the small area where the Kinderhook beds are known to be present they show great variation in thickness. They consist of shales with some limestone, indicating that the sediments came from low-lying lands from which little or no coarse material was derived. Following the deposition of the Kinderhook there was another withdrawal of the waters and the beds were eroded slightly.

At the beginning of the Osage epoch the sea advanced over the entire area, and the limestones and cherts of the Boone formation were deposited. The nature of these beds indicates that the seas were clear, and the known extent of the formation shows that land must have been distant from the Oklahoma area. There was possibly land in the Arbuckle Mountain region at this time, but the greater part of the material for the Boone formation probably was derived from land far to the northward. The entire Ozark region was submerged and could have furnished none of the sediments. The formation at present appears to consist largely of chert, and the conditions which could give so much non-clastic siliceous sediment are not easily pictured. It has been suggested that much of the chert is of secondary origin, formed by the replacement of limestone by silica, and this is certainly true in large measure. However, this solution leaves the ultimate source of the silica in question, and there is no doubt that some of the chert is primary. The formation must have assumed its present aspect at least before the end of the Mississippian period, for in the succeeding beds of Chester age there are embedded angular pieces of chert which are entirely comparable to those now covering the hillsides of the area.

The submergence during which the Boone formation was deposited lasted through the Burlington and Keokuk epochs and into the Warsaw. There was then a withdrawal of the sea and a long period of erosion lasting through the greater part of the Warsaw, and all of the Salem, St. Louis, and Ste. Genevieve epochs, and possibly into the early part of the Chester. During this time the area was deeply eroded. The southern portion seems to have been worn down to a plain, for the succeeding sediments are shales and limestones and rest with apparent conformity on the Boone formation. In the central part of the Pryor quadrangle, however, there was a pronounced range of hills, and as the sea advanced, the tops of these hills formed islands around which the younger beds were deposited. These hills already have been discussed in the section on stratigraphy. In this same region there are large fragments of chert embedded in the limestone at the base of the younger rocks showing that the hills of that time must have been covered with chert blocks as are those of the present.

Following this prolonged erosion interval there was another advance of the sea in early Chester time. In the southern part of the area there was continuous deposition throughout the rest of the Chester epoch, and only a slight emergence before the deposition of the basal formations of the Pennsylvanian system. Around the western and northwestern margins of the area the conditions were more unstable, and the sea advanced from and retreated to the south at different times during the Chester. The history of these movements is recorded in the distribution of the formations which is fully discussed in the previous section. The shore line was to the north, and while it was shifting from time to time, it probably may be regarded as having about the position of the Oklahoma-Kansas line. The Chester beds certainly were deposited to a considerable distance east of their present outcrop, but the great central portion of the Ozark region remained land, and probably furnished most of the material for the Chester sediments. To the west there was open sea connecting with the Great Basin area in which there had been a sea since Devonian times. The connection of the Oklahoma sea with the Great Basin sea is shown by the presence of a large number of Great Basin forms in the fauna of the Mayes limestone which has been noted.

IGNEOUS ROCKS.

The only igneous rock in the area is a small dike of granite crossing Spavinaw Creek about 1 mile west of the village of Spavinaw. This dike was discovered by N. F. Drake and his description* of the rock and its occurrence is given in full herewith, since the original publication is not generally available.

Previous knowledge of the Igneous rocks.—The existence of igneous rock in the Cherokee Nation has been known for a long time. It was referred to in D. D. Owen's *second* report of the Geology of Arkansas as a red granite which occurred at the mouth of Spavinaw Creek some thirty or forty miles west of the Arkansas line. Edward T. Cox failed to find it in place, but saw some millstones that were made from it, and obtained specimens which were broken off in fashioning the millstones. He thought this granite underlay the sedimentary rocks of southwestern Missouri and northwestern Arkansas.

The exact locality of this granite outcrop has, however, apparently not been definitely known to any one interested in the geology of the country until 1896 when the writer, after a special search, found the rock in place.

Locality and Mode of Occurrence.—The rock occurs in the Cherokee Nation [Mayes County] on the north side of Spavinaw Creek, about six miles from its mouth and three-fourths of a mile west of Spavinaw postoffice. It is a dike about twelve hundred feet long by fifty feet wide. The outcrop is not continuously exposed, but the breaks are probably due to a thin covering of detritus from the clastic rock. There are four exposures of the dike rock, which vary in length from about one hundred to two hundred feet, and occur at intervals of about two hundred feet.

This dike runs along the axis of a gentle anticlinal fold which extends about N. 30 degrees E. The dips of the sendimentary beds on either side of the dike are only 5 degrees to 10 degrees, but the fold is broad and affects the rocks for two or three miles to the west and probably as far to the east. Silurian [Ordo-

*Proc. Am. Phil. Soc., vol. 36, No. 156, 1898, pp. 338-342.

vician] strata which, over the adjoining country, are usually covered by two hundred to five hundred feet of Lower Carboniferous beds, are here exposed to a depth of about two hundred feet and outcrop in the valley. The Silurian [Ordovician] strata along the contact of the dike appear to be free from any special metamorphic action due to the dike rock.

Macroscopic Characters.—The general color of the rock is a light brick red with a mingling of black specks which are slightly grouped and in places so much as to give it a somewhat mottled appearance. In the red color are blended a light pink and also deeper red, due to the feldspar crystals, which are red and form by far the larger part of the rock. The black specks are small magnetite crystals. Associated with the black crystals are greenish hornblende and chlorite crystals, which give a greenish tint hardly noticeable on a casual observation. It contains also a few small white quartz crystals. The crystals composing the rock vary in size from those which give a general granular appearance to the ground mass to feldspar crystals that are 1 cm. or more in length. The freshly broken rock shows a general fine-grained, somewhat shiny and bright appearance with numerous shining crystal faces of the larger feldspars.

Microscopic Examination.—Feldspars, quartz, chlorite and magnetite are the principal minerals of the rock, while hornblende and epidote occur sparingly. A holocrystalline texture is shown throughout the rock. The most striking and general microscopic feature is its granophyric and micropegmatitic structure. Through most of the orthoclase crystals quartz is intergrown in the most intimate manner, so that each feldspar shows radiating or alternating quartz and feldspar in each crystal, the included quartz plates or prisms show the same orientation. Quartz occurs sparingly isolated in larger crystals, but very rarely shows its outlines. Feldspars are the predominant minerals. They are principally orthoclase but plagioclase feldspars are of rather common occurrence. The feldspars have a fine granular appearance and a reddish color. Phenocrysts of feldspar are quite common; they, however, generally show irregular outlines instead of crystal faces. Magnetite occurs in small opaque masses, many of which show perfect crystal outlines. They show a slight grouping through the rock and in places give a blended appearance to the crystals.

The hornblende is the greenish variety and of rather uncommon occurrence. The chlorite is common and occurs in greenish bands, spherular aggregates and in minute particles. Epidote is of rather common occurrence.

Chemical Analysis.—

	per cent
Loss on ignition	1.11
Silica (Si O_2)	71.10
Ferric Oxide and Alumina (Fe_2O_3 and Al_2O_3)	20.60
Calcium Oxide (Ca O)	2.53
Magnesium Oxide (Mg O)	.99
Potassium and Sodium Oxides (K_2O and Na_2O)	3.76
Total	100.09

Classification of the Rock.—The high percentage of silica, the holocrystalline texture, and the general interference of crystallization shown in the irregular crystal outlines at once place the rock in the granitic series. As shown by the feldspars, quartz, and magnetite, however, there is a strong tendency to the porphyritic texture: it is, therefore, a porphyritic granite. The minute textures of the feldspars and quartz is designated by the name granophyric.

Age of the Dike.—As noted above, the dike breaks through Silurian [Ordovician] strata along the axis of an anticlinal fold. The igneous rock was, from this evidence, most likely intruded at the time of the folding. This anticline is one of the outlying folds of that mountain system which is such a marked feature of central western Arkansas and the adjoining part of the Indian Territory. This system of folding is post-Carboniferous, pre-Cretaceous and quite likely pre-Mesozoic, because Upper Coal Measures deposits are folded, lower Cretaceous deposits lie almost undisturbed upon these folds and no Jurassic or Triassic beds occur over the area.

In the concluding paragraph Drake compares the rock with the granites of southeastern Missouri and those of the Arbuckle Mountains of Oklahoma, as well as with the igneous rocks of the Hot Springs region of Arkansas. The rocks of the two former areas are more or less similar to that of the dike, but are now definitely known to be pre-Cambrian, while those near Hot Springs are of very different types and are much younger than the dike, if its age be Carboniferous.

STRUCTURE.

GENERAL STATEMENT.

The region covered by this report lies on the southwestern flank of the Ozark uplift. In general the rocks dip away from the axis of the uplift, nearly to the west in the northern part of the area and to the west, southwest and south in passing around the margin of the uplift. The general dip away from the axis of the uplift is interrupted in many places by folding and faulting. As a rule these folds and faults trend northeast-southwest. In the northern part of the area such structures die out to the west and the dip merges into the gentle westerly dip of the Prairie plains monocline. To the southwest and south the structures are continued across Arkansas River into the folds of the coal fields. The structure is most pronounced in the region of the outcrop of the Chester and the lowermost Pennsylvanian rocks. Many of the faults and folds undoubtedly extend to the northeast into the chert area, but it is impossible to trace them in the chert hills which are covered with loose residual chert. The date of the folding and faulting is almost certainly late Pennsylvanian.

The structure of the Tahlequah and Muskogee quadrangles is described at length in the folios for those quadrangles, and will be only briefly reviewed here. The structure of the remaining quadrangles is given in more detail, but without claim to completeness, since the observations on the structure were only incidental to the determination of the stratigraphy.

STRUCTURE OF THE TAHLEQUAH AND MUSKOGEE QUADRANGLES.

The minor structure of the Tahlequah and Muskogee quadrangles consists of a series of moderate basin-like folds separated by normal faults. The faults and the axes of the synclines trend northeast-southwest. Taff states that the faulting is normal, but says that the association of the faults and folds shows that they were produced by the same forces. As a rule, thrust faulting would occur under these conditions. With few exceptions, the downthrow of the faults is to the northwest.

The largest of the faults of the Tahlequah quadrangle both in extent and displacement is one which extends from near the center of the quadrangle to the southwest corner, where it dies out into an anticline which continues across Arkansas River. The downthrow is to the southeast. The maximum displacement of this fault is near Marble City where the St. Clair marble of the Silurian system is brought into contact with the Winslow formation of the Pennsylvanian, a throw of at least 600 feet.

Approximately parallel to this fault and 6 to 10 miles to the northwest is another fault of almost as great length but with less displacement. The Boone formation is brought into contact with the Winslow for most of the length of the fault. The displacement is probably less than 500 feet. The downthrow is to the northwest so that the block between this fault and the one described in the previous paragraph is relatively elevated. To the southwest, the fault dies out into an anticline shortly after entering the Muskogee quadrangle. This fold continues to the southwest, crossing Arkansas River about 2 miles upstream from the villages of Gore and Webbers Falls. Several outcrops of the Morrow, Pitkin, and Fayetteville formations are produced by the small tributaries of Illinois River cutting across the axis of the anticline. To the northeast both the faults mentioned die out or are lost in the Boone chert.

A third fault with the downthrow to the northwest extends southwestward from near Welling and crosses into the Muskogee quadrangle where it grades into an anticlinal fold near Garfield. The anticline continues to the southwest, crossing Arkansas River

near the mouth of Greenleaf Creek. The Morrow and Pitkin formations—and in one place the Fayetteville—are exposed along the axis of the anticline in the valley of Greenleaf Creek. In the vicinity of Cookson a smaller fault parallels the larger one for about 6 miles, with an elevated block from 1 to 2 miles wide between them. The anticline just mentioned may be regarded as the structural continuation of either or both of the faults.

Another fault extends southwestward from a point about 2 miles south of Tahlequah, into the Muskogee quadrangle, and disappears under the alluvium of the Arkansas near the mouth of Bayou Manard. Farther to the northwest are two similar faults, and also a complicated series of small faults along the northern border of the Muskogee quadrangle. The downthrow of the larger faults is to the northwest, and the displacement not very great, probably 300 to 400 feet.

To the northeast all the larger faults disappear in the Boone chert. While the faulting may extend into the chert area considerably farther than it can be traced, the indications are that it dies out into anticlinal folding. Outcrops of the Chattanooga shale and of the Tyner and Burgen formations are produced along Barren Fork and Illinois rivers by anticlinal folding. The strike of the anticline on Barren Fork appears to be in line with the second and third faults described above, and that of the anticline on Illinois River northeast of Tahlequah with the faults which die out or disappear near that town.

Besides the faults and folds mentioned above there are several minor ones. One of the more noticeable of the minor structural features is the small dome in the east-central part of T. 12 N., R. 25 E., in the southeastern part of the Tahlequah quadrangle. This dome is particularly interesting in view of the development of similar structures in the Pryor quadrangle on the west side of the area.

STRUCTURE OF THE SILOAM SPRINGS QUADRANGLE.

The Siloam Springs quadrangle lies almost entirely in the Boone chert area, and the minor structure can not be determined except where the older rocks are brought to the surface by folding.

On Illinois River a few miles north of the south line of the quadrangle, an anticline crosses the river, bringing the Chattanooga shale and the Tyner and Burgen formations to the surface. This anticline probably is the continuation to the northeast of the fault in the northeastern part of the Muskogee quadrangle. Traced to the northeast, this fault enters the Siloam Springs quadrangle at the southwestern corner, and the anticline on Illinois River is in the direction of its strike. The axis of the anticline passes south of Whitmire where the top of the Burgen sandstone reaches an elevation of about 50 feet above the river. From this vicinity the strata dip northward so that the Burgen and Tyner formations and the Sylamore sandstone member of the Chattanooga are beneath the surface at the confluence of Illinois River and Flint Creek. There is a slight rise to the north so that the Sylamore sandstone is exposed on Flint Creek south of Flint Post-Office.

Two anticlines on Spavinaw Creek are indicated by the distribution of the Chattanooga shale. The creek flows on the Boone chert near the mouth of Cloud Creek but the strata rise to the east and west, so that the Chattanooga shale forms the valley floor. The axis of the eastern fold was not located. To the west the strata rise very gently as far as the line between the Siloam Springs and Pryor quadrangles, and then more rapidly to the axis of the fold at Spavinaw.

The dips in all these folds are gentle, the maximum being about 5 degrees.

Exposures of the Boone chert commonly show apparent dips, but they are irregular in direction, and probably are due in large measure to the solution of the limestone beds and the resulting slump of the chert. Some of the dips may be due to folding, but it is impossible to determine in the short exposures which are true dips and which are due to slump.

STRUCTURE OF THE PRYOR QUADRANGLE.

The minor structure is much less pronounced in the Pryor quadrangle than in the area to the south and southeast in the Muskogee and Tahlequah quadrangles. Faulting of the type so common in those quadrangles is almost absent in the Pryor, and the folds are more gentle. The general direction of the folding is more nearly east and west than northeast and southwest.

Faults.—Four of the faults of the extreme northern portion of the Muskogee quadrangle extend for short distances into the Pryor quadrangle. The two faults in the southern part of T. 18 N., R. 21 E., converge to the north and intersect on the west side of Blackbird Creek, about 2 miles north of the quadrangle line. The faults in the southern part of T. 18 N., R. 20 E., also converge and intersect about the same distance north of the line. The actual intersection of neither pair of faults was observed, but the northern limit of the down-dropped blocks of the Winslow formation was determined with a fair degree of accuracy. The faults may continue beyond their intersections but it is impossible to trace them in the Boone chert.

The *Locust fault* extends southward from the vicinity o Grove nearly or quite to the southern boundary of the qua The downthrow is to the west, bringing the Chester fo below the level of the top of the Boone hills on the east si fault for the greater part of its length. Near its southern e the fault brings the Chattanooga shale in contact with th formation well above the base. The displacement of the probably nowhere more than 200 feet.

The *Seneca fault* extends northeastward from a point miles south of Pryor to the vicinity of Spurgen, Missouri, near Seneca, Missouri, from which place the fault takes it In the Pryor quadrangle, the fault is a simple block fault, from one-eighth of a mile to more than one-half mile wid block consists of the Morrow limestone, and sandstones an of the lower part of the Winslow formation which are brou contact with the Chester formations on either side for the part of its course. In the southwestern part of T. 22 N., R the lower Pennsylvanian rocks are brought down betwe crops of the Boone formation on either side and, immedi the southwest, between the Boone and the Fayetteville forr Where the dips in the fault block can be determined they ar northwest and at angles up to 30 degrees. In the v Grand River in the vicinity of Strang the fault is concealed alluvium, but to the northeast it is plainly shown with the Chester formations and the lowest Pennsylvanian rocks l down into the Mayes limestone or into the Boone formatio dips of the rocks on either side of the block, except very n fault, is away from the fault at angles up to 5 degrees. pears then, that the fault is due to the dropping of a block crest of a rather strong anticline. The maximum displace probably about 300 feet.

Two minor faults of small extent and displacement w served, one in southern part of sec. 16, T. 19 N., R. 19 E., a in the eastern part of sec. 6 of the same township.

Folds.—The strata in the Pryor quadrangle are nearly where affected by minor folding, but most of the folding is All the major tributaries of Grand River from the east flow near the axes of anticlines. The anticline on Spavinaw Cre been described in connection with the structure of the Springs quadrangle. The anticlines on Salina, Spring, and creeks are of the same type, but are less pronounced. The fold on Spring Creek brings the Chattanooga shale and the Ordovician rocks to the surface a short distance above the junction of Spring and Little Spring creeks. These folds extend across Grand River to the west but soon die out and the dip becomes uniform to the west, forming the Prairie plains monocline.

The presence of domes has been noticed in the Tahlequah quadrangle. Several of them are present in the southern portion of the outcrop of the Chester formations and the lowermost Pennsylvanian rocks. A series of three of these domes is situated in secs. 18, 7, and 6, T. 18 N., R. 19 E., and in sec. 36 of the township to the north. These domes produce small outcrops of the Fayetteville shale surrounded by the Morrow formation. A dome on the southwest side of Grand River in sec. 9, T. 19 N., R. 19 E., brings the Chattanooga shale to the surface over a small area. Another, 3 miles northeast of Chouteau, gives an outcrop of Fayetteville shale about a square mile in extent, with a small outcrop of the Mayes limestone in the center. The Fayetteville shale outcrop is surrounded by that of the Morrow and Winslow formations.

The dips from all the anticlines and domes mentioned is gentle, rarely, if ever, exceeding 5 degrees and in most cases considerably less.

STRUCTURE OF THE VINITA AND WYANDOTTE QUADRANGLES.

The principal structural features of the Wyandotte quadrangle are the Seneca fault and the Horse Creek anticline, the latter of which extends into the Vinita quadrangle as far as Cabin Creek. These structures were described by Siebenthal* as follows:

* * * The Seneca fault * * * extends from a point about midway between Chouteau and Pryor Creek to a point several miles northeast of Spurgeon, beyond the limits of the area shown on the accompanying map, having an almost due northeast course parallel to the main axis of the uplift and roughly parallel to its northwest margin. This fault is double and in places multiple, letting down a long, narrow block of Boone, Chester, and overlying rocks into the Boone formation. In addition to the down-thrown block, the strata for some distance, in places for a mile or two on either side, dip toward the fault. This combination has had a strong influence on the drainage, as may be seen from the map. From Seneca toward the northeast the fault closely follows the valley of Lost Creek. South of Seneca it crosses the divide to Sycamore Creek and follows down the valley to Neosho [Grand] River. From the mouth of Sycamore Creek the fault cuts across the various meanders of Neosho River [Grand] to a point just above the mouth of Spavinaw Creek. Southwest of this point it traverses the flat upland to and beyond Pryor Creek. Near the Neosho [Grand] where the rocks on either side are the cherty limestones of the Boone formation, it is easy to trace the down-dropped strip of Chester consisting of limestone and sandstone. * * *

The intersections of this fault line with the meanders of the Neosho [Grand] River afford many fine cross sections of the faulted area. The width of the down-dropped block ranges from less than 200 feet to more than 1,500 feet. The fault ranges in character from a simple pair of opposed breaks with the down-thrown block between them, and with the strata of the wall rocks on either side dipping more or less steeply toward the faulted block, to a sort of faulted syncline, the limbs of which are made up of distributive faults with the cumulative downthrow toward the axis of the syncline. The best view of the latter phase is shown in the west bluff of the Neosho [Grand] opposite the mouth of Cowskin River, where the south limb dips from 2 degrees to 5 degrees, the angle increasing toward the axis, and shows four distinct dislocations, one being opposed to the other three, but leaving a resultant throw of 14 feet to the north. On the north side there is a faulted zone 55 feet wide in which there is an upthrow of 18 feet, but this is more than counterbalanced by three small faults and one with a throw of 22 feet to the south, and by the southerly dip of 2 degrees some distance from the fault and of 11 degrees adjacent to the fault.

The amount of displacement on either side of the block varies from place to place. In the west bluff of Neosho [Grand] River 2 miles below the mouth of Horse Creek it is more than 90 feet. At the Bedker mines, south of Seneca, it is from 100 feet to 140 feet. Between Seneca and Spurgeon it must be as much as 100 feet in many places, for it serves to bring the Chester formation down to the level of the valley, though the Boone forms the top of the hills on either side.

The Horse Creek anticline is an asymmetric fold which starts at a point on Cabin Creek, 5 miles southeast of Big Cabin station and trends east northeastward by Cleora to the mouth of Cowskin River, where it intersects the Seneca fault. East of this point it swings a little more eastward to the vicinity of Tiff City, where it trends nearly due east for 10 miles and farther east gradually dies out. The anticline has a gently sloping northern limb and a steeper southern limb. To the south of the anticline and parallel to it is a long, low synclinal trough beyond which the strata rise again to the south, with a gentle incline. The average dip of the northern limb of the anticline is about 2 degrees; the dip of the southern limb ranges from 5 degrees to 18 degrees. West of Neosho [Grand] River the fold expresses itself topographically in an abrupt fault-like escarpment to the south and a low upland slope to the north. East of the Neosho the anticline is cut through on either side by many short, steep hollows, and forms the greatly dissected highland known as the Seneca Hills. In places, notably where the fold is cut through by Neosho [Grand] River, the rocks lie nearly flat, but where it is crossed by Buffalo Creek and Horse Creek the dip is about 5 degrees SE. About 2 miles west of Horse Creek Gap the dip is 18 degrees SE. For the most part the dip of the southern limb is concealed by debris

*Siebenthal, C. E., Bull. U. S. Geol. Survey No. 340, 1907.

washed down from the steep slope, and can be made out only in exceptional places. It is entirely possible that for short distances along the axis west of Horse Creek the anticline may break down into small faults. Though cut across in several places by streams, this fold is nowhere breached parallel to the axis, a fact due doubtless to its monoclinal nature.

ECONOMIC GEOLOGY.

The principal economic resources of the region are lead and zinc, structural and road materials, soils and water resources.

LEAD AND ZINC.

The lead and zinc deposits of Ottawa County were investigated by the writer in 1911, and were made the subject of a report published as Bulletin No. 9 of this Survey. This report is still available and it seems sufficient here to give only a brief statement of the nature of the deposits and to notice briefly their development since 1911.

The commercial deposits of lead and zinc occur in the northeastern part of Ottawa County near Miami. The important producing area is a belt about a mile wide extending slightly east of north from a point about one mile northwest of Miami practically to the Kansas line, a distance of about 8 miles. The greater part of the production to the present has been made from what is known as the Hattonville camp, situated 4 miles north of Miami. The camp of Commerce is a new camp farther to the north. The development is practically continuous from Hattonville to the Kansas line, but to the south of Hattonville there is a break of about 3 miles to the mines immediately northwest of Miami. The first production of lead and zinc at Hattonville was made in 1907, and the development has proceeded very rapidly, the Miami camp as a whole ranking as one of the leading camps of the Joplin District for the past few years.

The general conditions under which the ore is found are similar to those in the other camps of the district. The ore bodies are runs of varying width and thickness. No circles are known in the Miami camp. The runs extend in the direction of the length of the belt and, as a rule, dip to the north. The main run at the Hattonville camp is considerably the longest ore body of the kind which has been developed in the Joplin district.

The ores consist of sphalerite or zinc blende and galena in varying proportions. In general the galena is more abundant in the upper levels and often exceeds the sphalerite, a condition seldom observed in the district. The ore is exceptionally rich, several important bodies having been encountered which produced over 60 per cent of concentrates of which a large portion was galena.

The ores occur in the cracks of the brecciated sandstones lying

immediately above the Boone chert, to a less extent disseminated through the sandstone, and in cracks and cavities in the upper part of the Boone. The first workings were in the sandstones but the deeper runs which are now more important than the upper ones and promise to become still more so, are in the upper part of the chert. The runs are apparently due to the effect of solution and are not connected with faulting. Some calcite occurs with the ores but dolomite is practically absent. Pyrite and marcasite are extremely abundant and lower the grade of the ores which is the principal drawback to the camp as a whole. In newly opened mines there is often considerable bitumen which causes some difficulty in the concentration of the ores. The bitumen seems to follow the water and disappears from the workings when the water level is permanently lowered.

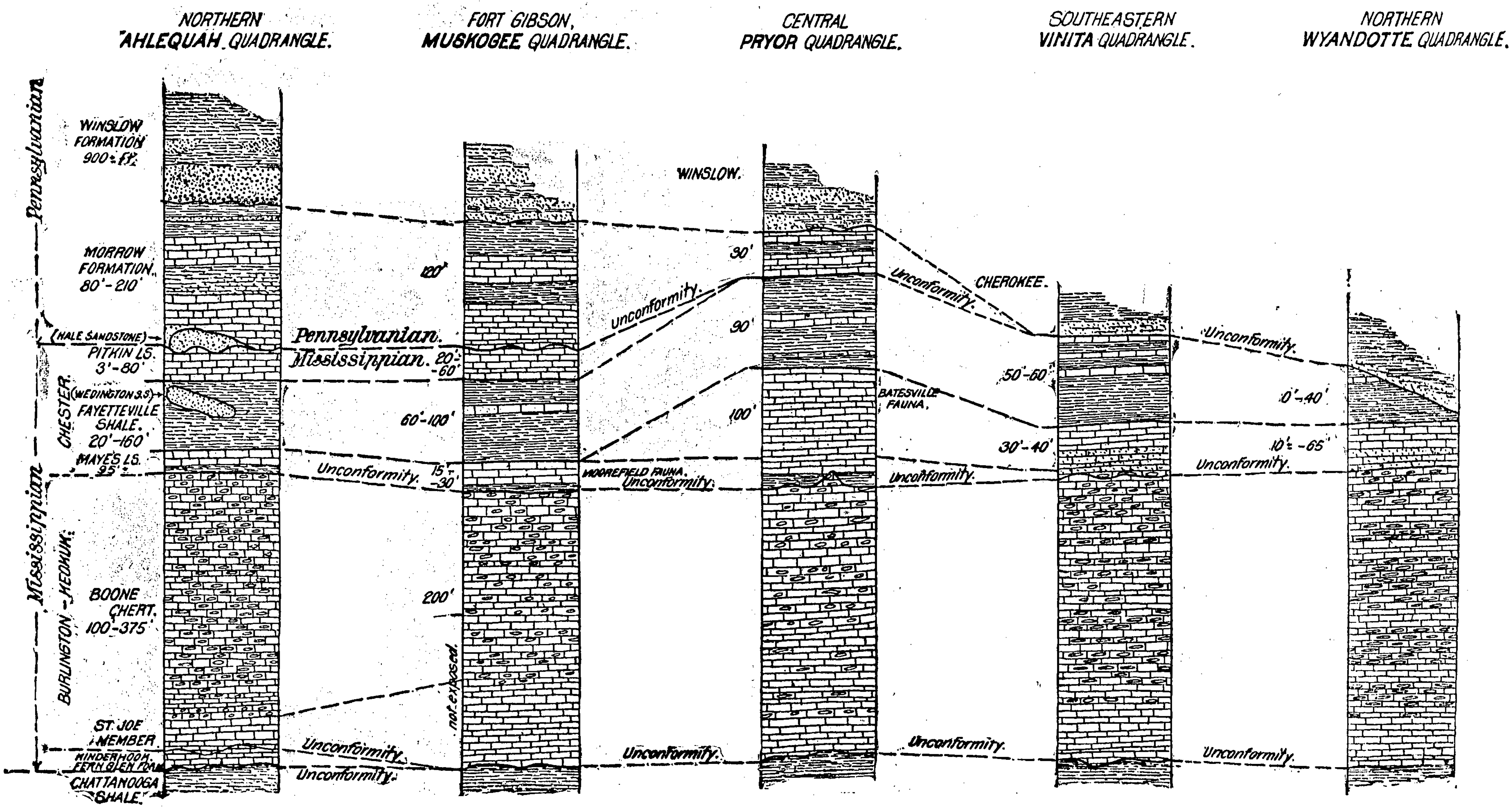
The head of water is very strong and has hindered development to some extent. The water is very strongly charged with hydrogen sulphide. The largest pump in the Joplin district is installed in one of the mines in the Hattonville camp and in conjunction with smaller pumps in the other mines, has been able to lower the water level considerably in a large part of the camp.

The camp has been developed as an extension of the Joplin district and the methods of mining and concentrating are those of that district. They are described in the bulletin referred to above and need not be noticed here.

Besides the Miami camp, there are two other camps in Ottawa County which have made some production. The camp at Quapaw is situated about 10 miles northeast of Miami. The surface rocks are of Boone chert and the ore bodies are runs, circles and sheet ground in the chert. The circles occur around outliers of the Chester rocks in sink holes in the Boone. The ore is predominantly sphalerite and is of low grade compared to that of the Miami camp, although the concentrates are of higher grade, containing less pyrite. This camp was very active prior to 1907 but has declined rapidly since that time and the production has been almost negligible for the last few years. There was no activity when the camp was visited in the summer of 1914 and only 2 or 3 mills out of over 40 which have been built in the camp were in condition to resume operations.

The Peoria camp, situated about 5 miles southeast of the Quapaw camp, and 3 miles from the Missouri line, is the oldest camp in Oklahoma. The development started in 1891 and for some years a considerable production was made. The ore consisted of galena, smithsonite, and calamine in the red, residual clay of the Boone, which is the surface rock. The production has been very small for several years and there was no activity when the camp was visited in the summer of 1914.

Columnar sections of the MISSISSIPPIAN ROCKS in northeastern Oklahoma.



The production of the three camps since 1907 is shown in the following table.*

MIAMI CAMP.

Year	Galena	Value	Sphalerite	Value	Total tons concentrates	Total value
*1907	----	-------	------			
1908	1730	$ 92,177	6475	$139.595	8205	$ 231,772
1909	4056	210,586	11569	361,029	15265	571,615
1910	3364	174,134	10055	294,877	13419	469,011
1911	2848	152,527	8391	247,530	11039	400,057
1912	4256	231,628	10258	405,975	14514	637,603
1913	7710	397,927	23018	725,163	31728	1,123,090

QUAPAW CAMP.

Year	Galena	Value	Sphalerite	Value	Zinc carbonate	Value	Total production	Total value
1907	647	$43,644	3062	$118,400	97	$1,631	3806	$163,675
1908	504	26,076	3539	109,779	19	300	4062	136,155
1909	244	12,545	5015	207,585	38	586	5297	220,716
1910	270	13,727	3921	152,166	--	----	4191	165,183
1911	329	18,202	2245	82,571	6	85	2580	100,858
1912	1	50	1621	78,404	2	50	1624	78,504
1913	97	5,000	1097	41,037	--	----	1194	46.037

PEORIA CAMP.

Year	Galena	Value	Lead carbonate	Value	Sphalerite	Value	Zinc carbonate and silicate	Value	Total production	Total Total
1907	15	$1,157	5	$275	14	$568	583	$14,036	587	$16,006
1908	2	80	---	----	24	617	261	6,325	287	7,012
1909	6	246	---	----	--	----	267	7,348	273	7,594
1910	3	160	1	42	--	----	65	1,406	69	1,608
1911	12	628	---	----	--	----	311	8,330	323	8,958
1912	--	-----	---	----	--	----	90	2,500	90	2,500
1913	3	170	---	----	6	192	67	1,340	76	1,702

*Mineral Resources of the U. S., U. S. Geol. Survey.

STRUCTURAL MATERIALS.

Several of the formations of the area are more or less suitable for use as building stone or road materials, but the region is so sparsely settled that there is little or no home market for such products and none of them possess sufficiently valuable properties to enable them to be shipped long distances in competition with other materials nearer the markets.

The St. Clair marble has been quarried on a commercial scale at Marble City in Sequoyah County. The stone is massive and can be quarried with tolerable ease, and large blocks of uniform texture and color can be obtained. The color is a light gray, grading into a pinkish. The stone takes a good polish but is too soft to retain the polish when exposed to the weather. When left rough or with a sawed face it makes an excellent building stone, and when polished is suitable for interior work.

The Pitkin and Morrow limestones have been quarried for crushed stone at Keough, near Ft. Gibson. The principal use of the product was for concrete, although some was used in the making of macadam streets in Muskogee. The quarry has not been operated for some time.

These limestones, as well as the limestone and cherts of the Boone formation, will furnish an inexhaustible supply of road material when the development of the country is such that improved roads are demanded. Some use has been made of the "chats" or tailings from the lead and zinc mines in the vicinity of Miami and some has been used for ballast by the Missouri, Oklahoma and Gulf Railroad.

The shale of the Fayetteville formation and those of the Winslow and Cherokee are suitable for the manufacture of the ordinary clay products but at present there is not sufficient demand for these products to justify any attempts at development.

SOILS.

The only formation of the area which has sufficient area of outcrop to render the consideration of the soils of importance is the Boone formation. This formation produces a cherty soil which on the level uplands reaches a depth of 10 feet or even more. The upper portion of the soil may be free from chert, but the chert increases rapidly with depth. Where it is free from chert, the soil is a dark red, sandy loam, porous and well drained. It is a very productive soil, all of the common crops of the region doing well on it. It is especially adapted for fruit raising. The famous fruit belt of southwestern Missouri and northwestern Arkansas is in the same area of the Boone formation and the soils are precisely similar to those of the Boone in Oklahoma. Fruit raising is beginning to attract some attention in this section of Oklahoma, but the lack of transportation facilities is a serious drawback to the development of the industry in much of the area.

The soil of the narrow valleys is generally very cherty but is quite productive. The hill slopes are too steep to hold the soil and are covered with loose chert, with sufficient soil in the lower part to support tree growth.

The areas of the older rocks are too small to have any important bearing on the soils. They occur in the stream valleys and the soil is largely wash from the higher Boone areas.

The Chester formations outcrop on the slopes in the southern part of the area and produce practically no soil areas of importance. Along the west side of the uplift the Chester outcrop widens and produces a prairie of considerable extent from the vicinity of Pryor to the northeast. The soil of the Mayes is generally thin, but where it is of sufficient thickness is very productive. The Fayetteville soil is thicker than that of the Mayes, but is a tight, poorly drained soil less productive than that of the Mayes. The most important crop from the Chester soils of this prairie as well as from the soils of the Cherokee is prairie hay which is produced in enormous quantities.

WATER RESOURCES.

The Boone chert area is well supplied with surface water of excellent quality. Springs are abundant and many of them are of large capacity. The water of the streams is clear and free from harmful impurities. The fall of many of the smaller streams is sufficient to develop considerable water power and of the larger streams, the Illinois and Grand rivers furnish several sites for the development of power on a large scale. The development of power from Grand River near Ft. Gibson and from Illinois River at the great bend northeast of Tahlequah has been planned. So far, however, the plans are in the formative stage.

Around the margin of the uplift and for some distance to the west, strong flows of highly mineralized water are obtained at a depth of a few hundred feet. The water-bearing horizons are the sandstones and dolomites near the top of the Ordovician system. The Chattanooga shale acts as a cap rock in preventing the escape of the water to the surface. The water varies considerably in the different wells but in general is a sulpho-saline water. Hydrogen sulphide is commonly present in considerable amount. Sodium

chloride forms the greater part of the mineral content and the chloride and carbonate of calcium and magnesium are also important constituents. A partial list of the localities where the mineral water has been obtained is as follows: Miami, Afton, Fairland, Vinita, Pryor, Adair, Chouteau, Chelsea, Claremore, Wagoner, Vian, and northeast of Tahlequah. The water is used for medicinal purposes in bath-houses and sanitariums at Claremore, Wagoner, Pryor, Chelsea, Nowata, and Vinita. Claremore has a considerable reputation as a health resort, based on the mineral water.

PROSPECTS FOR PETROLEUM AND NATURAL GAS.

The Mississippian area lies to the east and northeast of the main petroleum and gas fields of Oklahoma. Several attempts have been made to extend the field to the east but so far without success.

The rocks outcropping in the area underlie the productive rocks of the main field, where the Boone formation is known as the "Mississippi lime." So far as can be determined no commercial deposits of either oil or gas have been found in or below this formation in Oklahoma, Kansas, Missouri, or Arkansas, although the rocks have been penetrated in many places.

The structural conditions are favorable locally for accumulation, and strata favorable for reservoirs and cap rocks are present in the formations underlying the Boone. However, there seems to be little or no organic material in the rocks, and they are everywhere saturated with salt water. The flowing salt wells on such structures as the anticline northeast of Tahlequah and the dome on Grand River southeast of Chouteau almost preclude the possibility of oil or gas being present in commercial quantities.

DISTRIBUTION OF FOSSILS IN THE CHESTER GROUP.

MAYES FORMATION.

SPECIES	M.1 S. of Tahlequah	M.2 S.E. of Hulbert	M.3 Fourteen Mile Creek	M.4 S.E. of Fort Gibson	M.5 " " "	M.6 N.E. of Yonkers	M.7 S.W. of Locust Grove	M.8 (a S.E. of Chouteau	M.8 b " "	M.8 c " "	M.9 S.E. ¼ Sec. 16 T.19N. R.19E.	M.10 Pryor Creek	M.11 " "	M.12 Rock Creek	M.13 N.W. of Pensacola	M.14 Branch of Rock Cr. N.E. of Adair	M.15 S.E. of Vinita on Locust Cr.	M.16 Little Cabin Creek	M.17 Branch of Little Cabin Cr.	M.18 S.W. of Bernice	M.19 N.E. of Bernice	M.20 " "	M.21 S.E. of Miami
ANTHOZOA.																							
PALEACIS CUNEATA																							
ZAPHRENTIS SPINULOSA						◆		?								◆							◆
PACHYPORA OKLAHOMENSIS																						◆	
MICHELINIA MEEKANA																					◆		
BLASTOIDEA.																							
PENTREMITES SP.							◆																
CRINOIDEA.																							
AGASSIZOCRINUS SP.							◆									◆					◆		
CRINOIDEA SP.							◆			◆			◆										
BRYOZOA. (LIST NOT COMPLETE)																							
CYSTODICTYA NITIDA																							
CYSTODICTYA AMERICANA																							
CYSTODICTYA LABIOSA																							
RHOMBOPORA TABULATA																							
STREBLOTRYPA NICKLESI																							
STREBLOTRYPA SUBSPINOSA																							
FENESTELLA COMPRESSA																							
FENESTELLA SERRATULA																							
FENESTELLA CESTRIENSIS																							
FENESTELLA ELEVATIPORA																							
FENESTELLA cf. TRISERIALIS																							
ARCHIMEDES INVAGINATUS																							
ARCHIMEDES SUBLAXUS																							
ARCHIMEDES PROUTANUS							◆			◆													
ARCHIMEDES CONFERTUS							◆	◆								◆							
ARCHIMEDES DISTANS																							
POLYPORA CESTRIENSIS																							
POLYPORA SPINULIFERA																							
THAMNISCUS FURCILLATUS																							
BRACHIOPODA.																							
LINGULA BATESVILLAE								◆						◆	◆								
LINGULIDISCINA NEWBERRYI var. MOOREFIELDANA	◆			◆		◆		◆															
" " " OVATA						?																	
CRANIA CHESTERENSIS																							
RHIPIDOMELLA ARKANSANA				?				◆															
ORTHOTETES KASKASKIENSIS		◆					◆			◆	◆	◆	◆			◆	◆	◆	◆		◆		◆
CHONETES OKLAHOMENSIS							?									◆						?	
CHONETES CHEROKEENSIS	◆		◆	◆													◆						
CHONETES SERICEUS ?																◆	◆						
PRODUCTELLA HIRSUTIFORMIS				◆																			
" " var. BATESVILLENSIS				◆																			
PRODUCTUS INFLATUS									?														
PRODUCTUS OVATUS		◆	◆	◆	◆		◆			◆	◆		◆		◆	◆	◆	◆	◆	◆	◆	◆	◆
" " var. MINOR																							
" " var. LATIOR	◆			◆		◆			◆														
PRODUCTUS COLORADOENSIS				◆		◆			◆													◆	
PRODUCTUS CHEROKEENSIS																							
PRODUCTUS ARKANSANUS																					◆		
" " var. MULTILIRATUS				◆																			
PUSTULA ALTERNATA												◆										◆	
PUSTULA MOOREFIELDANA				◆																			
PUSTULA SUBSULCATA			◆	◆			◆	◆	◆														
PUSTULA BISERIATA?				◆																			
AVONIA OKLAHOMENSIS				◆																			
DIAPHRAGMUS ELEGANS		◆					◆			◆	◆		◆		◆	◆	◆	◆	◆	◆	◆		◆
MARGINIFERA ADAIRENSIS							◆									◆					◆		
CAMAROPHORIA CESTRIENSIS				◆																			
CAMAROTOECHIA PURDUEI		◆	◆			◆	◆		?					◆	◆							◆	◆
LIORHYNCHUS CARBONIFERUM	◆		◆	◆	◆	◆		◆	◆				◆										
" " var. POLYPLEURUM									◆														
MOOREFIELDELLA EUREKENSIS				◆	◆				◆					◆	◆							◆	
DIELASMA SHUMARDANA		◆		?						◆			◆	◆	◆	◆				◆			
DIELASMA COMPRESSA				◆																			
GIRTYELLA BREVILOBATA																							
GIRTYELLA INDIANENSIS							◆			◆	◆			◆	◆		◆	◆			◆		
" " var. EXPORRECTA																							
SPIRIFER PELLAENSIS		◆				◆														◆	◆		
SPIRIFER LEIDYI							◆			◆	◆			◆	◆	◆	◆	◆					
SPIRIFER ARKANSANUS				◆				◆														◆	
SPIRIFER FAYETTEVILLENSIS																							
BRACHYTHYRIS OZARKENSIS							?																
RETICULARIA SETIGERA		◆	◆	?		◆	◆	◆		◆						◆	◆	◆					
AMBOCOELIA LEVICULA ?			◆			◆																	
MARTINIA GLABRA?	◆			◆																			
SPIRIFERINA TRANSVERSA							◆									◆							
SPIRIFERINA SPINOSA				◆																	◆		
HUSTEDIA MULTICOSTATA																							
EUMETRIA VERNEUILANA									◆														
EUMETRIA VERA																◆							
EUMETRIA COSTATA		◆					◆			◆	◆			◆	◆		◆	◆		◆	◆		
EUMETRIA LATA																							
EUMETRIA PITKINENSIS																							
ATHYRIS CESTRIENSIS																		◆			◆		
CLIOTHYRIDINA SUBLAMELLOSA																							
COMPOSITA TRINUCLEA		◆					◆			◆			◆			◆		◆			◆		
COMPOSITA SP.				◆							◆			◆	◆							◆	◆
COMPOSITA LEWISENSIS																		◆					
COMPOSITA ROTUNDA				◆	◆																		

FAYETTEVILLE FORMATION.

SPECIES	F.1 S.E. of Hulbert	F.2 N.E. of Gore	F.3 S.E. of Fort Gibson	F.4 " "	F.5 S. of Yonkers	F.6 Sec. 8 T.18N. R.20E.	F.7 Cat Creek (Limestone)	F.8 " " (Shale)	F.9 S.E. ¼ Sec. 16 T.19N. R.19E.	F.10 On Grand River S.E. of Chouteau	F.11 S.W. ¼ Sec. 32 T.20N. R.19E.	F.12 S.W. of Locust Grove	F.13 S.E. of Pryor	F.14 E. of Adair	F.15 S.E. ¼ Sec. 6 T.22N. R.20E. S.E. of Adair	F.16 " "	F.17 S.E. of Vinita in Sec. 33 T.25N. R.21E.	F.18 S.E. of Vinita	F.19 " " in S.W. ¼ Sec. 22 T.25N. R.21E.	F.20 2 Miles S. of Todd	F.21 E. of Todd	F.22 S.E. of Fairland
ANTHOZOA.																						
PALEACIS CUNEATA																	◆	◆	◆	◆		
ZAPHRENTIS SPINULOSA	◆													◆		◆	◆	◆		◆	?	◆
PACHYPORA OKLAHOMENSIS																						
MICHELINIA MEEKANA														◆		◆	◆	◆	◆	◆	◆	
BLASTOIDEA.																						
PENTREMITES SP.	◆																					
CRINOIDEA.																						
AGASSIZOCRINUS SP.																						
CRINOIDEA SP.																			◆			
BRYOZOA. (LIST NOT COMPLETE)																						
CYSTODICTYA NITIDA																			◆	◆	◆	◆
CYSTODICTYA AMERICANA																					◆	
CYSTODICTYA LABIOSA																			◆	◆	◆	◆
RHOMBOPORA TABULATA																			◆	◆	◆	◆
STREBLOTRYPA NICKLESI																			◆	◆	◆	◆
STREBLOTRYPA SUBSPINOSA																					◆	
FENESTELLA COMPRESSA																			◆			
FENESTELLA SERRATULA																				◆		◆
FENESTELLA CESTRIENSIS																			◆	◆	◆	
FENESTELLA ELEVATIPORA																			◆		◆	
FENESTELLA cf. TRISERIALIS																			◆		◆	◆
ARCHIMEDES INVAGINATUS	◆																	◆		◆	◆	◆
ARCHIMEDES SUBLAXUS																					◆	
ARCHIMEDES PROUTANUS	◆								◆											◆	◆	
ARCHIMEDES CONFERTUS																						
ARCHIMEDES DISTANS																				◆		
POLYPORA CESTRIENSIS																			◆	◆	◆	◆
POLYPORA SPINULIFERA																						◆
THAMNISCUS FURCILLATUS																					◆	
BRACHIOPODA.																						
LINGULA BATESVILLAE																						
LINGULIDISCINA NEWBERRYI var. MOOREFIELDANA								?														
" " " OVATA																						
CRANIA CHESTERENSIS																◆	◆		◆			
RHIPIDOMELLA ARKANSANA																						
ORTHOTETES KASKASKIENSIS	◆	◆			◆	◆	◆		◆		◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆
CHONETES OKLAHOMENSIS		◆		◆							◆	◆		◆		◆	◆			◆	◆	◆
CHONETES CHEROKEENSIS																						
CHONETES SERICEUS ?																						
PRODUCTELLA HIRSUTIFORMIS																						
" " var. BATESVILLENSIS																						
PRODUCTUS INFLATUS									◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆		
PRODUCTUS OVATUS	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆		◆			◆						
" " var. MINOR															◆		◆		◆	◆	◆	◆
" " var. LATIOR																						
PRODUCTUS COLORADOENSIS																						
PRODUCTUS CHEROKEENSIS								◆		◆				◆		◆			◆		◆	◆
PRODUCTUS ARKANSANUS	◆	◆	◆							◆	◆	◆										
" " var. MULTILIRATUS																						
PUSTULA ALTERNATA													◆						◆	◆	◆	◆
PUSTULA MOOREFIELDANA																						
PUSTULA SUBSULCATA																						
PUSTULA BISERIATA?																						
AVONIA OKLAHOMENSIS																?						
DIAPHRAGMUS ELEGANS	◆	◆		◆	◆	◆	◆		◆							◆						
MARGINIFERA ADAIRENSIS			◆																			
CAMAROPHORIA CESTRIENSIS	◆						◆									◆						
CAMAROTOECHIA PURDUEI	◆							◆		◆	◆	◆		◆		◆	◆		◆	◆		◆
LIORHYNCHUS CARBONIFERUM																						
" " var. POLYPLEURUM																						
MOOREFIELDELLA EUREKENSIS																						
DIELASMA SHUMARDANA	◆	◆	◆						?			?										
DIELASMA COMPRESSA										◆			◆			◆						
GIRTYELLA BREVILOBATA									◆													
GIRTYELLA INDIANENSIS			◆	◆	◆				◆							◆	◆					
" " var. EXPORRECTA					◆																	
SPIRIFER PELLAENSIS	◆	◆		◆	◆	◆				◆	◆	◆	◆	◆		◆	◆	◆	◆			
SPIRIFER LEIDYI							◆		◆												◆	
SPIRIFER ARKANSANUS																						
SPIRIFER FAYETTEVILLENSIS								◆														
BRACHYTHYRIS OZARKENSIS										◆	◆	◆	◆	◆		◆						
RETICULARIA SETIGERA	◆			◆	◆		◆		◆				◆	◆		◆						
AMBOCOELIA LEVICULA ?																	?					
MARTINIA GLABRA?																						
SPIRIFERINA TRANSVERSA			◆													◆				◆		
SPIRIFERINA SPINOSA				◆		◆				◆				◆		◆	◆	◆	◆		◆	◆
HUSTEDIA MULTICOSTATA																						
EUMETRIA VERNEUILANA									◆													
EUMETRIA VERA	◆				◆								◆				◆					
EUMETRIA COSTATA		◆					◆									◆						
EUMETRIA LATA															◆							
EUMETRIA PITKINENSIS																						
ATHYRIS CESTRIENSIS				◆																		
CLIOTHYRIDINA SUBLAMELLOSA						◆		◆						◆						◆	◆	◆
COMPOSITA TRINUCLEA	?		◆	◆	◆		?	?	◆					◆		◆	◆	◆		◆	◆	
COMPOSITA SP.		◆											◆									
COMPOSITA LEWISENSIS																						
COMPOSITA ROTUNDA																						

PITKIN FORMATION.

SPECIES	P.1 E. of Stilwell	P.2 N.E. of Gore	P.3 S.W. of Maynard P.O.	P.4 S.E. of Fort Gibson	P.5 Quarry at Keough	P.6 1 Mile E. of Keough	P.7 Melvin	P.8 S.E. of Hulbert	P.9 N.W. of Hulbert	P.10 S. of Yonkers
ANTHOZOA.										
PALEACIS CUNEATA										
ZAPHRENTIS SPINULOSA							◆		◆	
PACHYPORA OKLAHOMENSIS										
MICHELINIA MEEKANA	◆									
BLASTOIDEA.										
PENTREMITES SP.							◆			
CRINOIDEA.										
AGASSIZOCRINUS SP.										
CRINOIDEA SP.										
BRYOZOA. (LIST NOT COMPLETE)										
CYSTODICTYA NITIDA										
CYSTODICTYA AMERICANA										
CYSTODICTYA LABIOSA										
RHOMBOPORA TABULATA										
STREBLOTRYPA NICKLESI										
STREBLOTRYPA SUBSPINOSA										
FENESTELLA COMPRESSA										
FENESTELLA SERRATULA										
FENESTELLA CESTRIENSIS										
FENESTELLA ELEVATIPORA										
FENESTELLA cf. TRISERIALIS										
ARCHIMEDES INVAGINATUS										
ARCHIMEDES SUBLAXUS										
ARCHIMEDES PROUTANUS										
ARCHIMEDES CONFERTUS										
ARCHIMEDES DISTANS										
POLYPORA CESTRIENSIS										
POLYPORA SPINULIFERA										
THAMNISCUS FURCILLATUS										
BRACHIOPODA.										
LINGULA BATESVILLAE										
LINGULIDISCINA NEWBERRYI var. MOOREFIELDANA					?					
" " " OVATA							?			
CRANIA CHESTERENSIS										
RHIPIDOMELLA ARKANSANA										
ORTHOTETES KASKASKIENSIS	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
CHONETES OKLAHOMENSIS				◆	◆				◆	
CHONETES CHEROKEENSIS										
CHONETES SERICEUS ?								◆		
PRODUCTELLA HIRSUTIFORMIS										
" " var. BATESVILLENSIS										
PRODUCTUS INFLATUS										
PRODUCTUS OVATUS	◆	◆		◆	◆	◆	◆	◆	◆	◆
" " var. MINOR										
" " var. LATIOR										
PRODUCTUS COLORADOENSIS										
PRODUCTUS CHEROKEENSIS										
PRODUCTUS ARKANSANUS	◆	◆	◆		◆		◆	◆		
" " var. MULTILIRATUS										
PUSTULA ALTERNATA							◆			
PUSTULA MOOREFIELDANA										
PUSTULA SUBSULCATA										
PUSTULA BISERIATA?										
AVONIA OKLAHOMENSIS										
DIAPHRAGMUS ELEGANS		◆		◆	◆	◆	◆	◆	◆	
MARGINIFERA ADAIRENSIS										
CAMAROPHORIA CESTRIENSIS				◆	◆		◆		◆	◆
CAMAROTOECHIA PURDUEI										
LIORHYNCHUS CARBONIFERUM										
" " var. POLYPLEURUM										
MOOREFIELDELLA EUREKENSIS										
DIELASMA SHUMARDANA						?		◆	◆	
DIELASMA COMPRESSA										
GIRTYELLA BREVILOBATA										
GIRTYELLA INDIANENSIS										
" " var. EXPORRECTA										
SPIRIFER PELLAENSIS	◆	◆		◆	◆	◆			◆	
SPIRIFER LEIDYI			◆	◆				◆		
SPIRIFER ARKANSANUS										
SPIRIFER FAYETTEVILLENSIS										
BRACHYTHYRIS OZARKENSIS										
RETICULARIA SETIGERA							◆	◆	◆	◆
AMBOCOELIA LEVICULA ?										
MARTINIA GLABRA?										
SPIRIFERINA TRANSVERSA										
SPIRIFERINA SPINOSA							◆	◆	◆	
HUSTEDIA MULTICOSTATA							◆		◆	
EUMETRIA VERNEUILANA										
EUMETRIA VERA							◆		◆	
EUMETRIA COSTATA				◆	◆				◆	
EUMETRIA LATA										
EUMETRIA PITKINENSIS								◆		
ATHYRIS CESTRIENSIS										
CLIOTHYRIDINA SUBLAMELLOSA									◆	
COMPOSITA TRINUCLEA	◆	◆			?		◆		◆	◆
COMPOSITA SP.			◆	◆				◆		
COMPOSITA LEWISENSIS										
COMPOSITA ROTUNDA										

DISTRIBUTION OF FOSSILS IN THE CHESTER GROUP

MAYES FORMATION.

SPECIES	M.1 S. of Tahlequah	M.2 S.E. of Hulbert	M.3 Fourteen Mile Creek	M.4 S.E. of Fort Gibson	M.5 " " "	M.6 N.E. of Yonkers	M.7 S.W. of Locust Grove	M.8 (a) S.E. of Chouteau	(b) " " "	(c) " " "	M.9 S.E. ¼ Sec.16 T.19N. R.19E.	M.10 Pryor Creek	M.11 " "	M.12 Rock Creek	M.13 N.W. of Pensacola	M.14 Branch of Rock Cr. N.E. of Adair	M.15 S.E. of Vinita on Locust Cr.	M.16 Little Cabin Creek	M.17 Branch of Little Cabin Cr.	M.18 S.W. of Bernice	M.19 N.E. of Bernice	M.20 " " "	M.21 S.E. of Miami
ANTHOZOA.																							
PALEACIS CUNEATA																							
ZAPHRENTIS SPINULOSA						◆		?								◆							
PACHYPORA OKLAHOMENSIS																							◆
MICHELINIA MEEKANA																					◆	◆	
BLASTOIDEA.																							
PENTREMITES SP.							◆																
CRINOIDEA.																							
AGASSIZOCRINUS SP.							◆									◆					◆		
CRINOIDEA SP.							◆			◆			◆										
BRYOZOA. (LIST NOT COMPLETE)																							
CYSTODICTYA NITIDA																							
CYSTODICTYA AMERICANA																							
CYSTODICTYA LABIOSA																							
RHOMBOPORA TABULATA																							
STREBLOTRYPA NICKLESI																							
STREBLOTRYPA SUBSPINOSA																							
FENESTELLA COMPRESSA																							
FENESTELLA SERRATULA																							
FENESTELLA CESTRIENSIS																							
FENESTELLA ELEVATIPORA																							
FENESTELLA cf. TRISERIALIS																							
ARCHIMEDES INVAGINATUS																							
ARCHIMEDES SUBLAXUS																							
ARCHIMEDES PROUTANUS							◆			◆													
ARCHIMEDES CONFERTUS							◆	◆								◆							
ARCHIMEDES DISTANS																							
POLYPORA CESTRIENSIS																							
POLYPORA SPINULIFERA																							
THAMNISCUS FURCILLATUS																							
BRACHIOPODA.																							
LINGULA BATESVILLAE								◆						◆	◆								
LINGULIDISCINA NEWBERRYI VAR. MOOREFIELDANA	◆			◆		◆		◆															
" " " OVATA						?																	
CRANIA CHESTERENSIS																							
RHIPIDOMELLA ARKANSANA				?				◆															
ORTHOTETES KASKASKIENSIS		◆																					
CHONETES OKLAHOMENSIS							◆			◆	◆	◆	◆			◆	◆	◆	◆		◆		◆
CHONETES CHEROKEENSIS	◆		◆	◆			?									◆						?	
CHONETES SERICEUS ?																	◆						
PRODUCTELLA HIRSUTIFORMIS				◆												◆	◆						
" " VAR. BATESVILLENSIS				◆																			
PRODUCTUS INFLATUS									?														
PRODUCTUS OVATUS		◆	◆	◆	◆		◆			◆	◆		◆		◆	◆	◆	◆	◆	◆	◆	◆	◆
" " VAR. MINOR																							
" " VAR. LATIOR	◆			◆		◆			◆														
PRODUCTUS COLORADOENSIS				◆		◆			◆														
PRODUCTUS CHEROKEENSIS																						◆	
PRODUCTUS ARKANSANUS																							
" " VAR MULTILIRATUS				◆																	◆		
PUSTULA ALTERNATA												◆										◆	
PUSTULA MOOREFIELDANA				◆																			
PUSTULA SUBSULCATA			◆	◆			◆	◆	◆														
PUSTULA BISERIATA?				◆																			
AVONIA OKLAHOMENSIS				◆																			
DIAPHRAGMUS ELEGANS		◆																					
MARGINIFERA ADAIRENSIS							◆			◆	◆		◆		◆	◆	◆	◆	◆	◆	◆		◆
CAMAROPHORIA CESTRIENSIS				◆			◆									◆					◆		
CAMAROTOECHIA PURDUEI		◆	◆			◆	◆		?					◆	◆							◆	◆
LIORHYNCHUS CARBONIFERUM	◆		◆	◆	◆	◆		◆	◆				◆										
" " VAR POLYPLEURUM									◆														
MOOREFIELDELLA EUREKENSIS				◆	◆				◆					◆	◆								
DIELASMA SHUMARDANA		◆		?																		◆	
DIELASMA COMPRESSA				◆						◆			◆	◆	◆	◆				◆			
GIRTYELLA BREVILOBATA																							
GIRTYELLA INDIANENSIS							◆			◆	◆			◆	◆		◆	◆			◆		
" " VAR EXPORRECTA																							
SPIRIFER PELLAENSIS		◆				◆																	
SPIRIFER LEIDYI							◆			◆	◆			◆	◆	◆	◆	◆		◆	◆		
SPIRIFER ARKANSANUS				◆				◆															
SPIRIFER FAYETTEVILLENSIS																						◆	
BRACHYTHYRIS OZARKENSIS							?																
RETICULARIA SETIGERA		◆	◆	?		◆	◆	◆		◆													
AMBOCOELIA LEVICULA ?			◆			◆										◆	◆	◆					
MARTINIA GLABRA?	◆			◆																			
SPIRIFERINA TRANSVERSA							◆									◆							
SPIRIFERINA SPINOSA				◆																			
HUSTEDIA MULTICOSTATA																					◆		
EUMETRIA VERNEUILANA									◆														
EUMETRIA VERA																◆							
EUMETRIA COSTATA		◆					◆			◆	◆			◆	◆		◆	◆		◆	◆		
EUMETRIA LATA																							
EUMETRIA PITKINENSIS																							
ATHYRIS CESTRIENSIS																		◆			◆		
CLIOTHYRIDINA SUBLAMELLOSA																							
COMPOSITA TRINUCLEA		◆					◆			◆			◆			◆		◆			◆		
COMPOSITA SP.				◆							◆			◆	◆							◆	◆
COMPOSITA LEWISENSIS																		◆					
COMPOSITA ROTUNDA				◆	◆																		
PELECYPODA																							

FAYETTEVILLE FORMATION.

SPECIES	F.1 S.E. of Hulbert	F.2 N.E. of Gore	F.3 S.E. of Fort Gibson	F.4 " " "	F.5 S. of Yonkers	F.6 Sec.8 T.18N. R.20E.	F.7 Cat Creek (Limestone)	F.8 " " (Shale.)	F.9 S.E.¼ Sec.16 T.19N. R.19E.	F.10 On Grand River S.E. of Chouteau	F.11 S.W.¼ Sec.32 T.20N. R.19E.	F.12 S.W. of Locust Grove	F.13 S.E. of Pryor	F.14 E. of Adair	F.15 S.E.¼ Sec.6 T.22N. R.20E. S.E. of Adair	F.16 " " "	F.17 S.E. of Vinita in Sec.33 T.25N. R.21E.	F.18 S.E. of Vinita	F.19 " " in S.W.¼ Sec.22 T.25N. R.21E.	F.20 2 Miles S. of Todd	F.21 E. of Todd	F.22 S.E. of Fairland
ANTHOZOA.																						
PALEACIS CUNEATA																						
ZAPHRENTIS SPINULOSA																	◆	◆	◆	◆		
PACHYPORA OKLAHOMENSIS	◆													◆		◆	◆	◆		◆	?	◆
MICHELINIA MEEKANA														◆		◆	◆	◆	◆	◆	◆	
BLASTOIDEA.																						
PENTREMITES SP.	◆																					
CRINOIDEA.																						
AGASSIZOCRINUS SP.																						
CRINOIDEA SP.																			◆			
BRYOZOA. (LIST NOT COMPLETE)																						
CYSTODICTYA NITIDA																						
CYSTODICTYA AMERICANA																			◆	◆	◆	◆
CYSTODICTYA LABIOSA																					◆	
RHOMBOPORA TABULATA																			◆	◆	◆	◆
STREBLOTRYPA NICKLESI																			◆	◆	◆	◆
STREBLOTRYPA SUBSPINOSA																			◆	◆	◆	◆
FENESTELLA COMPRESSA																					◆	
FENESTELLA SERRATULA																			◆			
FENESTELLA CESTRIENSIS																				◆		◆
FENESTELLA ELEVATIPORA																			◆	◆	◆	
FENESTELLA cf. TRISERIALIS																			◆		◆	
ARCHIMEDES INVAGINATUS																			◆		◆	◆
ARCHIMEDES SUBLAXUS	◆																	◆		◆	◆	◆
ARCHIMEDES PROUTANUS																					◆	
ARCHIMEDES CONFERTUS	◆								◆											◆	◆	
ARCHIMEDES DISTANS																						
POLYPORA CESTRIENSIS																				◆		
POLYPORA SPINULIFERA																			◆	◆	◆	◆
THAMNISCUS FURCILLATUS																					◆	◆
BRACHIOPODA.																						
LINGULA BATESVILLAE																						
LINGULIDISCINA NEWBERRYI VAR. MOOREFIELDANA																						
" " " OVATA								?														
CRANIA CHESTERENSIS																						
RHIPIDOMELLA ARKANSANA																◆	◆		◆			
ORTHOTETES KASKASKIENSIS																						
CHONETES OKLAHOMENSIS	◆	◆			◆	◆	◆		◆		◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆
CHONETES CHEROKEENSIS		◆		◆							◆	◆		◆		◆	◆			◆	◆	◆
CHONETES SERICEUS ?																						
PRODUCTELLA HIRSUTIFORMIS																						
" " VAR. BATESVILLENSIS																						
PRODUCTUS INFLATUS																						
PRODUCTUS OVATUS	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆		
" " VAR. MINOR									◆	◆	◆		◆			◆						
" " VAR. LATIOR															◆		◆		◆	◆	◆	◆
PRODUCTUS COLORADOENSIS																						
PRODUCTUS CHEROKEENSIS																						
PRODUCTUS ARKANSANUS								◆		◆				◆		◆			◆		◆	◆
" " VAR MULTILIRATUS	◆	◆	◆							◆	◆	◆										
PUSTULA ALTERNATA																						
PUSTULA MOOREFIELDANA													◆						◆	◆	◆	◆
PUSTULA SUBSULCATA																						
PUSTULA BISERIATA?																						
AVONIA OKLAHOMENSIS																						
DIAPHRAGMUS ELEGANS																?						
MARGINIFERA ADAIRENSIS	◆	◆		◆	◆	◆	◆		◆							◆						
CAMAROPHORIA CESTRIENSIS			◆																			
CAMAROTOECHIA PURDUEI	◆						◆									◆						
LIORHYNCHUS CARBONIFERUM								◆		◆	◆	◆		◆		◆	◆		◆	◆		◆
" " VAR POLYPLEURUM																						
MOOREFIELDELLA EUREKENSIS																						
DIELASMA SHUMARDANA																						
DIELASMA COMPRESSA	◆	◆	◆						?			?										
GIRTYELLA BREVILOBATA										◆			◆			◆						
GIRTYELLA INDIANENSIS			◆	◆	◆				◆													
" " VAR EXPORRECTA									◆							◆	◆					
SPIRIFER PELLAENSIS					◆																	
SPIRIFER LEIDYI	◆	◆		◆	◆	◆				◆	◆	◆	◆	◆		◆	◆	◆	◆			
SPIRIFER ARKANSANUS							◆		◆												◆	
SPIRIFER FAYETTEVILLENSIS																						
BRACHYTHYRIS OZARKENSIS								◆														
RETICULARIA SETIGERA										◆	◆	◆	◆	◆		◆						
AMBOCOELIA LEVICULA ?	◆			◆	◆		◆		◆				◆	◆		◆						
MARTINIA GLABRA?																	?					
SPIRIFERINA TRANSVERSA																						
SPIRIFERINA SPINOSA			◆													◆				◆		
HUSTEDIA MULTICOSTATA				◆		◆				◆				◆		◆	◆	◆	◆		◆	◆
EUMETRIA VERNEUILANA																						
EUMETRIA VERA	◆				◆				◆													
EUMETRIA COSTATA													◆				◆					
EUMETRIA LATA		◆					◆									◆						
EUMETRIA PITKINENSIS															◆							
ATHYRIS CESTRIENSIS				◆																		
CLIOTHYRIDINA SUBLAMELLOSA																						
COMPOSITA TRINUCLEA	?		◆	◆	◆	◆	?	?	◆					◆						◆	◆	◆
COMPOSITA SP.		◆												◆		◆	◆	◆		◆	◆	
COMPOSITA LEWISENSIS													◆									
COMPOSITA ROTUNDA																						
PELECYPODA																						

PITKIN FORMA[TION]

SPECIES	P.1 E. of Stilwell	P.2 N.E. of Gore	P.3 S.W. of Manard P.O.	P.4 S.E. of Fort Gibson	P.5 Quarry at Keough	P.6 1 Mile E. of Keough	P.7 Melvin	P.8 S.E. of Hulbert	
ANTHOZOA.									
PALEACIS CUNEATA									
ZAPHRENTIS SPINULOSA									
PACHYPORA OKLAHOMENSIS							◆		
MICHELINIA MEEKANA	◆								
BLASTOIDEA.									
PENTREMITES SP.							◆		
CRINOIDEA.									
AGASSIZOCRINUS SP.									
CRINOIDEA SP.									
BRYOZOA. (LIST NOT COMPLETE)									
CYSTODICTYA NITIDA									
CYSTODICTYA AMERICANA									
CYSTODICTYA LABIOSA									
RHOMBOPORA TABULATA									
STREBLOTRYPA NICKLESI									
STREBLOTRYPA SUBSPINOSA									
FENESTELLA COMPRESSA									
FENESTELLA SERRATULA									
FENESTELLA CESTRIENSIS									
FENESTELLA ELEVATIPORA									
FENESTELLA cf. TRISERIALIS									
ARCHIMEDES INVAGINATUS									
ARCHIMEDES SUBLAXUS									
ARCHIMEDES PROUTANUS									
ARCHIMEDES CONFERTUS									
ARCHIMEDES DISTANS									
POLYPORA CESTRIENSIS									
POLYPORA SPINULIFERA									
THAMNISCUS FURCILLATUS									
BRACHIOPODA.									
LINGULA BATESVILLAE									
LINGULIDISCINA NEWBERRYI VAR. MOOREFIELDANA									
" " " OVATA					?				
CRANIA CHESTERENSIS							?		
RHIPIDOMELLA ARKANSANA									
ORTHOTETES KASKASKIENSIS									
CHONETES OKLAHOMENSIS	◆	◆	◆	◆	◆	◆	◆	◆	
CHONETES CHEROKEENSIS				◆	◆				
CHONETES SERICEUS ?									
PRODUCTELLA HIRSUTIFORMIS								◆	
" " VAR. BATESVILLENSIS									
PRODUCTUS INFLATUS									
PRODUCTUS OVATUS									
" " VAR. MINOR	◆	◆		◆	◆	◆	◆	◆	
" " VAR. LATIOR									
PRODUCTUS COLORADOENSIS									
PRODUCTUS CHEROKEENSIS									
PRODUCTUS ARKANSANUS									
" " VAR MULTILIRATUS	◆	◆	◆		◆		◆	◆	
PUSTULA ALTERNATA									
PUSTULA MOOREFIELDANA							◆		
PUSTULA SUBSULCATA									
PUSTULA BISERIATA?									
AVONIA OKLAHOMENSIS									
DIAPHRAGMUS ELEGANS									
MARGINIFERA ADAIRENSIS		◆		◆	◆	◆	◆	◆	◆
CAMAROPHORIA CESTRIENSIS									
CAMAROTOECHIA PURDUEI				◆	◆		◆		◆
LIORHYNCHUS CARBONIFERUM									
" " VAR POLYPLEURUM									
MOOREFIELDELLA EUREKENSIS									
DIELASMA SHUMARDANA									
DIELASMA COMPRESSA						?		◆	◆
GIRTYELLA BREVILOBATA									
GIRTYELLA INDIANENSIS									
" " VAR EXPORRECTA									
SPIRIFER PELLAENSIS									
SPIRIFER LEIDYI	◆	◆		◆	◆	◆			◆
SPIRIFER ARKANSANUS			◆	◆				◆	
SPIRIFER FAYETTEVILLENSIS									
BRACHYTHYRIS OZARKENSIS									
RETICULARIA SETIGERA									
AMBOCOELIA LEVICULA ?							◆	◆	◆
MARTINIA GLABRA?									
SPIRIFERINA TRANSVERSA									
SPIRIFERINA SPINOSA									
HUSTEDIA MULTICOSTATA							◆	◆	◆
EUMETRIA VERNEUILANA							◆		◆
EUMETRIA VERA									
EUMETRIA COSTATA							◆		◆
EUMETRIA LATA				◆	◆				◆
EUMETRIA PITKINENSIS									
ATHYRIS CESTRIENSIS								◆	
CLIOTHYRIDINA SUBLAMELLOSA									
COMPOSITA TRINUCLEA									◆
COMPOSITA SP.	◆	◆			?		◆		◆
COMPOSITA LEWISENSIS			◆	◆				◆	
COMPOSITA ROTUNDA									
PELECYPODA									

" " var MINOR
" " var LATIOR
PRODUCTUS COLORADOENSIS
PRODUCTUS CHEROKEENSIS
PRODUCTUS ARKANSANUS
" " var MULTILIRATUS
PUSTULA ALTERNATA
PUSTULA MOOREFIELDANA
PUSTULA SUBSULCATA
PUSTULA BISERIATA?
AVONIA OKLAHOMENSIS
DIAPHRAGMUS ELEGANS
MARGINIFERA ADAIRENSIS
CAMAROPHORIA CESTRIENSIS
CAMAROTOECHIA PURDUEI
LIORHYNCHUS CARBONIFERUM
" " var POLYPLEURUM
MOOREFIELDELLA EUREKENSIS
DIELASMA SHUMARDANA
DIELASMA COMPRESSA
GIRTYELLA BREVILOBATA
GIRTYELLA INDIANENSIS
" " var EXPORRECTA
SPIRIFER PELLAENSIS
SPIRIFER LEIDYI
SPIRIFER ARKANSANUS
SPIRIFER FAYETTEVILLENSIS
BRACHYTHYRIS OZARKENSIS
RETICULARIA SETIGERA
AMBOCOELIA LEVICULA ?
MARTINIA GLABRA ?
SPIRIFERINA TRANSVERSA
SPIRIFERINA SPINOSA
HUSTEDIA MULTICOSTATA
EUMETRIA VERNEUILANA
EUMETRIA VERA
EUMETRIA COSTATA
EUMETRIA LATA
EUMETRIA PITKINENSIS
ATHYRIS CESTRIENSIS
CLIOTHYRIDINA SUBLAMELLOSA
COMPOSITA TRINUCLEA
COMPOSITA SP.
COMPOSITA LEWISENSIS
COMPOSITA ROTUNDA

PELECYPODA.

SOLENOMYA ? SP.
SOLENOPSIS NITIDA ?
SPHENOTUS CHEROKEENSE
SPHENOTUS OKLAHOMENSE
SPHENOTUS QUADRIPLICATUM
SPHENOTUS WASHINGTONENSE
SPHENOTUS GIBSONENSE
EDMONDIA CRASSA
" " var SUBORBICULATA
EDMONDIA PITKINENSIS
NUCULA RECTANGULA
NUCULA ILLINOIENSIS
LEDA VASEYANA
CYPRICARDINIA MOOREFIELDANA
PARALLELODON MULTIRATUS
PINNA CONSIMILIS
PINNA ARKANSANA ?
CONOCARDIUM PECULIARE
CANEYELLA VAUGHANI ?
LEIOPTERIA ? SP.
MYALINA COMPRESSA
MYALINA LONGICARDINALIS
SCHIZODUS DEPRESSUS
SCHIZODUS CHESTERENSIS ?
SCHIZODUS INSIGNIS ?
SCHIZODUS SP.
DELTOPECTEN BATESVILLENSIS
DELTOPECTEN TAHLEQUAHENSIS
AVICULOPECTEN EUREKENSIS
AVICULOPECTEN MAYESENSIS
AVICULOPECTEN MORROWENSIS
AVICULOPECTEN OZARKENSIS
AVICULOPECTEN KEOUGHENSIS
AVICULOPECTEN PITKINENSIS
AVICULOPECTEN SP. 1 & 2
STREBLOPTERIA SIMILIS
ALLORISMA WALKERI
ALLORISMA ARKANSANA

GASTROPODA.

BELLEROPHON SP.
BELLEROPHON PITKINENSIS
PLEUROTOMARIA ? SP. 1
PLEUROTOMARIA ? SP. 2
PLEUROTOMARIA ? SP. 3
MURCHISONIA ? SP.
BEMBEXIA NODOMARGINATA
BULIMORPHA CANALICULATA ?
STRAPAROLLUS SPERGENENSIS
STRAPAROLLUS PLANIDORSATUS
STROPHOSTYLUS ? SP.
HOLOPEA NEWTONENSIS
SPHAERODOMA SUBCORPULENTA
ORTHONYCHIA MAYESENSE
ORTHONYCHIA ? SP.
PLATYCERAS SUBROTUNDUM

CEPHALOPODA.

ORTHOCERAS EUREKENSIS ?
CYCLOCERAS RANDOLPHENSIS ?
CYCLOCERAS SEQUOYAHENSIS
LEUROCERAS ? SP.
GLYPHIOCERAS KENTUCKIENSIS

TRILOBITA.

GRIFFITHIDES PUSTULOSUS

PART II.

THE PALEONTOLOGY OF THE CHESTER OROUP IN OKLAHOMA.

INTRODUCTION.

In this section of the report the paleontology of the Chester group is considered systematically. The stratigraphy of the formations has been considered at length and the faunal lists have been given in Part I. Consequently it is necessary to give in this place only the list of collection localities and descriptions or notes of the genera and species.

Two important publications bearing on the fauna of this group have appeared recently: *The Fauna of the Moorefield Shale* by George H. Girty, published as Bulletin No. 439 of the United States Geological Survey in 1911, and *A Monograph of the Mississippian Brachiopoda of the Mississippi Valley* by Stuart Weller, published as Monograph No. 1 of the Illinois State Geological Survey in 1914. A .rge proportion of the species of the Chester faunas of Oklahoma, especially of the brachiopoda, are described and illustrated in these reports.

No attempt is made in the present report to redescribe and illustrate these forms, such treatment being restricted to the new forms and to those for which the literature is not easily available. All the species are listed, however, with notes on their distribution in Oklahoma and such other notes as have seemed desirable.

Neither have complete bibliographic references been made. References to the original description and figures are given, and in most cases, to some easily available publication, especially to those of Girty and Weller which have been mentioned.

The information concerning the fauna is summarized in a table giving a complete list of the forms and their distribution by localities.

The collections on which this report is based are 55 in number; 23 from the Mayes formation, 22 from the Fayetteville formation, and 10 from the Pitkin formation.

LIST OF COLLECTION LOCALITIES.

In the following list the collection localities for each formation studied are numbered serially, beginning at the east end of the strip south of the Boone chert area, and numbering to the west, then to the north and northeast around the margin of the uplift. The formations are listed separately, the initial letter of the formation name being prefixed to the serial number of the collection.

Collection localities in the Mayes formation.

M 1. Sec. 4, T. 16 N., R. 22 E., about center of section, on road 1 mile south of Tahlequah. Tahlequah quadrangle.

M 2. NE. 1-4 sec. 25, T. 17 N., R. 20 E., about 1 mile east of Hulbert. Muskogee quadrangle.

M 3. N. 1-2 sec. 10, T. 17 N., R. 20 E., just south of Fourteen-mile Creek, mile west and 3 miles north of Hulbert. Muskogee quadrangle.

M 4. SW. 1-4 sec. 21, T. 15 N., R. 20 E., 3 miles east and 3 miles south of Ft. Gibson. Muskogee quadrangle.

M 5. N. 1-2 sec. 29, T. 15 N., R. 20 E., about 1 mile southwest of M 4. Muskogee quadrangle.

M 6. Sec. 2, T. 18 N., R. 19 E., in small quarry along road about 2 miles northeast of Yonkers. Pryor quadrangle.

M 7. SW. 1-4 sec. 29, T. 20 N., R. 20 E., in cut of Missouri, Oklahoma and Gulf R. R., about 3 miles southwest of Locust Grove. Pryor quadrangle.

M 8. NE. 1-4 sec. 8, T. 19 N., R. 19 E., on bluff of Grand River, about 5 miles southeast of Chouteau. Pryor quadrangle.

c. Upper part of limestone immediately below the black shale of the Fayetteville.

b. Lower part of limestone about 15 feet above chert in a draw toward the south end of the bluff.

a. Black, sandy shale immediately above the chert.

M 9. SE. 1-4 sec. 16, T. 19 N., R. 19 E., at foot of hill. Pryor quadrangle.

M 10. On road on section line between secs. 11 and 14, T. 20 N., R. 19 E., immediately east of Pryor Creek. Pryor quadrangle.

M 11. NW. 1-4 sec. 11, T. 20 N., R. 19 E., in draw into Pryor Creek from northeast, one mile north of M 10. Pryor quadrangle.

M 12. NE. 1-4 sec. 32, T. 23 N., R. 20 E., west side of road crossing Rock Creek, 3 miles west and 1 mile south of Pensacola. Pryor quadrangle.

M 13. About middle of west side of sec. 23, T. 23 N., R. 20 E., on east side of road in draw into Cabin Creek, 1 mile west and 1-2 mile north of Pensacola. Pryor quadrangle.

M 14. Near southeast corner of sec. 23, T. 23 N., R. 19 E., at road crossing of small draw leading northeast into Rock Creek; 2 miles east and 1 mile north of Adair. Pryor quadrangle.

M 15. On east side of road on section line between secs. 31 and 32, T. 25 N., R. 21 E., about 40 rods south of Locust Creek. Vinita quadrangle.

M 16. Below bridge over Little Cabin Creek, 3 miles east of Vinita, north center of sec. 19, T. 25 N., R. 21 E. Vinita quadrangle.

M 17. About 1 mile west of M 16, on south line of sec. 13, T. 25 N., R. 20 E. Vinita quadrangle.

M 18. On road on section line between secs. 35 and 36, T. 25 N., R. 22 E., 1 mile west and one-half mile south of Bernice. Wyandotte quadrangle.

M 19. Along road in SE. 1-4 sec. 10, T. 25 N., R. 23 E., about 5 miles northeast of Bernice. Wyandotte quadrangle.

M 20. Along Grand River in SE. 1-4 sec. 10, T. 25 N., R. 23 E., about one-fourth mile from M 19. Wyandotte quadrangle.

M 21. On west slope of hill at NE. corner sec. 4, T. 27 N., R. 22 E., 3 miles east and 1 mile south of Miami. Wyandotte quadrangle.

Collection localities in the Fayetteville formation.

(All collections except F 8 are from the limestone member or the calcareous shales immediately associated with the limestone).

F 1. NE. 1-4 sec. 25, T. 17 N., R. 20 E., about 1 mile east of Hulbert, up hill from M 2. Muskogee quadrangle.

F 2. Near NE. corner of sec. 20, T. 13 N., R. 21 E., about 4 miles north and 1 mile east of Gore, (formerly Campbell). Muskogee quadrangle.

F 3. SW. 1-4 sec. 21, T. 15 N., R. 20 E., 3 miles east and 3 miles south of Ft. Gibson, up hill from M 4. Muskogee quadrangle.

F 4. N. 1-2 sec. 29, T. 15 N., R. 20 E., about 1 mile southwest of F 3, up hill from M 5. Muskogee quadrangle.

F 5. From banks of small westward flowing stream in E. 1-2 sec. 16, T. 18 N., R. 19 E., about 1 1-2 miles southwest of Yonkers. Pryor quadrangle.

F 6. About the center of sec. 8, T. 18 N., R. 20 E., about 4 miles east of Yonkers. Pryor quadrangle.

F 7. Cat Creek at road crossing on line between secs. 5 and 8, T. 18 N., R. 19 E. Pryor quadrangle.

F 8. Cat Creek about three-fourths mile up stream from F 7. (From black shale above the limestone in the Fayetteville). Pryor quadrangle.

F 9. SE. 1-4 sec. 16, T. 19 N., R. 19 E., up hill from M 9. Pryor quadrangle

F 10. NE. 1-4 sec. 8, T. 19 N., R. 19 E., on bluff of Grand River, about 5 miles southeast of Chouteau, up hill from M 8. Pryor quadrangle.

F 11. Near top of hill on road in SW. 1-4 sec. 32, T. 20 N., R. 19 E. Pryor quadrangle.

F 12. East side of hill in sec. 32, T. 20 N., R. 20 E. Pryor quadrangle.

F 13. Slope of hill in NW. 1-4 sec. 31, T. 21 N., R. 20 E., 5 miles east and 3 miles south of Pryor. Pryor quadrangle.

F 14. E. 1-2 sec. 7, T. 22 N., R. 20 E., 4 miles east and 1 1-2 miles south of Adair. Pryor quadrangle.

F 15. SE. 1-4 sec. 6, T. 22 N., R. 20 E., about 1-2 mile north of F 14. Pryor quadrangle.

F 16. SW. 1-4 sec. 6, T. 22 N., R. 20 E., about 3-4 mile west of F 15. Pryor quadrangle.

F 17. Hillside above road in NE. 1-4 sec. 33, T. 25 N., R. 21 E. Vinita quadrangle.

F 18. SW. 1-4 sec. 19, T. 25 N., R. 21 E., 2 miles east and 1 mile south of Vinita. Vinita quadrangle.

F 19. In road, near south end of line between secs. 21 and 22, T. 25 N., R. 21 E. Vinita quadrangle.

F 20. About 40 rods east of section corner 2 miles south of Todd, (on line between secs. 15 and 22, T. 25 N., R. 21 E.). Vinita quadrangle.

F 21. NE. 1-4 sec. 11, and NW. 1-4 sec. 12, T. 25 N., R. 21 E., 2 miles east of Todd. Vinita quadrangle.

F 22. Small hill in NW. 1-4 sec. 15, T. 26 N., R. 23 E., 1 mile southeast of Fairland. Wyandotte quadrangle.

Collection localities in the Pitkin formation.

P 1. NE. 1-4 sec. 2, T. 15 N., R. 25 E., 1-2 mile east of Stilwell. Tahlequah quadrangle.

P 2. Near NE. corner of sec. 20, T. 13 N., R. 21 E., about 4 miles north and 1 mile east of Gore. Muskogee quadrangle.

P 3. About the center of sec. 12, T. 15 N., R. 20 E., on eastward facing bluff, 6 1-2 miles east and 1-2 mile south of Ft. Gibson. Muskogee quadrangle.

P 4. N. 1-2 sec. 29, T. 15 N., R. 29 E., up hill from M 5 and F 4. Muskogee quadrangle.

P 5. Quarry at Keough switch, 2 miles northeast of Ft. Gibson on St. Louis & San Francisco Railroad. Muskogee quadrangle.

P 6. Near foot of bluff about 1 mile northeast of quarry at Keough. Muskogee quadrangle.

P 7. Hillside about 1 mile east of Melvin, in sec. 27, T. 17 N., R. 20 E. Muskogee quadrangle.

P 8. NE. 1-4 sec. 25, T. 17 N., R. 20 E., about 1 mile east of Hulbert, up hill from M 2 and F 1. Muskogee quadrangle.

P 9. Hill in N. 1-2 sec. 18, T. 17 N., R. 20 E., 4 miles west and 2 miles north of Hulbert. Muskogee quadrangle.

P 10. E. 1-2 sec. 16, T. 18 N., R. 19 E., about 1 1-2 miles southeast of Yonkers, up hill from F 5. Pryor quadrangle.

DESCRIPTION OF SPECIES.

COELENTERATA.

ANTHOZOA.

Genus PALEACIS E. and H.

PALEACIS CUNEATA n. sp.

Pl. III, Figs. 1-6.

Description.—Corallum compressed, with flattened sides, diverging at an angle of 25 to 30 degrees, height and width usually about equal but there is considerable variation in this respect. The rounded ends diverge from the slender base at an angle of about 100 degrees. Top of the larger specimens well arched, almost semicircular. Corallites numbering from 2 to 6 on the specimens examined; opening on the upper surface; usually in one row, sometimes in two rows for part of the distance across the top; rather deep, those in the center sometimes having a depth of about one-third the height of the corallum; circular in section. Walls separating the cells varying in thickness from very thin to nearly one-half the diameter of the cell. The surface is ornamented by fine. irregular lirae, which radiate from the slender base to the upper surface, They are somewhat discontinuous and are locally inosculating. Lirae narrower than the striae which separate them. On the base the lirae are continued as rows of tubercles.

Dimensions of two specimens: height, 16 mm. and 15 mm.; width, 13 mm. and 16 mm.; greatest thickness, 8 mm. and 7 mm.; diameter of largest (central) corallites. 4 mm. in both specimens.

Remarks.—This species resembles *P. carinata* Girty from the lower Fayetteville shale of Arkansas but is larger, has more and deeper corallites and the sides diverge much less rapidly.

Occurs at localities F 17, F 18, F 19, and F 20, but is nowhere abundant.

ZAPHRENTIDAE.

Genus ZAPHRENTIS Raffinesque

ZAPHRENTIS SPINULOSA E. and H.

1851. *Zaphrentis spinulosa*, Milne-Edwards and Haime, Monog. des Blyp. Foss., p. 334, pl. 5, figs. 7, 7a.

1890. *Zaphrentis spinulosa*, Worthen, Geol. Survey Ill., vol. 8, p. 73, pl. 10, figs. 6, 6a.

Remarks.—All the horn corals in the Chester collections seem to be referable to this common Chester species, although the material from some localities is too incomplete to make the identification certain.

From localities M 6, M 8a (?), M 14 (?), M 21, F 1, F 14, F 16, F 17, F 18, F 20, F 21 (?), F 22, P 7, and P 9 (?).

FAVOSITIDAE.

Genus MICHELINIA de Koninck.

MICHELINIA MEEKANA Girty.

Pl. III, Figs. 9-11.

1910. *Michelinia meekana*, Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 189.

Girty's description.—Zoarium lenticular, attaining a large size, about 85 mm. in diameter and 45 mm. in thickness, more or less. Upper surface irregular Corallites very variable in size; the large ones reach a diameter of 7 mm., but very few are of this size. The rudimentary septa consist of fine ridges, more distinct in some specimens than in others, and are very numerous. They are so

*Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 100.

fine and obscure that no satisfactory count can be made in the material available. Mural pores apparently are small and regularly disposed. They seem to occur in longitudinal rows near the angles of the cells. Tabulae very closely arranged and irregular. In some instances they are one-fifth to one-eighth of a cell diameter apart and seem to extend completely across in parallel plates. In other instances, they are somewhat farther apart, oblique and vesicular. Walls moderately thick.

Remarks.—The specimens in the Oklahoma collections which are referred to this species are extremely variable in habit of growth. Some show only a few corallites with a wrinkled epitheca attached to brachiopod shells; others are massive and hemispherical or irregular in shape; others consist of irregular, undulating expansions, with corallites on both sides and with prominent nodes; and still others appear to have had an irregular branching habit. There is great variation in the size of the corallites in the same and in different specimens. The same is true of the thickness of the walls.

While these variations may represent different species, there seems to be no sharp distinctions between them and they are all tentatively referred to the same species.

From localities M 19, F 14, F 16, F 17, F 18, F 19, F 20, F 21, and P 1.

Genus PACHYPORA Lind.

PACHYPORA OKLAHOMENSIS n. sp.

Pl. III, Figs. 7-8.

Description.—Corallum of irregular branching habit, with branches reaching a diameter of 30 mm. to 40 mm. Corallites circular at the surface with diameters varying from very small to about 2 mm.; polygonal in the axial region; axial region occupying only one-third the diameter of the branch. The corallites turn directly from the axial region and extend through the greatly thickened walls at right-angles to the length of the stem. The tabulae are closely crowded and generally convex toward the surface in the thickened wall region. They occasionally branch. On a well preserved surface there is a sharp narrow depression in the walls which separate the corallites. These apparently mark the projection on the surface of the true wall of the axial region, and they usually form more or less regular pentagons.

Remarks.—This species is present only in collection M 20. It is placed in the genus *Pachypora* rather than *Trachypora* on account of the numerous tabulae. The only other species of the genus known to occur in the American Carboniferous is from the Morrow limestone in the same general region. The axial region of that species occupies a much greater proportion of the diameter of the branches.

ECHINODERMATA

BLASTOIDEA.

Remarks.—In contrast with the abundance of *Pentremites* in the Chester of the Mississippi Valley and in the Morrow formation of Arkansas and Oklahoma, the genus is rather uncommon in the Chester formations in Oklahoma. Fragments of a rather large species resembling *P. godoni* are in collections F 1 and P 7, and an imperfect specimen near *P. conoideus* in collection M 7. Fragments were observed at several localities where collections were not made, but on the whole, the material is scant and poorly preserved.

CRINOIDEA.

Remarks.—While the remains of crinoids are fairly abundant in the Chester formations, they are much less so than in the Burlington and Keokuk beds of the Boone formation. The remains consist almost entirely of stems, and no specifically identifiable specimens are present in any of the Chester collections. Bases of *Agassizocrinus* are present in collections M 7, M 14, and M 19. Small bases of two plates are in collection F 19; an unidentifiable specimen of a large form showing the arms and pinnules in collection M 8c; and fragments of two small specimens in collections M 7 and M 11.

MOLLUSCOIDEA.

BRYOZOA.

Remarks.—The number of species of bryozoa in the collections is quite large and many of the species are new, but it is not practicable at this time to describe and illustrate these forms properly. A list of the species which have been identified is given below, with some notes on the other forms which are present in the collections. Most of the bryozoa have been collected from the Fayetteville shale in the Vinita and Wyandotte quadrangles. A considerable number also occurs in the Mayes formation, but these collections have not been fully studied.

It should be said that the evidence furnished by the bryozoa coincides with that of the other groups in pointing to the Chester age of the formations, although a few of the species have strong Keokuk affinities.

All the species in the following list are described and figured by Ulrich in volume 8 of the Illinois Geological Survey (1890), unless otherwise noted.

SPECIES.	LOCALITIES.
Cystodictya nitida	F 19, F 20, F 21, and F 22
Cystodictya americana	F 21.
Cystodictya labiosa Ulr. (Mss.)	F 19, F 20, F 21, and F 22.

SPECIES.	LOCALITIES.
Rhombopora tabulata	F 19, F 20, F 21, and F 22.
Streblotrypa nicklesi	F 19, F 20, F 21, and F 22.
Streblotrypa subspinosa	F 21.
Fenestella compressa	F 19.
Fenestella serratula	F 20 and F 22.
Fenestella cestriensis	F 19, F 20, and F 21.
Fenestella elevatipora	F 19 and F 21.
Fenestella cf. triserialis	F 19, F 21, and F 22.
Archimedes invaginatus	F 1, F 18, F 20, F 21, and F 22.
Archimedes sublaxus	F 21.
Archimedes proutanus	M 7, M 8c, F 1, F 9, F 20, and F 21.
Archimedes confertus	M 7, M 8a, and M 14.
Archimedes distans	F 20.
Polypora cestriensis	F 19, F 20, F 21, and F 22.
Polypora spinulifera	F 22.
Thamniscus furcillatus	F 21.

Among the forms which are not specifically identified and those which seem to be new may be listed the following:

A species of *Fistulipora* near *F. excellens* Ulr. (Mss.).

An undescribed *Chilotrypa.*

Two species of *Batostomella,* one near *B. nitidula* Ulr.

A large, massive *Stenopora* probably *S. longicamerata* Girty,* and one near *S. tuberculata* Prout.

Three species of *Lioclema?* which are apparently undescribed.

An undescribed *Cystodictya,* possibly a variety of *C. labiosa* Ulr.

A *Glyptopora.*

Several species of *Rhombopora,* mostly very slender forms. Among them are specimens closely related and probably identical with several of Ulrich's species, *angustata, minor, pulchella, persimilis, tenuirama,* and *attenuata;* besides three or four species which are new.

A species of *Coeloconus,* near *C. tuba* Girty.

Two undescribed species of *Streblotrypa.*

A species of *Lyropora* represented by the support.

BRACHIOPODA.

ATREMATA.

LINGULIDAE.

Genus LINGULA Bruguiere.

LINGULA BATESVILLAE Girty.

1911. *Lingula batesvillae,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 32, pl. 1, figs. 1-10.

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*Girty, Geo. H., Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, 1910.

Remarks.—This species is known in Oklahoma only in the Mayes limestone, in collections M 8a, M 12, and M 13 (very abundant).

NEOTREMATA.

DISCINIDAE.

Genus LINGULIDISCINA Whitfield.

LINGULIDISCINA NEWBERRYI var. MOOREFIELDANA Girty.

1911. *Lingulidiscina newberryi* var. *moorefieldana.* Girty. Bull. U. S. Geol. Survey, No. 439, p. 38, pl. 2, figs. 1-3.

Remarks.—The shells definitely included under this name occur in the black limestone of the Mayes formation, while two specimens from the Fayetteville and one from the Pitkin are doubtfully referred to it. Those from the Fayetteville are not sufficiently well preserved to make the identification sure. The brachial valve is sub-conical, nearly circular in outline and has the apex about one-fourth the distance from the posterior to the anterior margin. The beak is much more prominent than in *L. batesvillensis* Weller, and the slope to the anterior margin is more nearly straight. The pedicle valve is circular, with the pedicle slit extending from the center about three-fourths of the distance to the margin. The ornamentation of both valves consists of concentric lamellose markings. The shell reaches a diameter of 15 mm. From localities M 1, M 4, M 6, M 8a, F 8 (?), and P 5 (?).

LINGULIDISCINA NEWBERRYI var. OVATA Girty?

1909. *Lingulidiscina newberryi* var. *ovata,* Girty, Bull. U. S. Geol. Survey, No. 20, pl. 1, figs. 9-11.

Remarks.—Two specimens, one from locality M 6 and one from P 7, are referred doubtfully to this variety. They are smaller than *L. newberryi* var. *moorefieldana,* the beak is more centra and there are fine radiating costae as well as concentric lamellose markings. The outline of the shell from locality P 7 is sub-ovate; that of the one from locality M 6 cannot be fully made out.

CRANIIDAE.

Genus CRANIA Retzius.

CRANIA CHESTERENSIS Miller and Gurley.

1897 *Crania chesterensis,* Miller and Gurley, Bull. Ill. State Mus. Nat. Hist. No. 12, p. 47, pl. 3, figs. 24-26.

1914. *Crania chesterensis.* Weller, Mon. Ill. State Geol. Survey, No. 1, p. 45, pl. 1, figs. 27-29.

Remarks.—This species is present in 3 collections from the Fayetteville formation. All the specimens are attached to shells of

Productus inflatus or *P. cherokeensis*. Both brachial and pedicle valves are shown.

In collections F 16, F 17, and F 19.

PROTREMATA.

ORTHIDAE.

Genus RHIPIDOMELLA Oehlert.

RHIPIDOMELLA ARKANSANA Girty.

1911. *Rhipidomella arkansana*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 53, pl. 2, figs. 14-16.

Remarks.—A single specimen from locality M 8a is referred to this species with considerable certainty, and a fragmentary specimen from locality M 4 with dou

Genus ORTH TES Fischer.

ORTHOTETES KASKASKIENSIS McChesney.

1860. *Orthis kaskaskiensis*, McChesney, Desc. New Pal. Foss., p. 31.
1892. *Derbya kaskaskiensis*, Hall and Clarke, Pal. N. Y., vol. 8, pt. 1, pl. 11B, fig. 6.
1914. *Orthotetes kaskaskiensis*, Weller, Mon. Ill. State Geol. Survey, No. 1, p. 77, pl. 6, figs. 1-14.

Remarks.—This species is one of the most abundant brachiopods in the Chester of Oklahoma. It exhibits considerable variation but none sufficiently constant to permit of separation into varieties.

In collections M 2, M 7, M 8c, M 9, M 10, M 11, M 14, M 15, M 16, M 17, M 19, M 21, F 2, F 5, F 6, F 7, F 9, F 11, F 12, F 13, F 14, F 16 to F 22 inclusive, P 1 to P 10 inclusive.

PRODUCTIDAE.

Genus CHONETES Fischer.

CHONETES OKLAHOMENSIS n. sp.

Pl. III, Figs. 12-15.

Description.—Shell concavo-convex, the length about two-thirds the width. The greatest width usually about the middle of the shell but in the older specimens the greatest width may be along the hinge-line. The cardinal extremities are angular, lateral margins straight, or slightly concave in front of the cardinal extremities, passing with gradual curvature into the anterior margin, which is gently rounded. The dimensions of the mature shells are: width 17 to 19 mm., length 11.5 to 13.5 mm., and convexity about 3 mm.

Pedicle valve convex, the greatest convexity near the middle; the slopes to the beaks and to the anterior margin about equal, that toward the cardinal extremities at first steeply convex but becoming concave toward the extremities; beak small, scarcely produced beyond the cardinal margin; cardinal area low and flat, with its lateral margins sharply defined and bearing 8 to 12 apparently erect spines on each side of the beak. Brachial valve only slightly concave in well-preserved specimens. As usually preserved it is crushed to conform with the curvature of the pedicle valve; cardinal area almost equal in size to that of the pedicle valve.

Surface of both valves marked by fine, regular, radiating costae, which increase by bifurcation and intercalation, 5 or 6 in 1 mm.; lines of growth are sometimes well developed toward the lateral and anterior margins.

Remarks.—This species differs from the other species of the genus with which it is likely to occur in its larger size and in the larger number of spines along the margin of the cardinal area of the pedicle valve. It resembles *C. granulifer* of the Pennsylvanian, but the hinge line is proportionately shorter. It is a fairly abundant species in the Fayetteville and Pitkin formations occuring at localities M 7 (?), M 14, M 20 (?), F 2, F 4, F 11, F 12, F 14, F 16, F 17, F 20, F 21, F 22, P 4, P 5, and P 9.

CHONETES CHEROKEENSIS n. sp.

Pl. III, Figs. 16-18.

Description.—Shell small, the maximum width being about 12 mm., length two-thirds of the width, greatest width along hinge line.

Pedicle valve convex; greatest convexity posterior to the middle; the slope to the beak steeper than that to the anterior margin; slope to the lateral margins and cardinal extremities gentle and becoming concave toward the margins. The cardinal extremities are angular, the lateral margins rather sharply inflected just in front of the extremities, extending almost straight anteriorly, and then gradually joining the curve of the anterior margin. The cardinal area is not well shown on the specimens in hand but is apparently very low and flat; margin sharply defined and bearing 3 or 4 spine bases on each side of the beak.

Brachial valve concave, corresponding closely to the shape of the pedicle valve.

Surface of both valves marked by fine, very obscure costae about 10 in 1 mm.

Remarks.—This species is easily distinguished from others with which it is associated by its small size and proportional convexity and especially by the obscurity and fineness of the costae.

From localities M 1, M 3, M 4 and M 15.

CHONETES SERICEUS G

1910. *Chonetes sericeus,* Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 215.
1911. *Chonetes sericeus,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 41, pl. 2, fig. 9.

Remarks.—One nearly perfect specimen from locality M 15 and fragmentary material from localities M 14 and P 8 are referred to this species with some doubt. The specimens are small, are less convex than *C. cherokeensis* and have notably coarser costae than that species or *C. oklahomensis.*

Genus PRODUCTELLA Hall.

PRODUCTELLA HIRSUTIFORMIS Walcott.

1884. *Productella hirsutiformis,* Walcott, Mon. U. S. Geol. Survey, No. 8, p. 133, pl. 2, fig. 10.
1909. *Productella hirsutiformis,* Girty, Bull. U. S. Geol. Survey, No. 377, p. 24, pl. 2, figs. 4-6.
1911. *Productella hirsutiformis,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 50, pl. 3, figs. 1-4.

Remarks.—Three specimens from collection M 4 are referred to this species with considerable certainty.

PRODUCTELLA HIRSUTIFORMIS var. BATESVILLENSIS Girty.

1911. *Productella hirsutiformis* var. *batesvillensis,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 51, pl. 3, fig. 5.

Remarks.—Associated with the above specimens are three which are smaller, with an inflated middle portion and large ears. These are believed to represent the variety *batesvillensis* described by Girty from the Moorefield shale of Arkansas.

Genus PRODUCTUS Sowerby, (emend. Thomas).

The genus *Productus* as restricted includes those productid forms which are costate throughout all stages of growth. Sporadic spines or groups of spines may occur on the costae or at the intersection of costae and ribs in the semi-reticulate portion of the shells where this feature is developed.

PRODUCTUS INFLATUS McChesney.

1860. *Productus inflatus,* McChesney, Desc. New Foss., p. 40.
1861. *Productus inflatus,* McChesney, Ill. New Spec. Foss., pl. 6, figs. 1a-c.
1914. *Productus inflatus,* Weller, Mon. Ill. State Geol. Survey, No. 1, p. 111, pl. 10, figs. 1-6.

Remarks.—This species occurs principally in the limestone of the Fayetteville formation in the northern part of the Pryor and in the Vinita quadrangle. where it is locally extremely abundant and exceptionally well preserved.

*Thomas, Ivor, The British Carboniferous Producti, Mem. Geol. Survey of Great Britain, (Paleontology) vol. 1, pt. 4, 1914, pp. 258-259.

From the localities M 8b (?), F 9, F 10, F 11, F 12. F 13. F 14, F 16. F 17. F 18. F 19. and F 20.

PRODUCTUS OVATUS Hall

1858. *Productus ovatus,* Hall, Geol. Iowa, vol. 1, pt. 2, p. 674, pl. 24, fig. 11
1859. *Productus pileiformis,* McChesney, Desc. New Pal. Foss., p. 40.
1860. *Productus laevicostus,* White, Jour. Boston Soc. Nat. Hist. vol. 7, p. 230.
1909. *Productus pileiformis,* Girty, Bull. U. S. Geol. Survey, No. 377, p. 26, pl. 2, fig. 7.
1914. *Productus ovatus,* Weller, Mon. Ill. State Geol. Survey, No. 1, p. 132, pl. 16, figs. 1-15.

Remarks.—This species is the most abundant brachiopod in the Chester collections, occurring in the three formations at practically all the localities. The greater number of the collections contain a form which is typical *P. ovatus* but in some of the collections from the Mayes limestone (Moorefield) and in some from the Fayetteville formation there are variations sufficiently distinct to be classed as varieties.

The typical form occurs in collections M 2, M 3, M 4, M 5, M 7, M 8c, M 9, M 11, M 13, M 14, M 15, M 16, M 17, M 18, M 19, M 20, M 21, F 1, F 2, F 3, F 4. F 5, F 6, F 7, F 9, F 10, F 11 F 13, F 16, P 1, P 2, P 4, P 5, P 6 P 7 P 8, P 9 and P 10.

PRODUCTUS OVATUS var. MINOR n. var.

Pl. III, Figs. 19-21.

This variety is based upon a large number of specimens which resemble *P. ovatus* but which are not associated with the typical form. They are much smaller, none attaining a width of over 10 mm. The shell is thicker than in typical *P. ovatus* and fine concentric markings are better developed.

Remarks.—On account of its size this form might be considered a distinct species were it not that it occurs only in limited areas, at a horizon in which typical *P. ovatus* is abundant in other localities. It is believed to be merely a dwarfed form due to peculiar local conditions in which it lived.

It occurs in collections F 15. F 17. F 19. F 20. F 21, and F 22

PRODUCTUS OVATUS var. LATIOR n. var.

1911. *Productus pileiformis,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 44, pl. 11, figs. 1-2.

This variety is proposed for a form occurring in the Mayes limestone in the southern part of the area. It differs from typical *P. ovatus* in attaining a greater breadth and having a greater apical angle, in having the wrinkles on the ears not so well developed, and in having somewhat finer costae, 15 or 16 to 5 mm. as against about 12 in the same distance on the typical form.

This form is associated with the typical Moorefield (Arkansas) shale fauna and is the form figured from that fauna by Girty as *P. pileiformis* McChesney. McChesney's species, however, cannot be distinguished from *P. ovatus* even as a variety. In the Oklahoma collections *P. ovatus* var. *latior* is associated with typical *P. ovatus* in collection M 4, and occurs separately in collections M 1, M 6, and M 8b.

PRODUCTUS COLORADOENSIS Girty.

1903. *Productus inflatus,* Girty, (non McChesney), Prof. Paper U. S. Geol. Survey, No. 16, p. 359, pl. 3, figs. 1-1b, 2, 2a, 3.

1910. *Productus inflatus* var. *coloradoensis,* Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 215.

1911. *Productus inflatus* var. *coloradoensis,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 42, pl. 4, fig. 3.

Remarks.—This species is quite distinct from *P. inflatus,* being much larger, having the inflation of the auriculations much less pronounced and having coarser costae, 9 or 10 in 10 mm. The sinus is much less sharply defined and on some specimens is absent. Measurements of 4 speciments give the following dimensions: length, 40 to 42 mm.; width, 48 to 53 mm.; convexity, 20 to 27 mm.

Occurs rather abundantly in the Mayes limestone in collections M 4, M 6, M 8b, and M 20.

PRODUCTUS CHEROKEENSIS Drake.

Pl. III, Figs. 22-24.

1898. *Productus cherokeensis,* Drake, Cont. to Biol. from Hopkins Seaside Lab. (Leland Stanford Jr. Univ.) No. 14, p. 404. pl. 9, figs. 4-5. (Also Proc. Am. Phil. Soc., vol. 36, No. 156).

Drake's description of this species is as follows:

This species resembles closely *P. semireticulatus* Martin, but is always smaller, more compressed laterally, more highly arched, and has the mesial sinus more pronounced. It is nearest akin to *P. inflatus* McChesney, but the umbo is not so prominent, nor so greatly incurved as in *P. inflatus;* also the ribs [costae] seem a little coarser on *P. cherokeensis.*

The ears are somewhat more extended than on *P. semireticulatus;* but the total proportional width of the shell is less than on that species.

Remarks.—The specimens figured by Drake are reported as being from 5 miles southeast of Adair. In this locality the species occurs in considerable abundance, associated with large numbers of typical *P. inflatus* McChesney. Since the latter species is not reported in Drake's list, it is probable that he included the specimens of that species under his *P. cherokeensis.* There is thus some doubt as to whether the species should stand but it is here retained for the form represented by his figures, with which his description agrees fairly well.

The principal feature which distinguishes *P. cherokeensis* from *P. inflatus* is the almost complete lack of the inflation of the ears which is so characteristic of *P. inflatus* and which probably suggested the name. In addition *P. cherokeensis* is usually larger and is always broader in proportion to its size. The reticulations are much sharper, due to the better development of the ribs (lines of growth?) and the reticulated portion extends farther forward on the valve.

Occurs in collections F 8, F 10, F 14, F 16, F 19 F 21 and F 22.

PRODUCTUS ARKANSANUS Girty.

Pl. III, Figs. 1-3.

1910. *Productus arkansanus* Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 216.

Girty's description.—Ventral valve strongly convex, with gradually enlarging umbo. Of course, in the narrow specimens the umbonal angle is more acute than in the broader ones. Ears small and depressed. There is usually a broad, shallow, sometimes indistinct median sinus.

In the brachial valve the shell is gently concave over the visceral area, more strongly flexed around its border. A median fold is usually present. The ears are small and indistinct.

The costae vary greatly in character. They are usually rather irregular, with relatively broad striae in between. At rather frequent and regularly increasing intervals they give off small spines and are swollen and elevated at the spines and constricted and depressed just in front, so that in some cases the surface looks as if marked less by continuous costae than by elongated spine bases which terminate rather abruptly at the anterior end with the development of the spine which gave rise to them. This effect is more marked in some specimens than in others, and also in some specimens the costae are finer and more closely arranged than in others. Toward the front, the costae tend to be more regular and continuous. Distinct striae of growth usually show upon well-preserved specimens, to which are in some cases added transverse wrinkles more or less irregular and obscure, except on the ears. In some cases, also, there are well defined, regularly arranged transverse bands. The arrangement of the spines is more regular in some specimens than in others, and occasionally they appear to occur in transverse rows, especially in connection with the sub-lamellose bands just mentioned.

In the brachial valve the structure is the reverse of that described. In the most strongly characteristic specimens, the external mold appears to be marked by sharply defined regular spine bases with prominent spines. In others the appearance is more that of continuous costae. Regularly concentric sub-lamellose bands frequently occur, and spines are developed on this valve as well as on the other.

Remarks.—This is an abundant species in the Oklahoma collections. The specimens reach a length of about 35 mm. and a width of about 30 mm. The costae while irregular, usually number about 10 or 11 in 10 mm.

Occurs in collections M 19, F 1, F 2, F 3, F 10, F 11, F 12, P 1, P 2, P 3, P 5, P 7, and P 8.

Genus PUSTULA Thomas.*

PUSTULA ALTERNATA Norwood and Pratten.

1855. *Productus alternatus,* Norwood and Pratten, Jour. Acad. Nat. Sci. Phila., (2), vol. 3, p. 20, pl. 2, figs. 1a-e.
1858. *Productus vittatus,* Hall, Geol. Iowa, vol. 1, pt. 2, p. 639.
1863. *Productus gradatus,* Swallow, Trans. St. Louis Acad. Sci., vol. 2, p. 93
1914. *Echinoconchus alternatus,* Weller, Mon. Ill. State Geol. Survev. No. 1, p. 138, pl. 17, figs. 1-7.

Remarks.—The material of this species is poorly preserved and there is a little doubt as to the identification. No features distinguishing it from *Pustula punctata* Martin can be made out from the specimens in hand, but the reference is made to the Mississippian rather than to the Pennsylvanian species.

Occurs in collections M 10, M 20, F 13, F 19, F 20, F 21, F 22, and P 7.

PUSTULA MOOREFIELDANA Girty.

1911. *Productus moorefieldanus,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 48, pl. 3, fig.

Remarks.—Several specimens in collection M 4 are referred to this species.

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*Loc. cit. The genus *Pustula* includes those productid forms in which the ornamentation is essentially spinose. The generic name *Echinoconchus* proposed by Weller (Mon. Ill. State Geol. Survey, No. 1) later in the same year (1914) in a synonym.

PUSTULA SUBSULCATA Girty.

1911. *Productus subsulcatus,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 47, pl. 3, figs. 12-14.

Present at localities M 3, M 4, M 7, M 8a, and M 8b.

PUSTULA BISERIATA Hall?

1856. *Productus biseriatus,* Hall, Trans. Albany Inst., vol. 4, p. 12.
1906. *Productus biseriatus,* Beede, 30th Ann. Rept. Ind. Dept. Geol. and Nat. Res., p. 325, pl. 29, figs. 8-12.
1911. *Productus biseriatus,* Girty, Bull. U. S. Geol. Survey, No 439, p. 46, pl. 3, figs. 10-11.
1914. *Echinoconchus biseriatus,* Weller, Mon. Ill. State Geol Survey, No. 1, p. 141, pl. 17, figs. 10-15.

Remarks.—One incomplete specimen from collection M 4 is doubtfully referred to this species. It is also known to occur in the upper part of the Boone formation.

Genus AVONIA Thomas.*

AVONIA OKLAHOMENSIS n. sp.

Pl. IV, Figs. 4-11.

Description.—Shell small to medium, the dimensions of the type specimen being: length along hinge line, 23 mm., (hinge line equal to or only very slightly less than the greatest width of the shell); length from the umbonal region, 23 mm.; from the hinge line, 17 mm.; convexity. 12 mm.

Pedicle valve with the greatest convexity near the middle of the shell. Beak projecting slightly over the hinge line. The medial portion (ventre, Thomas) is broadly flattened, with very steep slopes to the lateral margins. The slope from the umbones to the ...l margins is at first convex and then broadly concave to the ... Auriculations small and outlined by the bases of 3 or 4 erect spines. The posterior portion of the valve is orna... by growth lines or ribs with a few scattered spine bases. ...terior portion is ornamented by strong sub-angular costae ...ed by broader rounded grooves. The costae begin abruptly ...he middle of the shell at the growth line or rib connecting ...remities of the auriculations and continue to the anterior without bifurcations. Those on the lateral slopes are near... ...lete and widely spaced. Spine bases are few in number. ...iole surface of the valve is ornamented with fine concentric ...gs which show only on well preserved specimens.

...cit. The genus *Avonia* includes those productid forms in which the ...ation is spinose in the young stages and costate in the older stages.

Brachial valve gently concave, with the ornamentation corresponding to that of the pedicle valve.

Remarks.—This is a rare form occurring only in collection M 4, with one specimen from collection F 16 doubtfully referred to the species. It may be compared with the figures of *Productus lachrymosus* var. *limus* Walcott* from the Devonian of the Eureka district, Nevada.

Genus DIAPHRAGMUS Girty.

DIAPHRAGMUS ELEGANS Norwood and Pratten.

1855. *Productus elegans,* Norwood and Pratten, Jour. Acad. Nat. Sci. Phila. (2), vol. 3, p. 3, pl. 1, figs. 7 a-c.

1860. *Productus Cestriensis,* Worthen, Trans. St. Louis Acad. Sci., vol. 1, p. 570.

1910. *Diaphragmus elegans,* Girty, Ann. N. Y. Acad. Sci., vol. 20, p. 217.

1911. *Diaphragmus elegans,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 51, pl. figs. 4-5.

1914. *Diaphragmus elegans,* Weller, Mon. Ill. State Geol. Survey, No. 1, p. 136, pl. 12, figs. 8-17.

Remarks.—One of the most abundant species in the Oklahoma collections. The specimens from the Fayetteville and Pitkin formations are somewhat broader than those from the Mayes, corresponding to the difference between the Moorefield and Fayetteville forms in Arkansas noted by Girty. It is especially abundant in the limestone of the Fayetteville, almost entirely composing some layers locally. It becomes less abundant to the north, decreasing in number as *Productus inflatus* increases at the same horizon.

From localities M 2, M 7, M 8c, M 9, M 11, M 13, M 14, M 15, M 16, M 17, M 18, M 19, M 21, F 1, F 2, F 4, F 5, F 6, F 7, F 9, F 16, P 2, P 4, P 5, P 6, P 7, P 8, and P 9.

Genus MARGINIFERA Waagen.

MARGINIFERA ADAIRENSIS Drake?

Pl. IV, Figs. 12-14.

1898. *Productus* (*Marginifera*) *adairensis,* Drake, Proc. Am. Phil. Soc., vol. 36, No. 156, p. 402, pl. 9, figs. 1-3.

Remarks.—The shells referred to this species are small, the maximum length being about 15 mm., and the maximum width about 20 mm. The pedicle valve is strongly convex, with concave slopes to the cardinal extremities. The beak is fairly prominent and strongly incurved. The brachial valve is nearly flat over the visceral portion, strongly inflected around the edges. The visceral portion of the valve is surrounded by a strong ridge on the interior

*Mon. U. S Geol. Survey, vol. 8, pl. 13, figs. 18, 18a.

of the valve, on account of which the species is placed in the genus *Marginifera.* The surface of both valves is ornamented with very fine costae which are not noticeable on weathered specimens. There is a suggestion of reticulation on the anterior portion of the pedicle valve.

The size and shape of the shell together with the ornamentation separate the species distinctly from any with which it is associated. The resemblance to Drake's figures and description is very strong, but in the absence of the type specimens the reference is made with some doubt.

From localities M 7, M 14, M 19, and F 3.

PENTAMERIDAE.

Genus CAMAROPHORIA King.

CAMAROPHORIA CESTRIENSIS n. sp.

Pl IV, Figs. 15-26

Description.—Shell small, subovate to subpentagonal, length and width nearly equal, the greatest width anterior to the middle of the shell. The dimensions of the largest shell and one of average size are as follows: length of pedicle valve, 13 mm. and 10.5 mm.; length of brachial valve, 11 mm. and 9 mm.; greatest width, 12.5 mm. and 9.5 mm.; thickness, 9 mm. and 6.5 mm.

Pedicle valve arched from beak to front, greatest convexity in the umbonal region, slope steep toward the cardinal margin, and very gentle to the antero-lateral margin. The mesial sinus begins posterior to the middle of valve, and deepens rapidly anteriorly being produced into a lingual extension deeply inflecting the margin of the brachial valve, with a single, ill-defined, rounded plication in the anterior portion. Beak small and incurved. The median septum usually shows as a dark line on the surface and the spondylium is often exposed by the breaking away of the beak.

Brachial valve more convex than the pedicle, the greatest depth anterior to the middle. Slope from the middle to the beak and margins about equal except on the mesial fold; the mesial fold begins about the middle of the valve and has a single ill-defined furrow. Beak pointed and incurved beneath that of the pedicle valve.

Ordinarily the lateral slopes are without plications, but in a few of the largest specimens a very faint plication is developed at the anterior margin near the mesial fold on the brachial valve and a corresponding furrow is shown on the ventral valve.

Surface markings consist of faint concentric lines of growth

Remarks.—This species is easily separated from *C. explanata*, the only other species of the genus known to occur in the Chester, by its larger size and by the absence of well defined plications on the lateral slopes.

In collections M 4, F 1, F 7, F 16, P 4, P 5, P 7, P 9, and P 10.

TELOTREMATA.

RHYNCHONELLIDAE.

Genus CAMAROTOECHIA Hall and Clarke.

CAMAROTOECHIA PURDUEI Girty.

1910. *Camarotoechia purduei*, Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 219.

1911. *Camarotoechia purduei*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 60, pl. 5, figs. 5, 5a.

1911. *Camarotoechia purduei* var. *agrestis*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 60, pl. 5, figs. 1-4a.

1911. *Camarotoechia purduei* var. *laxa*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 61, pl. 5, figs. 6-11b.

Remarks.—The specimens included under this title show considerable variation in size, and in number, arrangement, and angularity of plications, but are believed to represent one species. Girty separates his varieties *laxa* and *agrestis* on the basis of size of shell and on the number and angularity of the costae. The variety *agrestis* is said to be larger than typical *purduei* and to have usually 4 plications on the fold in place of 3. In the Oklahoma collections there seems to be no such relation; the specimens in collection F 10 are, as a rule, considerably larger than those in collection M 2, but the majority of the larger shells have 3, while the majority of the smaller ones have 4 plications on the fold. In fact, the gradation in characters is so uniform that it seems necessary to include the forms under the one species, although specimens representing Girty's varieties could be selected.

From localities M 2, M 3, M 6, M 7, M 8b (?), M 12, M 13, M 20, M 21, F 1, F 8, F 10, F 11, F 12, F 14, F 16, F 17, F 19, F 20, and F 22. The specimens from M 8b are very doubtfully referred to this species. They are much larger than common, and the plications are broad, low and rounded.

Genus LEIORHYNCHUS Hall.

LEIORHYNCHUS CARBONIFERUM *Girty*.

1877. *Leiorhynchus quadricostatus*?, Meek, U. S. Geol. Expl. 40th Par. Rept., vol. 4, p. 79, pl. 3, figs. 9-9b.

1909. *Liorhynchus* aff. *mesicostale*, Girty, Bull. U. S. Geol. Survey, No. 377, p. 26, pl. 2, figs. 11-12.

1911. *Liorhynchus carboniferum*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 54, pl. 6, figs. 1-8, pl. 7, figs. 13-16.

Remarks.—This form occurs only in the lower part of the Mayes limestone, where it is locally very abundant. In collections M 1, M 3, M 4, M 5, M 6, M 8a, M 8b, and M 11.

LEIORHYNCHUS CARBONIFERUM var. POLYPLEURUM Girty.

1911. *Liorhynchus carboniferum* var. *polyleurum*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 59, pl. 7, figs. 7-12.

Remarks.—A few small specimens from locality M 8b are referred to this vicinity.

Genus MOOREFIELDELLA Girty.

MOOREFIELDELLA EUREKENSIS Walcott.

1884. *Rhynchonella Eurekensis*, Walcott, Mon. U. S. Geol. Survey, vol. 8, p. 223, pl. 18, figs. 8-8c.

1911. *Moorefieldella eurekensis*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 63, pl. 5, figs. 12-17.

Remarks.—This species has a restricted range in the lower part of the Mayes limestone. It offers no striking variations from the figures and descriptions of the specimens from the Moorefield shale of Arkansas.

In collections M 4, M 5, M 8b, M 12, M 13, and M 20 locally extremely abundant.

Genus DIELASMA King.

DIELASMA SHUMARDANA Miller.

1863. *Terebratula arcuata*, Swallow, Trans. St. Louis Acad. Sci., vol. 2, p. 83 (Not *T. arcuata*, Roemer, 1840).

1883. *Terebratula shumardana*, Miller, Am. Pal. Foss., 2nd. ed., p. 299.

1914. *Dielasma shumardanum*, Weller, Mon. Ill. State Geol. Survey, No. 1, p. 268, pl. 31, figs. 25-27.

Remarks.—This species is one of rather common occurrence in the Chester of Oklahoma. In some collections the material is too poorly preserved to make the identification certain.

In collections M 2, M 4 (?), M 8c, M 11, M 12, M 13, M 14, M 18, F 1, F 2, F 3, F 9 (?), F 12 (?), P 7 (?), and P 9.

DIELASMA COMPRESSA n. sp.

Pl. IV, Figs. 27-29.

Description.—Shell of small to medium size, elongate-subovate in outline, greatest length about one and one-third times the greatest width, which is about twice the greatest thickness. Greatest width about one-third the length from the anterior margin. Dimensions of the type specimen: length, 25 mm; width, 20 mm.; thickness, 10 mm.

Pedicle valve moderately arched from beak to front, greatest convexity posterior to the middle, curving strongly to the beak and postero-lateral margins and more gently to the antero-lateral and anterior margins. Postero-lateral margins slightly concave, antero-lateral and anterior margins strongly rounded, nearly semicircular. Beak prominent, strongly incurved, with a large foramen encroaching on the umbones. There is no mesial sinus. Internally the dental plates are well developed and extend far forward in the valve.

Brachial valve much less convex than the pedicle, the greatest convexity posterior to the middle, slope fairly steep to the postero-lateral margins, valve only slightly arched from beak to front, without fold or sinus. Beak pointed and incurved beneath that of the opposite valve. Internally the muscle plate is well developed, with the crural laminae diverging from the beak.

Surface smooth except for faint lines of growth.

Remarks.—The outline of this species is very similar to that of *D. formosa* Hall, but the thickness is much less in proportion to the size of the shell.

Rare at localities M 4, F 10, F 13, and F 16.

Genus GIRTYELLA Weller.

GIRTYELLA BREVILOBATA Swallow.

1863. *Terebratula brevilobata,* Swallow, Trans. St. Louis Acad. Sci., vol. 2, p. 84.
1911. *Harttina brevilobata,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 65, pl. 2, fig. 12.
1911. *Girtyella brevilobata,* Weller, Jour. Geol., vol. 19, p. 443.
1914. *Girtyella brevilobata,* Weller, Mon. Ill. State Geol. Survey, No. 1, p. 278, pl. 34, figs. 37-41.

Remarks.—Present only in collection F 9, 6 specimens.

GIRTYELLA INDIANENSIS Girty.

1891. *Terebratula turgida,* Whitfield, Ann. N. Y. Acad. Sci., vol. 5, p. 586, pl. 13. figs. 21-22.
1908. *Harttina indianensis,* Girty, Proc. U. S. Nat. Mus., vol. 34, p. 293, pl. 19, figs. 6-15.
1911. *Girtyella indianensis,* Weller, Jour. Geol., vol. 19, p. 442, figs. 2a-i.
1914. *Girtyella indianensis,* Weller, Mon. Ill. State Geol. Survey, No. 1, p. 275, pl. 34, figs. 1-24.

Remarks.—This is the most abundant species of the genus in the Oklahoma collections. In collections M 7, M 8c, M 9, M 12, M 13, M 15, M 16, M 19, F 3, F 4, F 5, F 9, F 16, and F 17.

GIRTYELLA INDIANENSIS var. EXPORRECTA Girty.

1910. *Harttina indianensis* var. *exporrecta,* Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 220.

Remarks.—In collection F 5, *Girtyella indianensis* is abundant but several of the specimens are relatively wider than is typical of the species, some of them having the length and width almost equal. Others in the same collection are of the normal shape. The wide variety is identified with Girty's variety *exporrecta* from the same horizon in Arkansas.

SPIRIFERIDAE.

Genus SPIRIFER Sowerby

SPIRIFER PELLAENSIS Weller.

1914. *Spirifer pellaensis,* Weller, Mon. Ill. State Geol. Survey, No. 1, p. 340, pl. 45, figs. 1-11.

Remarks.—The shells included under this species show considerable variation, some of them approaching *S. increbescens* Hall. It is an abundant form occurring in collections M 2, M 6, M 18, M 19, F 1, F 2, F 4, F 5, F 6, F 10, F 11, F 12, F 13, F 14, F 16, F 17, F 18, F 19, P 1, P 2, P 4, P 5, P 6, and P 9.

SPIRIFER LEIDYI Norwood and Pratten.

1855. *Spirifer Leidyi,* Norwood and Pratten, Jour. Acad. Nat. Sci. Phila., (2), vol. 3, p. 72, pl. 9, figs. 2a-c.
1914. *Spirifer leidyi,* Weller, Mon. Ill. State Geol. Survey, No 1 p. 345, pl. 47, figs. 17-31.

Remarks.—This species is closely related to *S. increbescens* but may be distinguished by the bifurcate median fold.

In collections M 7, M 8c, M 9, M 12, M13, M 14, M 15, M 16, F 7, F 9, F 21, P 3, P 4, and P 8.

SPIRIFER ARKANSANUS Girty.

1911. *Spirifer arkansanus,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 66, figs. 2-4.

Remarks.—In collections M 4, M 8a, and M 20.

SPIRIFER FAYETTEVILLENSIS n. sp.

Pl. V, Figs. 1-2.

Description.—The pedicle valve is medium to [illegible]ge, measuring about 40 mm. in width. It is only moderately convex, with a broad, rounded sinus which widens rapidly from the beak forward. At ak there is only one plication in the sinus, but the number in- s to 10 or 12 near the front margin. The method of increase t be told definitely from the specimens in hand. The lateral have about 15 fine rounded plications similar to those of the The surface is ornamented by concentric marking and by ing striae which are quite distinct where the preservation is

narks.—This species is easily distinguished from any asso- with it by the fineness of the plications and by the broad, ed sinus.

om the shale of the Fayetteville formation above the lime- locality F 8.

Genus BRACHYTHYRIS McCoy.

BRACHYTHYRIS OZARKENSIS n. sp.

Pl. V, Figs. 3-6.

cription.—Shell of medium size, sub-orbicular in outline, st width near the mid-length, cardinal extremities rounded. imensions of a nearly perfect specimen of small size are: , 20 mm.; width, 23 mm.; thickness, 11 mm.; convexity of valve, 7 mm.; convexity of the brachial valve, 4 mm.; length hinge-line, 10 mm. The maximum dimensions shown are: , 35 mm.; width about 35 mm.; convexity of pedicle valve, a d of the brachial valve about 6 mm.; length of hinge- out 5 mm.

licle valve strongly convex, with its greatest convexity pos- to the middle, surface curving abruptly to the cardinal mar- ss sharply to the lateral margins, and with a gentle slope to erior margin. Convexity of the valve extending to the car- nargin. Beak prominent, pointed and strongly incurved; il area rather small, concave, becoming more curved toward ak, central part occupied by a triangular delthyrium; lateral s not well defined. Lateral slopes with 5 or 6 broad, slight- ated plications, separated by narrow, shallow depressions, ons obsolete near the cardinal extremities. Mesial sinus ting at the beak, very shallow and ill-defined, scarcely in- the anterior margin, with three poorly defined plications rly, of which the central one is usually smaller than the

chial valve much less convex than the pedicle, greatest con- near the middle, compressed toward the cardinal extremi- eak projecting slightly beyond the hinge-line. Mesial fold ightly elevated, widening rapidly toward the front, with 3 orly defined plications anteriorly which are practically ob-

solete in the larger specimens. Plications of the lateral slopes similar to those of the pedicle valve. The grooves on either side the mesial fold are wider than the others.

Minute surface markings consist of extremely fine, wavy, concentric lines. On partially exfoliated specimens very fine longitudinal lines are also shown, especially in the grooves between the plications.

Remarks.—The material of this species is fairly abundant but is mostly fragmentary. The species is easily differentiated from *B. subcardiiformis* Hall by the absence of a false cardinal area and by the broad, low plications, and from *B. suborbicularis* Hall by the fewer plications and the less developed fold and sinus.

From localities M 7 (?), F 10, F 11, F 12, F 13, F 14, and F 16.

Genus RETICULARIA McCoy.

RETICULARIA SETIGERA Hall.

1858. *Spirifer setigerus*, Hall, Geol. Iowa, vol. 1, pt. 2, p. 705, pl. 27, figs. 4a-b.
1911. *Reticularia setigera*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 69, pl. 8, fig. 6.
pl. 74, figs. 12-22.

Remarks.—This shell is found in the three Chester formations in several localities but nowhere is it extremely abundant. The specimens differ considerably in the strength of the fold and sinus. Those in collection M 4 have these features almost or quite obsolete, and may represent a variety or even a distinct species. The material is not abundant, however and is retained under *R. setigera* with some doubt.

In collections M 2, M 3, M 4 (?), M 6, M 7, M 8a, M 8c, M 14, M 15, M 16, F 1, F 4, F 5 F 7, F 9, F 13, F 14, F 16, P 7, P 8, P 9, and P 10.

Genus AMBOCOELIA Hall.

AMBOCELIA LEVICULA Rowley?

1900. *Ambocoelia levicula*, Rowley, Am. Geologist, vol. 25, No. 5, p. 262, pl. 5, figs. 12-14.
1911. *Ambocoelia levicula* (?), Girty, Bull. U. S. Geol. Survey, No. 439, p. 73, pl. 8, figs. 7-9.
1914. *Ambocoelia levicula*, Weller, Mon. Ill. State Geol. Survey, No. 1 p. 426, pl. 77, figs. 26-31.

Remarks.—This species is found abundantly only in the Mayes limestone in the southern portion of the area. It is believed to be identical with the species listed under this name by Girty from the

1914. *Reticularia setigera*, Weller Mon. Ill. State Geol. Survey, No. 1, p. 431

Moorefield shale of Arkansas. Concerning the reference to *A. levicula* he says:

Specifically this form seems to be extremely similar to *Ambocoelia levicula* Rowley, though I have not had specimens of Rowley's species for comparison. The two forms are of somewhat different geologic ages and occur in association with very unlike faunas, and the probability would certainly appear to be that they are different species rather than the same. This genus, however, appears to adhere very closely to a type, and these Moorefield shells are so similar to Rowley's description and figures that I would be at a loss to name characters by which they could be discriminated unless it be that in the typical form the umbo of the ventral valve is fuller and its beak more recurved so as to overhang the area.

Common in collection M 3, and very abundant in M 6. One specimen from locality F 17 is doubtfully referred to the same species.

Genus MARTINIA McCoy.

MARTINIA GLABRA Martin?

1809. *Anomites glaber*, Martin, Petrifacta Derbiensia, pl. 48, figs, 9-10.
1911. *Martinia glabra*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 70, pl. 9, figs. 9-11.

Remarks.—The shells included under this name seem to be identical with those described and figured by Girty from the Moorefield shale of Arkansas, and provisionally assigned to *M. glabra.* The shells have a somewhat lower area than the majority of those labeled *M. glabra* in the University of Chicago collections, but the difference is not sufficiently constant to justify specific differentiation of the material in hand.

In collections M 1 (one specimen), and M 4.

Genus SPIRIFERINA d'Orbigny.

SPIRIFERINA TRANSVERSA McChesney.

1860. *Spiriferina transversa*, McChesney, Desc. New Pal. Foss., p. 42.
1894. *Spiriferina transversa*, Hall & Clarke, Int. to Study of Brach., pt. 2, pl. 31, figs. 1-3.
1895. *Spiriferina transversa*, Hall & Clarke, Pal. N. Y., vol. 8, pt. 2, pl. 35, figs. 19, 20, 23-25.
1914. *Spiriferina transversa*, Weller, Mon. Ill. State Geol. Survey, No. 1, p. 297, pl. 35, figs. 41-49.

Remarks.—This species is distinguished by the great width of the shell and by the mesial plication in the fold and sinus.

Occurs in collections M 7, M 14, F 3, F 16, and F 20.

SPIRIFERINA SPINOSA Norwood and Pratten.

1855. *Spirifer spinosus*, Norwood and Pratten, Jour. Acad. Nat. Sci. Phila. (2) vol. 3, p. 71, pl. 9, figs. 1a-b.
1858. *Spirifer spinosus*, Hall, Geol. Iowa, vol. 1, pt. 2, p. 706, pl. 27, figs. 5a-c.
1895. *Spiriferina spinosa*, Hall and Clarke, Pal. N. Y., vol. 8, pt. 2, pl. 35.
1914. *Spiriferina spinosa*, Weller, Mon. Ill. State Geol. Survey, No. 1, p. 299, pl. 35, figs. 50-58.

Remarks.—This is a fairly abundant species in the Chester formations. It is easily separated from *S. transversa* with which it is associated by its less transverse shape and fewer plications, by the absence of a plication in the mesial sinus, and the presence of the spinose tubercles. In a few of the larger specimens which are weathered from shale there is a very slight development of a plication on the mesial fold

In collections M 4, M 19, F 4, F 6, F 10, F 14, F 16, F 17, F 18, F 19, F 21, F 22, P 7, P 8, and P 9.

RHYNCHOSPIRIDAE.

Genus HUSTEDIA Hall.

HUSTEDIA MULTICOSTATA Girty.

Pl. V, Figs. 7-12.

1910. *Hustedia multicostata*, Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 222.

Girty's description.—Shell rather large, a length of 13 mm. being about the maximum observed. Shape regularly ovate, broad in some specimens, narrow in others. Convexity moderate to high, about equal in both valves.

The ventral valve has a distinct though undefined sinus and a beak moderately projecting and incurved.

The dorsal valve is without a distinct fold. Its cardinal line is short.

The surface is marked by from 25 to 32 gradually enlarging costae. When unexfoliated, these are high and narrow and separated by striae of about their own width. When exfoliated, the ribs are narrow and abruptly elevated from broad flat interspaces.

Remarks.—The Oklahoma specimens have been compared with the types of this species and those of intermediate size are indistinguishable from them. The larger specimens are very ventricose and appear quite different from the smaller ones but the two types are so connected by intermediate forms that only one species is believed to be represented.

From localities F 14, F 20, P 7, and P 9.

Genus EUMETRIA Hall.

Remarks.—The genus *Eumetria* is well represented in the collections from northeastern Oklahoma. The majority of these shells have for several years been grouped under the species *E. marcyi* Shumard, but Weller,* on account of the poor description and figures and in the absence of the types of this form which have been lost, abandons the species and returns to the species *E. verneuilana*, *E. vera*, and *E. vera* var. *costata* described by Hall, raising the variety *costata* to species rank. All these forms are present in the collections and can be separated, although their relationships are very close. In addition there are two species which are new and are described here.

EUMETRIA VERNEUILANA Hall.

1852. *Terebratula serpentaria?*, Owen, Geol. Rept. Wis., Iowa and Minn., tab. 3A, fig. 13.

1856. *Retzia Verneuilana*, Hall, Trans. Albany Inst., vol. 4, p. 9.

1882. *Retzia Verneuilana*, Hall, Geol. Iowa, vol. 1, pt. 2, p. 657, pl. 23, figs. 1a-d.

1911. *Eumetria marcyi*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 77, pl. 8, fig. 10.

1914. *Eumetria verneuilana*, Weller, Mon. Ill. State Geol. Survey, No. 1, p. 442, pl. 76, figs. 18-24.

Remarks.—This species varies greatly in size and proportions and in number of plications. In general, however, its maximum size is less than that of *E. vera* or *E. costata* and the plications are finer and more numerous, numbering from 42 to 55, usually between 46 and 50 on each valve. The greatest width is near the mid-length of the shell.

It is a rare form in the Oklahoma collections, being found only in collections M 8b and F 9.

EUMETRIA VERA Hall.

1858. *Retzia vera*, Hall, Geol. Iowa, vol. 1, pt. 2, p. 704, pl. 27, fig. 3a.

1914. *Eumetria vera*, Weller, Mon. Ill. State Geol. Survey, No. 1, p. 444, pl. 76, figs. 13-17.

Remarks.—*Eumetria vera* is very closely allied to *E. verneuilana* but attains a somewhat larger size and has somewhat fewer plications, numbering from 42 to 48 on each valve. The greatest width is anterior to the mid-length of the shell, and the convexity is usually less than in *E. verneuilana*.

It is present in collections M 14, F 1, F 5, F 13, F 17, P 7, and P 9, being most abundant in the last two.

EUMETRIA COSTATA Hall.

1858. *Retzia vera* var. *costata*, Hall, Geol. Iowa, vol. 1, pt. 2, p. 704, pl. 27, figs. 3a-b.

*Weller, Stuart, Mon. Ill. State Geol. Survey, No. 1, 1914.

1914. *Eumetria costata*, Weller, Mon. Ill. State Geol. Survey, No. 1, p. 445, pl. 76, figs. 25-29.

Remarks.—*E. costata* was described as a variety of *E. vera* and has the general outline of that species, with the greatest width anterior to the mid-length of the shell. It has fewer and coarser plications, numbering 30 to 40, usually about 35, to each valve.

This species is by far the most abundant of the genus in the area, occurring in collections M 2, M 7, M 8c, M 9, M 12, M 13, M 15, M 16, M 18, M 19, F 2, F 7, F 16, 4, P 5, and P 9.

EUMETRIA LATA n.

Pl. V, Figs. 13-14.

This species is represented by two brachial valves from a single locality. The specimens are somewhat exfoliated but are sufficiently distinct to merit description.

Description.—Brachial valve medium to large, nearly circular in outline, slightly wider than long, greatest width about the mid-length of the valve. The two cotypes are of practically equal size, the dimensions being: length, 27 mm.; width, about 30 mm.; length of hinge-line, about 7 mm.; convexity, about 2.5 mm. Greatest convexity posterior to the middle, sloping abruptly to the cardinal margins which are deflected to form small auriculations. Curvature anteriorly from the umbonal region depressed convex, and more strongly convex to the lateral margins.

Surface marked by between 50 and 55 simple rounded plications, which appear to be slightly expanded very near the margin. This appearance, however, may be due to the state of preservation. Lines of growth are well developed.

Shell structure rather more coarsely punctate than is usual in *Eumetria*.

Remarks.—The large size coupled with the large number of plications, and the nearly circular outline separate this species sharply from any species of *Eumetria* with which it is associated.

Known only in collection F 15.

EUMETRIA PITKINENSIS n. sp.

Pl. V, Figs. 15-18.

Description.—Shell small to medium, longer than wide, subovate in outline, the lateral margins diverging at an angle of about 60 degrees from the beaks to the greatest width which is anterior to the mid-length of the shell. The dimensions of two pedicle valves are: length, 15 mm. and 16 mm.; width, 12 mm. and 13 mm.; convexity, 4 mm. and 5 mm. Dimensions of two brachial valves: length, 12 mm. and 11 mm.; breadth, 12 mm. and 10 mm.; convexity, about 2 mm.

Pedicle valve convex, the greatest convexity in the umbonal regions. The slope from the umbonal region to the cardinal margins is at first convex, then is inflected sharply and becomes flat or slightly concave before reaching the margins. The slope to the lateral margins is steep. The slope to the anterior margins is much more gentle, giving the valve a profile approximating a circular arc.

Brachial valve less convex than the pedicle, sloping rapidly to the cardinal and lateral margins and more gently anteriorly. Surface of both valves marked by from 26 to 35 simple rounded or subangular radiating plications, increasing gradually in size from the beaks to the margins. Lines of growth are present but indistinct.

Remarks.—This species is distinguished from *E. acuticosta* Weller by the less angular and more numerous plications and the narrower shape, and from *E. costata* Hall by the narrower shape, generally more angular plications, and more sharply inflected lateral margins. *E. vera* Hall and *E. verneuilana* Hall are both much broader and have more numerous plications.

From locality P 8.

ATHYRIDAE.

Genus ATHYRIS McCoy.

ATHYRIS CESTRIENSIS n. sp.

Pl. V, Figs. 19-24.

Description.—Shell of medium size, transversely sub-elliptical, wider than long, greatest width near the mid-length, length of the hinge-line about two-thirds of the greatest width, cardinal extremities rounded, valves sub-equally convex, with mesial fold and sinus obsolete. Dimensions of two nearly perfect specimens of about the maximum size: length, 17 and 16 mm.; width, 20 mm. and 21 mm.; thickness, 8 mm. and 7 mm.

Pedicle valve moderately convex, with the greatest convexity posterior to the middle, surface sloping steeply to the cardinal margins, in a nearly straight line to the cardinal extremities, and gently curving to the antero-lateral margins. Beak small, incurved over that of the brachial valve and with a small circular foramen. Cardinal area small and narrow. Delthyrium triangular, usually filled by the beak of the brachial valve.

Brachial valve slightly less convex than the pedicle, greatest

convexity posterior to the middle, surface sloping rather steeply to the cardinal margins and gently to the antero-lateral margins. Beak small and incurved beneath that of the opposite valve.

Surface of most specimens smooth on account of exfoliation, but on well-preserved specimens showing the lamellar extensions characteristic of the genus. These are narrow and closely spaced.

Remarks.—The size and proportions of this species, together with the absence of fold and sinus, differentiate it sharply from any Mississippian species of the genus.

Abundant at localities M 16 and M 19, and common at F 4.

Genus CLIOTHYRIDINA Buckman.

CLIOTHYRIDINA SUBLAMELLOSA Hall.

1858. *Athyris sublamellosa*, Hall, Geol. Iowa, vol. 1, pt. 2, p. 702, pl. 27, figs. 1a-c.
1894. *Athyris sublamellosa*, Keyes, Mo. Geol. Survey vol. 5, p. 92.
1911 *Cleiothyris hirsuta*, Morse, Proc. Ohio State Acad. Sci. vol. 5 p. 388, fig. 15.
1914. *Cliothyridina sublamellosa*, Weller, Mon. Ill. State Geol. Survey, No. p. 482, pl. 80, figs. 31-60.

Remarks.—The specimens are somewhat smaller than the majority of those of this species in the University of Chicago collections, but the differences do not seem to be sufficient for specific differentiation.

Occurs at localities F 6, F 8, F 14, F 20, F 21, F 22, and P 9, very abundantly in F 20.

Genus COMPOSITA Brown.

COMPOSITA TRINUCLEA Hall.

1856. *Terebratula trinuclea*, Hall, Trans. Albany Inst. vol. 4, p. 7.
1858. *Terebratula trinuclea*, Hall, Geol. Iowa, vol. 1, pt. 2, p 659, pl. 23, figs. 4a-c, 5.
1894. *Seminula trinuclea*, Hall and Clarke, Int. to Study of Brach., pt. 2. pl. 35, figs. 11, 12, 14.
1914. *Composita trinuclea*, Weller, Mon. Ill. State Geol. Survey, No. 1, p. 486, pl. 81, figs. 16-45.

Remarks.—The specimens referred to this species show considerable variation but the variations are not sufficient to make specific differentiation advisable. The specimens of this genus from the Chester of Oklahoma have usually been referred to *C. subquadrata* Hall but the relationship as shown by the development of the sinus of the pedicle valve is closer to *C. trinuclea*, although some doubt exists as to the identity of these shells with the Salem species.

Abundant in all the formations of the Chester in Oklahoma, occurring at the following localities: M 2, M 7, M 8c (?), M 11, M 14. M 16, M 19, F 1 (?), F 3, F 4, F 5, F 7 (?), F 8 (?), F 9, F 14, F 16, F 17, F 18, F 20, F 21, P 1, P 2, P 5 (?), P 7, P 9, and P 10.

At those localities the numbers of which are queried the specimens seem to show an approach to *C. subquadrata.*

COMPOSITA sp.

Remarks.—Under this title are grouped specimens from several localities which are too poorly preserved to make even an approximate specific identification possible.

Localities M 4, M 9, M 12, M 13, M 20, M 21, F 2, F 13, P 3, P 4, and P 8.

COMPOSITA cf. LEWISENSIS Weller.

1914. *Composita lewisensis,* Weller, Mon. Ill. State Geol. Survey, No. 1, p. 488, pl. 81, figs. 46-51.

Remarks.—In collection M 16 are several specimens doubtfully referred to the species described by Weller from Lewis County, Missouri. The specimens are uniformly small, none reaching 10 mm. in maximum dimension, longer than wide, with a slight mesial sinus, and with the fold obsolete.

COMPOSITA ROTUNDA n. sp.

Pl. V, Figs. 25-28.

Description.—Shell medium to large, rounded sub-quadrate in outline, length and width sub-equal, greatest width near the mid-length. Dimensions of two nearly perfect specimens; length, 26 mm. and 26 mm.; width, 23 mm. and 26 mm.; thickness, 17 mm. and 16 mm.

Pedicle valve strongly convex, greatest convexity posterior to the middle, surface sloping steeply to the postero-lateral margins becoming inflected to the cardinal extremities and curving more gently to the antero-lateral margins. Mesial sinus originating at or in front of the middle of the valve, widening very rapidly, very shallow and ill-defined, produced into a lingual extension emarginating the anterior outline of the brachial valve. Beak rather small and incurved closely over that of the brachial valve.

Brachial valve less convex than the pedicle, but well-rounded. Greatest convexity posterior to the middle with steep slopes to the postero-lateral and more gentle slopes to the antero-lateral margins. Mesial fold present only on the extreme anterior portion, broadly rounded and poorly defined. Beak incurved beneath that of the pedicle valve and filling the delthyrium.

On specimens of small and medium size the fold and sinus are absent.

Surface smooth except for lines of growth.

Remarks.—This species is separated from others of the genus by the size, the rounded outline, the strong convexity of both valves and the slight development of the fold and sinus.

From localities M 4 and M 5.

MOLLUSCA.

PELECYPODA.

SOLENOMYACIDAE.

Genus SOLENOMYA Lamarck.

SOLENOMYA? SP.

Remarks.—One specimen from locality M 13 and one from P 5 seem to belong to *Solenomya.* They both resemble *Solenomya* (?) *sp.* from the Moorefield shale of Arkansas figured by Girty in Bulletin 439 of the United States Geological Survey.

SOLENOPSIDAE.

Genus SOLENOPSIS McCoy

SOLENOPSIS NITIDA Girty?

1910. *Solenopsis nitida,* Girty, Ann. N. Y. Acad. Sci. vol. 20, No. 3, pt. 2, p. 223.
1911. *Solenopsis nitida?,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 81. pl. 12, fig. 12.

Remarks.—A single valve from locality M 8c and an imperfect one from M 8a are doubtfully referred to this species.

Genus SPHENOTUS Hall.

SPHENOTUS CHEROKEENSE n. sp.

Pl. VI, Fig. 1

Description.—Shell of medium size, transverse, greatest width about two and one-half times the height. Dimensions of type; width, 33 mm.; height, 13 mm.; convexity of each valve, about 4 mm. Beaks prominent and nearly erect, situated about one-fourth the width of the shell from the anterior extremity. The upper and lower margins converge posteriorily, making that portion of the shell of less height than the anterior. Anterior margin strongly convex, with the greatest anterior extension below the mid-height of the shell; lower margin gently and uniformly rounded; posterior margin sharply convex with the greatest extension above the mid-height. Surface ornamented with very faint lines of growth. A shallow, poorly-defined depression extends slightly backward from the beak to the lower margin. It is best developed about the mid-height.

Remarks.—This species is fairly common in the Oklahoma collections, but most of the material is fragmentary.

From localities M 12 (?), M 16, P 2, P 3, P 5, P 6, P 8, and P 9.

SPHENOTUS OKLAHOMENSE n. sp.

Pl. VI, Fig. 2.

Description.—Shell of medium size, transversely sub-elliptical; width about one and one-half times the height; hinge-line straight, with a length equal to the height of the shell. Dimensions of the type specimen: greatest width, 30 mm.; height, 20 mm.; length of hinge-line, 20 mm.; convexity of valve, about 3 mm. Beaks of moderate size and inclined to the front. Anterior margin forming a slightly concave slope to the greatest anterior extension, which is below the middle, then making a strongly convex curve to the lower margin. Lower margin gently rounded and sub-parallel to the hinge-line, with a strongly convex curve to the greatest posterior extension which is below the middle of the shell. From the greatest posterior extension the margin proceeds in an almost straight line to the hinge-line, meeting it at an angle of about 120 degrees. Umbonal ridge distinct from the beak almost to the postero-ventral margin. Umbonal slope nearly flat with two or three very faint, radiating costae developed on some specimens. There is usually a flattening or a very shallow depression anterior to the umbonal ridge. Surface ornamented with lines of growth and also with extremely fine concentric striae.

Remarks.—The outline of this shell separates it from any others with which it is associated.

From localities M 1, M 3, M 4, and M 6.

SPHENOTUS QUADRIPLICATUM n. sp.

Pl. VI, Fig. 3.

Description.—Shell small; transverse, width a little over twice the height, hinge-line straight with a length four-fifths the width of the shell. Dimensions of the type, which is the largest specimen observed: width, 26 mm.; height, 11 mm.; convexity, about 2 mm.; length of hinge-line, 20 mm. Beaks inconspicuous, very near the anterior extremity. Anterior margin concave below the beaks and then strongly rounded to the lower margin. Greatest anterior extension of the shell near the mid-height. Lower margin nearly straight, and diverging slightly from the hinge-line, making the distance across the posterior portion of the shell greater than across the anterior. The lower margin rounds into the posterior with a strongly convex curve to the greatest posterior extension which is below the mid-height. From the point of greatest extension the posterior margin is straight to the hinge-line, meeting it at an angle of about 130 degrees.

Umbonal ridge fairly prominent. A broad shallow depression extends from the beak obliquely backward to the lower margin in front of the umbonal ridge. Surface ornamented by fine concentric striae and stronger lines of growth. Faint plications (usually four in number) extend from the beaks to the anterior margin, between the hinge-line and the umbonal ridge.

Remarks.—This species is not likely to be confused with any with which it is associated. It resembles the figure of *Sanguinolites saltere*, Walcott,* but the proportions of the shell are different, and the plications on the umbonal slope are much stronger in Walcott's figure.

*Walcott, C. D., Mon. U. S. Geol. Survey, vol. 8, p. 248, pl. 20, fig. 12.

From localities P 3, P 5, and P 6.

SPHENOTUS WASHINGTONENSE Girty.

Pl. VI, Fig. 4.

1910. *Sphenotus washingtonense*, Girty, Ann. N. Y. Acad. Sci., vol. 20, No 3, pt. 2, p. 228.

Remarks.—One specimen from locality F 10 is referred to this species. It is distinguished principally by the high, angular umbonal ridge. The shell is very transverse, width about three times the height, hinge-line longer than one-half the width of the shell, cardinal and ventral margins sub-parallel. A broad shallow depression extends from the beaks to the ventral margin in front of the umbonal ridge. Surface markings of fine concentric striae. Dimensions of the specimen (a left valve): height, 9 mm.; width, about 26 mm.; length of hinge-line, 17 mm.; convexity, about 4 mm.

SPHENOTUS GIBSONENSE n. sp.

Pl. VI, Fig. 5.

Description.—Left valve unknown.

Right valve transversly sub-elliptical, twice as wide as high, greatest width below the mid-height, hinge-line straight, nearly equal to the width of the valve. Dimensions of the type (only known) specimen, with posterior margin restored width, 36 mm.; height, 19 mm.; length of hinge-line, about 32 mm.; convexity of valve, 6 mm. Beak rather large, flattened on the dorsal surface and somewhat incurved over the hinge-line situated at about one-fourth the length of the hinge-line from its anterior extremity. Anterior margin meeting the hinge-line at an angle of about 120 degrees, strongly convex and curving gradually into the lower margin which is moderately and uniformly rounded. Posterior margin not preserved but, judging from the pallial line, its curvature is nearly continuous with that of the lower margin to a point about the mid-height of the valve where it is bent sharply and extends on in a nearly straight line to its intersection with the hinge-line. Umbonal ridge prominent near the beaks but becoming nearly obsolete toward the postero-ventral margin. Umbonal slope concave near the beak, becoming flattened posteriorly. Anterior to the umbonal slope the valve is strongly convex with some indication of a depression from the beak to the ventral margin.

Surface ornamented by the very fine concentric striae.

Remarks.—The specimen on which this species is founded bears considerable resemblance to *S. cherokeensis*, but is larger, more convex and relatively higher, especially across the posterior portion of the valve, and the anterior extension of the hinge-line is more pronounced.

From locality P 6, near Ft. Gibson.

GRAMMYSIIDAE.

Genus EDMONDIA de Koninck.

EDMONDIA CRASSA Girty.

1911. *Edmondia crassa*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 82, pl. 12, fig. 8.

Remarks.—The shells belonging to this species in Oklahoma seem identical in all respects with those described and figured by Girty from the Moorefield shale of Arkansas.

From localities M 4, M 6, and P 6.

EDMONDIA CRASSA var. SUBORBICULATA Girty.

1911. *Edmondia crassa* var. *suborbiculata*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 82, pl. 12, fig. 9.

Remarks.—From localities M 6, F 1, and P 5.

EDMONDIA PITKINENSIS n. sp.

Pl. VI, Figs. 6-7.

Description.—Shell small; sub-circular, dimensions of three specimens: width, 15 mm., 12 mm., and 15 mm.; height, 14 mm., 11 mm., and 13.5 mm., respectively. Hinge-line straight, about two-thirds the greatest width. Posterior and anterior margir

broadly rounded. Beaks large and prominent. Convexity moderately high. Surface ornamented by rather strong, coarse lines of growth.

Remarks.—This species is somewhat similar to *E. crassa*, but the specimens at hand are uniformly smaller and more nearly circular.

From localities P 3, P 7, and P 8.

NUCULIDAE.

Genus NUCULA Lamarck.

NUCULA RECTANGULA McChesney.

1860. *Nucula rectangula*, McChesney, Desc. New Pal. Foss., p. 74.
1865. *Nucula rectangula*, McChesney, Ill. New Pal. Foss., pl. 7, figs. 5a-c.
1868. *Nucula (?) rectangula*, McChesney, Trans. Chi. Acad. Sci., vol. 1, p. 40, pl. 7, figs. 5a-c.
1911. *Nucula rectangula*, Girty, Bull. U. S. Geol. Survey, No. 439, pl. 12, figs. 13-17.

Remarks.—Represented in the Oklahoma collections by two specimens from locality F 2.

NUCULA ILLINOIENSIS Worthen.

1884. *Nucula illinoiensis*, Worthen, Bull. Ill. State Mus. Nat. Hist., No. 2, p. 15.
1890. *Nucula illinoiensis*, Worthen, Geol. Survey Ill., vol. 8, p. 128, pl. 19, figs. 4-4a.

Remarks.—Represented by one perfect specimen from locality P 2.

LEDIDAE.

Genus LEDA Schumacher.

LEDA VASEYANA McChesney

----. *Nuculites vaseyana*, McChesney, Des. New Pal. Foss., p. 73.
1865. *Nuculites vaseyana*, McChesney, Ill. New Pal. Foss., pl. 7, figs. 4a-d.
1868. *Nuculana Vaseyana*, McChesney, Trans. Chi. Acad. Sci., vol. 1, p. 37, pl. 7, figs. 4a-d.
1911. *Leda vaseyana*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 83, pl. 11. fig. 7

Remarks.—Specimens from all three formations of the Chester group of Oklahoma are referred to this species with some certainty.

From localities M 3, M 6, M 13, M 16, F 2, P 2, P 4, and P 9.

PARALLELODONTIDAE.

Genus CYPRICARDINIA Hall.

CYPRICARDINIA? MOOREFIELDANA Girty.

1911. *Cypricardinia? moorefieldana*, Girty, Bull. U. S. Geol. Survey, No. 439, p. 85, pl. 12, figs. 1, 2.

Remarks.—The specimens from Oklahoma seem in all respects identical with the descriptions and figures given by Girty of specimens from the Moorefield shale of Arkansas.

From the Mayes limestone in collections M 4, M 5, and M 6.

Genus PARALLELODON Meek.

PARALLELODON MULTIRATUS Girty.

1909. *Parallelodon multiratus,* Girty, Bull. U. S. Geol. Survey, No. 377, p. 39 pl. 3, figs. 4, 5.

1911. *Parallelodon multiratus,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 85, pl. 12, figs. 3, 4.

Remarks.—A single specimen from locality M 8a is referred to this species with a fair degree of certainty.

PINNIDAE.

Genus PINNA Meek.

PINNA CONSIMILIS Walcott.

1884. *Pinna consimilis,* Walcott, Mon. U. S. Geol. Survey, vol. 8, p. 236, pl. 20, fig. 13.

Remarks.—One fairly complete and one incomplete specimen from locality M 13 seem to be identical with the description and figure given by Walcott of a specimen from the lower part of the Carboniferous of the Eureka and White Pine districts, Nevada The specimen is 7 cm. long, and 2 cm. wide at the posterior end The surface is smooth except for faint lines of growth. The shell is sub-cylindrical at the beak and becomes more elliptical posteriorly.

PINNA ARKANSANA Weller?

1897. *Pinna arkansana,* Weller, Trans. N. Y. Acad. Sci., vol. 16, p. 260, pl. 20, figs. 1-2.

Remarks.—One specimen showing the impression of part of one valve is doubtfully referred to this species. It shows both the radiating and concentric ornamentations but apparently had the hinge-line and ventral margin meeting at an angle of between 20 and 25 degrees, while the angle in Weller's specimens is given at 27 degrees.

From locality M 19.

CONOCARDIIDAE.

Genus CONOCARDIUM Neumayr.

CONOCARDIUM PECULIARE Girty.

1910. *Conocardium peculiare,* Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 227.

Remarks.—A single specimen from locality P 9 is referred to this species. While the specimen is not quite complete, the surface ornamentation is so distinct that there is no doubt as to the reference.

PTERIIDAE.

Genus CANEYELLA Girty.

CANEYELLA VAUGHANI Girty?

1909. *Caneyella vaughani,* Girty, Bull. U. S. Geol. Survey, No. 377, p. 35, pl. 4, figs. 7-10.

1911. *Caneyella vaughani,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 86, pl. 11, fig. 12.

Remarks.—A single, small right valve from locality M 1 is doubtfully referred to this species on account of the concentric ornamentation.

Genus LEIOPTERIA Hall.

LEIOPTERIA? SP.

Remarks.—In collection P 9 are a few imperfect left valves of a species believed to belong to the genus *Leiopteria.* The valves are small; strongly convex; the total width having been about 20 mm., while the height was about half as much. The hinge-line is straight with a length of about two-thirds the width of the valve. Beaks small, about one-third the distance from the anterior end of the hinge-line. Posterior wing small, triangular; surface ornamented by few concentric lirae.

MYALINIDAE Frech.

Genus MYALINA de Koninck.

MYALINA COMPRESSA n. sp.

Pl. VI. Figs. 8-9.

Description.—Shell small, reaching a length of about 20 mm; oblique, greatest length about two and one-half times the greatest width. Valves very strongly convex in the umbonal region, depressed posteriorly. Hinge-line straight, equal to the greatest width of the shell. Beak almost or quite terminal. Ventral margin slightly concave and rounding with a regular, strongly convex curve into the posterior margin which is nearly straight and which meets the hinge-line at an angle of about 140 degrees. The slope from the umbones to the ventral margin is very steep, almost perpendicular becoming more gentle posteriorly. Surface marked by lines of growth which are distinct on well-preserved specimens.

Remarks.—This species is of the same size as *M. arkansana* Weller from the Batesville sandstone of Arkansas, but the umbonal region is more convex and the proportions of the shell are different. It differs from *M. sanctiludovici* Worthen, in the greater relative length, in having a steeper slope to the ventral margin, and in the beaks being less curved.

From localities M 13, M 16, M 18, F 1, F 5, F 9, P 4, and P 9.

MYALINA LONGICARDINALIS n. sp.

Pl. VI, Figs. 10-11.

Description.—Shell large, oblique, sub-quadrate, greatest length about one and three-fourths the greatest width, hinge-line straight with a length of about five-sixths or more of the greatest length of the shell. Approximate dimensions: length, 70 mm.; width, 45 mm.; length of hinge-line, 60 mm.; greatest thickness, 25 mm. Right valve less convex than the left. Beaks small and apparently very near the anterior end of the hinge-line. Anterior margin not preserved; ventral margin nearly straight, rounding abruptly into the posterior margin which is angulated at a point about halfway between the umbonal ridge and the end of the hinge-line, meeting the hinge-line at an angle of about 125 degrees. Umbonal ridge prominent, with its greatest prominence about one-third the distance from the beaks to the postero-ventral margin. Slope to the ventral margin very steep, to the anterior margin gently concave. Surface marked by irregular, narrow ridges.

Remarks.—This species is quite distinct from any with which it is associated. It bears some resemblance to *M. angulata* M. and W. from the Chester of Illinois and Missouri, but it is more oblique and the hinge-line is relatively longer.

Known only from locality P 5.

TRIGONIIDAE.

Genus SCHIZODUS King.

SCHIZODUS DEPRESSUS Worthen.

1884. *Schizodus depressus,* Worthen, Bull. Ill. State Mus. Nat. Hist., No. p. 11.

1890. *Schizodus depressus,* Worthen, Geol. Survey Ill., vol. 8, p. 109, pl. 18 figs. 8, 8a.

1897 *Schizodus depressus(?),* Weller, Trans. N. Y. Acad. Sci., vol. 16, p. 207 pl. 21, figs. 7, 8.

Description.—Shell below medium size, sub-triangular in outline, slightly convex, greatest convexity along the umbonal ridge. Umbonal ridge angular, extending from the beak to the most posterior extension of the shell, sub-parallel with the nearly straight upper portion of the posterior margin of the shell. Beak depressed, obtuse, situated a little anterior to the middle of the shell.

Hinge-line short, anterior margin of the shell nearly straight above, sloping ventrally, regularly rounded below. Ventral margin arcuate. Posterior margin sharply rounded below at the most posterior extension of the shell, straight or slightly arcuate above, sloping upward to a point just posterior to the beak.

Remarks.—This species is rather common in the Chester of Oklahoma, occurring in abundance in the white, siliceous phase of the Mayes limestone in the northeastern part of the Pryor quadrangle Some of the specimens attain a somewhat larger size than those illustrated by Worthen or by Weller.

From localities M 12, M 13, M 16, F 5 (?), F 6, and P 5.

SCHIZODUS CHESTERENSIS Meek and Worthen.

1860. *Schizodus Chesterensis,* Meek and Worthen. Proc. Acad. Nat. Sci. Phila., p. 457.

1866. *Schizodus chesterensis,* Meek and Worthen, Geol. Survey Ill, vol. 2, p. 301, pl. 23, figs. 6a-b.

1911. *Schizodus chesterensis,* Morse, Proc. Ohio State Acad. Sci., vol. 5, p. 390, fig. 16.

Remarks.—This species is easily separated from *S. depressus* by the more ovate outline with the greater posterior extension, and by the more acute beak.

From localities M 1 (?), M 14, M 21, F 10 (?), P 1, P 2 (?), P 3, P 4, P 6, P 8, P 9, and P 10.

SCHIZODUS? SP.

Remarks.—In collection P 6 are two specimens of a very transverse *Schizodus* (?). The shell was probably twice as wide as it was high. The beaks are prominent, near the anterior end, and strongly inclined anteriorly. The shell probably reached a width of 40 to 50 mm. There are large sub-circular posterior and anterior muscle scars.

SCHIZODUS INSIGNIS Drake (?).

1897. *Schizodus insignis,* Drake, Cont. to Biol. from the Hopkins Seaside Lab. (Leland Stanford Jr. Univ.), No. 14, p. 406, pl. 9, fig. 7. (Also Proc. Am. Phil. Soc., vol. 36, No. 156).

Drake's description of the species is as follows:

This species, one of the largest of the genus *Schizodus,* is represented in the collection only by a cast, so that the generic reference is not beyond doubt. The shell is large, being two and a half inches in length and two inches in height. Convexity of the valve is eleven-twentieths of an inch. The beak is rather high and pointed, rising two-fifths of an inch above the hinge line. The anterior margin is rounded, the posterior is broken off. The anterior and posterior adductor scars are quite large and distinct. The cast is smooth, so nothing is known of the sculpture of the surface. The only species with which *Schizodus insignis* may be compared is *Schizodus (Leptodomus) magnus* Worthen, (*Geol. Surv. Ill.*, vol. viii, p. 107, pl. xviii, Fig. 2) of the lower Carboniferous, Chester horizon; but *S. magnus* differs from *S. insignis* in the elongation of the anterior part of the valve, also in the sharp high ridge that runs from behind the beak obliquely to the rear of the shell. Otherwise there is considerable similarity, and the two species may well belong to the same genus.

Remarks.—The specimen figured by Drake was from 5 miles east of McDermitt, Indian Territory. The horizon is given as Permian, but this is impossible, and the shell is from well up in the Pennsylanian series. In spite of the different horizons, the specimens from the Chester of northeast Oklahoma seem to be identical with Drake's figure. The mode of preservation is also precisely similar.

From localities F 16 (one specimen) and P 2 (two specimens).

PECTINIDAE.

Genus DELTOPECTEN Etheridge.

DELTOPECTEN BATESVILLENSIS Weller.

1897. *Aviculopecten batesvillensis,* Weller, Trans. N. Y. Acad. Sci., vol. 16, p. 263, pl. 19, figs. 3, 4.

1911. *Deltopecten batesvillensis,* Girty, Bull. U. S. Geol. Survey, No. 439, p. 89, pl. 11, figs. 1-4.

Remarks.—The specimens of this species from the Mayes limestone of Oklahoma seem to be identical with those from the same horizon (Batesville and Moorefield) in Arkansas, which have been described and figured by Weller and Girty. There is considerable variation in the sculpture and also in the relative length of the hinge-line.

From localities M 2, M 8b, M 12, M 13, M 16, M 17, and P 2 (?)

DELTOPECTEN? TAHLEQUAHENSIS n. sp.

Pl. VI, Figs. 12-13.

Description.—Right valve of medium size, nearly flat, height and greatest width equal, length of hinge-line two-thirds of height of shell. Dimensions of two specimens: width (and height) 26 mm. and 29 mm.; lengh of hinge-line, 18 mm. and 20 mm.

The byssal sinus—which is in a straight line with the anterior margin—and the umbonal slope meet at the beak at an angle of 105 degrees. Greatest anterior extension above the middle of the shell, greatest posterior extension below the middle. Ventral margin semi-circular. Posterior margin deeply concave. Umbonal slope narrow, sharply set off from the posterior wing. Wings subequal, the anterior somewhat the smaller. Surface with irregular

concentric wrinkles and without radiating markings except five or six faint plications on the anterior wing.

Remarks.—The right valve from the Moorefield shale described and figured by Girty* as *Deltopecten? sp* is believed to belong to this species, although Girty's restoration of the posterior wing of his specimen differs considerably from the wing as preserved in the Oklahoma specimens. Known only from locality M 1 (Mayes limestone 1 mile south of Tahlequah) where it is fairly abundant.

Genus AVICULOPECTEN McCoy.

AVICULOPECTEN EUREKENSIS Walcott?

1884. *Aviculopecten Eurekensis,* Walcott, Mon. U. S. Geol. Survey, vol. 8, p. 227, pl. 19, figs. 2-3.

Walcott's description.—General outline exclusive of the ears subovate; varying somewhat in different specimens. General surface moderately convex when not accidentally compressed; ears subequal in size, the posterior being the larger, the anterior shorter and more obtuse. Hinge-line less than the greatest width of the shell. Beak small, obtusely pointed.

Surface marked by from 18 to 25 simple lines or radiating costae, that are crossed by fine concentric striae. Left valve unknown. The hinge is smooth each side of the beak.

Dimensions.—Height of narrow form 4 cm.; of broad form, 3.5 cm., width 3.5 cm. and 4 cm.; convexity of left valves, 1 cm. and .75 cm., respectively.

Remarks—Walcott's description is not diagnostic, but his figures show the surface of the left valve to be ornamented by very coarse costae in the central part of the shell, separated by broad, flat interspaces, the costae becoming more narrow and nearly obsolete on the sides. The concentric striae are much more prominent on the wings.

The material from Oklahoma is mostly fragmentary, only one specimen showing the wings. The specimens are considerably smaller than Walcott's, but the sculpture, and the shape of the wings in the one specimen, agree so well with his figures that the reference to the species is made with some degree of confidence.

From localities M 16, F 5, F 7, F 11, and P 4.

AVICULOPECTEN MAYESENSIS n. sp.

Pl. VII, Fig. 1.

Description.—Right valve unknown. Left valve medium to large in size; exclusive of the wings, sub-ovate in outline; axis inclined slightly backward; convexity low; height and greatest width

*Girty, G. H., Bull. U. S. Geol. Survey, No. 439, p. 90, pl. 11, fig. 5.

sub-equal; hinge-line slightly less than one-half the greatest width. Dimensions of the type specimen: height, 38 mm.; width, 40 mm.; convexity, about 3 mm.; length of hinge-line, 19 mm. The beaks slightly anterior to the middle of the hinge-line; angle at the beaks about 95 degrees. Wings sub-equal, triangular and nearly flat. Anterior margin strongly inflected below the hinge-line, and extending in a straight line to the greatest anterior extension, which is about the mid-height of the valve. Ventral margin semi-circular, from point of greatest anterior extension to that of greatest posterior extension, which is well below the mid-height of the shell. The posterior extension is greater than the anterior and the line of greatest width is inclined downwards from front to rear. Posterior margin concave below the hinge-line and then straight to the greatest posterior extension. Sculpture of fine, sub-equal, slightly wavy, radiating costae, about 22 in the space of 10 mm., which are nearly or quite obsolete on the wings. Also fine concentric lirae, not always preserved, with stronger lines of growth.

Remarks.—This species is distinguished from *Deltopecten batesvillensis* by the relatively shorter hinge-line, the greater posterior extension of the valve, and the finer and more uniform radiating plications.

It is fairly abundant in the black limestone of the Mayes formation, at localities M 1, M 3, M 4, and M 6.

AVICULOPECTEN MORROWENSIS Girty.

Pl. VI, Fig. 14.

1910. *Aviculipecten morrowensis,* Girty, Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 229.

Girty's description.—Shell small, a length of 11 mm., being about the maximum observed. Length and breadth nearly equal, or the breadth a little in excess. Hinge long but considerably shorter than the width below. Axis slightly inclined backward, with a greater development of the shell behind than before. Wings broad, defined either by being abruptly depressed or by a sinus in the outline which is nearly straight and slightly oblique on the anterior side, slightly concave and strongly oblique on the posterior side. The lower part of the outline is regularly rounded. The anterior wing is larger than the posterior. The convexity is low and the umbones small and inconspicuous.

The surface is crossed by numerous exceedingly-fine lirae which are scarcely visible without a lens. These are sharply elevated, rounded, with interspaces of about their own width, and they are in some cases slightly wavy. They bifurcate occasionally and thus tend to form groups or fasicles which in one specimen are visible to the naked eye as very obscure, regularly arranged costae, of which there appear to be six or seven. The radii are also more or less alternating. They are crossed in some cases by regular, fine, sublamellose concentric lirae which are differently arranged in different examples. In one specimen, they are

much farther apart than the radiating lirae; in another, only slightly farther apart. In most examples, they do not appear at all, the concentric markings consisting of fine, incremental striae, of which a few at irregular and distant intervals are stronger than the rest. On the wings, the radii become very obscure, while the concentric striae are intensified and conspicuous. In some specimens, the radii are sharp and strong; in others, possibly by exfoliation, they are more obscure. It may be owing to the same causes that the lamellose concentric lirae appear to be absent.

Remarks.—The specimens in the Oklahoma collections seem to be typical of the species.

From localities F 4, F 6, P 3, and P 9.

AVICULOPECTEN OZARKENSIS n. sp.

Pl. VI, Fig. 15.

Description.—Right valve unknown; left valve small to medium, a length of 20 mm. being the maximum observed, convexity low. Beaks small, scarcely protruding above the hinge. Length and maximum breadth equal. Hinge-line short, slightly over one-half the greatest breadth, divided nearly equally by the beak. Axis inclined backward with the greater portion of the valve in front. Anterior wing small, sub-triangular, separated from the body of the valve by a depression which is well defined at the umbones but becomes obsolete near the margin. Anterior margin strongly rounded, almost semi-circular with its greatest extension about the middle of the length, and continuing in an unbroken curve into the rounded lower margin. Posterior margin extending from the greatest posterior extension, which is well below the middle of the valve, in a straight or slightly concave line to its intersection with the hinge-line, which it meets at an angle of about 110 degrees. Posterior wing small and scarcely differentiated from the body of the valve.

Surface ornamented with lines of growth which are best developed on the anterior portion, and by radiating plications which are best developed on the lower central part of the shell, becoming obsolete on the umbones, on the extreme anterior portion, and on the wings. The plications increase by bifurcation and are broader than the intervening striae, about 10 or 12 plications in 5 mm. near the middle of the lower margin.

Remarks.—The size, peculiar shape—with the strongly convex anterior and lower margins, and the long, nearly straight posterior margin—together with the surface ornamentation, distinguish this species sharply from any with which it is associated.

Fairly abundant at locality M 1.

AVICULOPECTEN KEOUGHENSIS n. sp.

Pl. VII, Fig. 2.

Description.—Right valve unknown.

Left valve medium in size, sub-circular in outline, with the length and width about equal, hinge-line equal to one-half the greatest width, which is about 25 mm. Valve only moderately convex, with the greatest convexity in the umbonal region, and with gentle slopes to the posterior wing and to the posterior, ventral, and anterior margins, but with a steep slope to the anterior wing. The wings are small, triangular, the anterior sharply set off from the body of the valve by a steep slope, but the posterior not well differentiated. Beak prominent and sharp, extending above the hinge-line which it divides into two equal parts. The axis of the valve is perpendicular to the hinge-line.

Remarks.—Known only from a single valve from locality P 5, (quarry at Keough).

AVICULOPECTEN PITKINENSIS n. sp.

Pl. VI, Figs. 16-18.

Description.—Left valve unknown. Right valve small, probably not reaching a length of over 20 mm. and usually smaller. Length and breadth approximately equal. Hinge-line relatively long. Anterior wing small, triangular, nearly flat, separated from the body of the valve by a deep sinus with an almost vertical slope to the main portion of the valve. Anterior margin not preserved. Lower margin strongly rounded to the greatest posterior extension which is below the mid-height of the valve. The posterior margin concave from the greatest posterior extension to its intersection with the hinge-line. Umbonal angle about 70 degrees. Posterior wing small, concave, not sharply set off from the body of the valve.

Surface ornamented by alternating, radiating costae, those of one set beginning at the beak while the other originates at from one-fourth to one-third the length of the valve from the beak and increase rapidly in size anteriorly, seldom, however, attaining the size of those of the other set. All the costae are sharp and are separated by rounded interspaces much broader than themselves. There are also extremely fine concentric markings.

Remarks.—This species is moderately abundant in the Fayetteville and Pitkin formations but the material is all more or less fragmentary and it is difficult to give a satisfactory description. The small size and the surface ornamentation of alternating costae are believed to be distinctive.

From localities F 4, F 7, P 3, and P 9.

AVICULOPECTEN SP. 1.

Remarks.—In collection M 16 is one incomplete specimen showing the umbonal region and the anterior wing of a right valve of a large species probably belonging to *Aviculopecten.* The wing is subtriangular, with a pronounced ridge and sharply set off from the shell by a deep trench. The convexity is high. The surface ornamentation apparently consisted of fine, sub-equal, radiating costae The shell must have attained dimensions of 60 to 70 mm.

AVICULOPECTEN SP. 2.

Remarks.—One specimen in collection M 8b, one in M 15, and one in F 6, show an *Aviculopecten* attaining dimensions of about 50 mm. with the length and breadth about equal. The posterior wing is shown on one specimen. It is relatively small and is distinct from the main portion of the shell. The surface is ornamented by coarse, rounded costae, which are sometimes double or also bifurcate, separated by relatively narrow depressions. The costae are absent from the posterior ear which is ornamented by concentric ridges much finer than the costae on the main portion of the shell.

Genus STREBLOPTERIA McCoy.

STREBLOPTERIA SIMILIS Walcott.

Pl. VII, Fig. 3.

1884. *Streblopteria similis*, Walcott, Mon. U. S. Geol. Survey, vol. 8 p. 230, pl. 8, figs. 4, 4a-d, and pl. 19, fig. 7.

Walcott's description.—Shell of medium size; outline, exclusive of the anterior ear, ovate; general surface depressed convex. The two valves are very much alike in convexity and form, except at the anterior ear and the slope beneath; the right valve has a deep, sharply-cut byssal sinus beneath the ear, the ear joining the body of the shell higher up towards the beak. The posterior ear is either very short and small, or obsolete, being merged into the flattened posterior umbonal slope. Hinge-line very short. Beaks small, the sides sloping away at an angle of about 80 degrees.

Surface of the larger shells, smooth or with fine concentric striae and lines of growth; a few very indistinct fine radii are present towards the lower margin; the anterior ear of the right valve is marked by concentric lines of growth and rather strong radiating costae; on the left valve the anterior ear has only the concentric striae. On all the smaller shells the raised radiating striae or fine costae are present in varying degrees of distinctness up to well-marked striated forms that in surface characters apparently have no specific relation to the large, smooth shells.

Dimensions.—Height of two examples, 3.75 cm. and 1.75 cm: breadth, 3.25 cm. and 1.5 cm.; convexity of larger, 4 mm.; of smaller about 2 mm.

The peculiar obliquity of the valves, the deeply-cut sinus beneath the anterioear of the right valve, and the smooth surface relates this species to *Streblopteria laevigata* McCoy (Brit. Pal. Foss., p. 482), the type of the genus. The form is also that of species referred to the genus Pernopecten, but in a large number of examples I have not been able to find the crenulated hinge area characteristic of that genus; the species agrees more closly with Streblopteria in other characters. The smaller shells resemble *Pecten? pusillus* of the Permian (see Mon. Perm. Foss., England, p. 153), but differ in having a longitudinally striated surface.

Streblopteria tenuilineatus M. and W. (Geol. Surv. Ill., vol. ii, plate xxvi, fig. 9a) is the only American species that has been referred to the genus. It differs very materially in form and surface characters from the species under consideration.

Formation and localities.—Lower portion of the Carboniferous Group in the canon north of Pinto Peak; on the west slope of Richmond Mountain, and in the canon south of a small conical hill on the east side of Secret-canon-road Canon, Eureka District, Nevada.

Remarks.—The specimens from the Oklahoma Chester agree with Walcott's description and figures in all essential details. The species occur at the same horizon as *Moorefieldella eurekensis*, with which it is associated at the original locality.

From localities M 3, M 6, M 8a, and M 8b.

PHOLADELLIDAE.

Genus ALLORISMA King.

ALLORISMA WALKERI Weller.

Pl. VII, Figs. 4-5.

1897. *Allorisma walkeri*, Weller, Trans. N. Y. Acad. Sci., vol. 16, p. 265, pl. 20, figs. 6, 7.

Remarks.—This species is well represented in the collections, but the material is more or less fragmentary. The specimens cannot well be differentiated from the types of the species from the Batesville sandstone of Arkansas. The latter are possibly a little more transverse than the Oklahoma specimens and some of them have a very slight depression from the umbones to the ventral margin which is not developed in the Oklahoma shells:

From localities M 13, M 16, F 2, F 9, F 10, P 1, P 3, P 4, P 5, and P 7.

ALLORISMA ARKANSANA Weller.

1897. *Allorisma arkansana*, Weller, Trans. N. Y. Acad. Sci., vol. 16, p. 265 pl. 20, figs. 4-5.

Remarks.—One specimen from locality P 6 is referred to this species. The height of the posterior portion of the valve is less than that of the anterior, and the concentric ridges are obsolete on the posterior portion.

GASTROPODA.

Genus BELLEROPHON McCoy.

BELLEROPHON SP.

Remarks.—The specimens included under this title are preserved as internal casts. In view of the absence of surface characters and the fragmentary material it is impossible to make specific reference. The relationships of the shells are probably with *B. sublaevis* Hall, but it is entirely possible that more than one species is represented.

From localities M 8b, M 13, M 15, M 16, M 17, F 2, F 4, P 3, P 4, P 5, and P 9.

BELLEROPHON PITKINENSIS n. sp.

Pl. VII, Figs. 6-7.

Description.—Shell sub-globose, inflated on the last volution. Aperture transverse and broadly expanded. Lip thickened and much extended at the junction with the volution. Dorsum ornamented by a carina which widens near the front and is separated from the rest of the shell by narrow but distinct sulci. The species attains a length of about 25 mm.

Remarks.—This species is distinguished from *B. sublaevis* Hall by the broadening of the carina toward the front and the sulci separating it from the body of the shell.

From locality P 2.

Genus PLEUROTOMARIA Montfort.

PLEUROTOMARIA? SP. 1.

Remarks.—A fragmentary specimen from locality M 1 and another from M 3 are referred to *Pleurotomaria*. The shape and sculpture on the sides bear some resemblance to *P.? trilineata* Hall from the Salem limestone, but they cannot be referred to this species. It is entirely possible that the two specimens may belong to different species.

PLEUROTOMARIA? SP. 2.

Remarks.—A single distorted and incomplete Pleurotomarid is present in collection M 8b. The whorl is sub-triangular in cross-section and the slit-band is prominent.

PLEUROTOMARIA? SP. 3.

Remarks.—This species which is doubtfully referred to the genus *Pleurotomaria*, is a large, very low coiled form. As preserved the shape is almost discoidal but the specimens are probably flattended in preservation. The largest specimen reached a diameter of over 45 mm., and the height as preserved is 8 mm. The whorls are three in number; the diameter of the largest about 10 mm. One specimen shows what is taken for the slit.

From localities M 1 and M6.

Genus MURCHISONIA d'Arch and Vern.

MARCHISONIA? SP.

Remarks.—Some small casts from locality M 16 probably belong to the genus *Murchisonia.* They resemble *M.? terebriformis* Hall from the Salem limestone, but it is impossible to make specific determination of the material.

Genus BEMBEXIA Oehlert.

BEMBEXIA NODOMARGINATA McChesney.

1860. *Pleurotomaria nodomarginata,* McChesney, Desc. New Spec. Pal. Foss., p. 70.
1865. *Pleurotomaria nodomarginata,* McChesney, Ill. New Spec. Foss., pl. 7. figs. 1 a-c.
1884. *Pleurotomaria nodomarginata,* Walcott, Mon. U. S. Geol. Survey, No. 8, p. 259, pl. 18, fig. 15.
1911. *Bembexia nodomarginata,* Girty, Bull. U. S. Geol. Survey, No. 430, p. 91, pl. 7, figs. 1-5.

Remarks.—The specimens from the Mayes limestone in Oklahoma are very small, reaching a height of between 2 and 3 mm., but they seem to be specifically identical with the specimens from the Moorefield shale described by Girty.

Abundant in localities M 3 and M 6.

Genus BULIMORPHA Whitfield.

BULIMORPHA CANALICULATA Hall?

1856. *Bulimorpha canaliculata,* Hall, Trans. Albany Inst., vol. 4, p. 29.
1906. *Bulimorpha canaliculata,* Cumings, 30th Ann. Rept. Ind. Dept. Geol. Nat. Res., p. 1343, pl. 25, fig. 41.
1911. *Bulimorpha canaliculata,* Morse, Proc. Ohio Acad. Sci., vol. 5, p. 400, fig. 25.

Remarks.—Two incomplete specimens from locality M 16 are doubtfully referred to this species.

Genus STRAPAROLLUS Montfort.

STRAPAROLLUS SPERGENENSIS Hall?

1856. *Euomphalus Spergenensis,* Hall, Trans. Albany Inst., vol. 4, p. 19.

1906. *Straparollus spergenensis,* Cumings, 30th Ann. Rept. Ind. Dept. Geol. Nat. Res., p. 1337, pl. 25, figs. 16-19.

Remarks.—One small specimen from locality M 16 is doubtfully referred to this species.

STRAPAROLLUS PLANIDORSATUS Meek and Worthen.

1860. *Euomphalus planodorsatus,* Meek and Worthen, Proc. Acad. Nat. Sci. Phila., p. 462.
1863. *Euomphalus perspectinus.* Swallow, Trans. St. Louis Acad. Sci. vol. 2, p. 98.
1866. *Straparollus planidorsatus,* Meek and Worthen, Geol. Survey Ill. vol. 2, p. 302, pl. 24, figs. 2 a-c.
1894. *Straparollus planidorsatus,* Keyes, Mo. Geol. Survey, vol. 5, p. 160.

Remarks.—This species is one of the more abundant gastropods in the Oklahoma Chester occurring at localities M 21, F 6, F 17, and P 9. The same species occurs in the Pitkin limestone at Fayetteville, Arkansas.

Genus STROPHOSTYLUS Hall.

STROPHOSTYLUS? SP.

Remarks.—One specimen from locality P 2 is referred to the genus *Strophostylus.* It has the shape of *S. carleyana* Hall but is much larger, attaining a height of about 25 mm. The condition of the specimen is not such as to warrant description

Genus HOLOPEA Hall.

HOLOPEA NEWTONENSIS Whitfield?

1882. *Holopea Newtonensis,* Whitfield, Ann. N. Y. Acad. Sci., vol. 2, p. 224.
1895. *Holopea Newtonensis,* Whitfield, Geol. Survey Ohio, vol. 7, p. 477, pl. 10. fig. 12.
1911. *Holopea newtonensis,* Morse, Proc. Ohio Acad. Sci., vol. 5, p. 398, fig. 23.

Remarks.—One specimen from locality F 2 and one from P 6 are referred to this Maxville limestone species.

Genus SPHAERODOMA.

SPHAERODOMA SUBCORPULENTA Whitfield.

1882. *Macrocheilus subcorpulentus,* Whitfield, Ann. N. Y. Acad. Sci., vol. 2, p. 224.
1895. *Macrocheilus subcorpulentus,* Whitfield, Geol. Survey Ohio, vol. 7, p. 478, pl. 10, fig. 14.
1911. *Sphaerodoma subcorpulenta,* Morse, Proc. Ohio Acad. Sci., vol. 5, p. 401, fig. 26.

Remarks.—Five specimens from locality M 16, two from F 14 and two from P 1 are referred to this species with considerable confidence.

Genus ORTHONYCHIA Hall.

ORTHONYCHIA MAYESENSE n. sp.

Pl. VII, Figs. 8-9.

Description.—Shell obliquely sub-conical, laterally compressed Apex slightly incurved. Anterior outline gently and regularly convex; posterior, concave below the apex and then sloping backward in a nearly straight line. Margin irregular. Surface ornamented with longitudinal ridges on the front portion, becoming faint on the sides.

The type specimen is incomplete but apparently reached a height of about 25 mm., with a maximum antero-posterior diameter of about 20 mm., and a transverse diameter of about 15 mm.

From localities M 8a, M 13, and M 16.

ORTHONYCHIA? SP.

Remarks.—In collection M 21 are a few fragmentary specimens of a small species probably belonging to *Orthonychia.* They are much more strongly curved than *O. mayesense* but the material is too poor for description.

Genus PLATYCERAS Conrad.

PLATYCERAS SUBROTUNDUM n. sp.

Pl. VII, Figs. 10-11.

Description.—Shell attaining a medium size though the majority of the specimens are small. First volution closely coiled, approximately in the plane of the shell. Enlarges rapidly during first volution and then more slowly and uniformly. The cross-section of the whorl in the younger stages is sub-elliptical and in the older stages is practically circular. Aperture not well shown, apparently sub-circular, the plane cutting the axis of the whorl at an angle. Surface smooth except for faint lines of growth which bend backwards on the peripheral portion. The type specimen has a maximum dimension of 22 mm.; with the greatest diameter of the whorl about 12 mm. One incomplete specimen must have reached a somewhat larger size.

Remarks.—From localities M2, F 1, F 2, F 20, P 3, P 4, P 6, P 7, P 8, and P 9.

CEPHALOPODA.

Genus ORTHOCERAS Breyn.

ORTHOCERAS EUREKENSIS Walcott?

1884. *Orthoceras Eurekensis,* Walcott, Mon. U. S. Geol. Survey, No. 8, p. 265, pl. 23, figs. 2, 2a.

1897. *Orthoceras eurekensis* (?), Weller, Trans. N. Y. Acad. Sci. vol. 16, p. 270, pl. 21, fig. 3:

Remarks.—The specimens doubtfully referred to this species are straight (or possibly slightly curved), gradually and regularly tapering. Septa nearly straight and 3 mm. to 4 mm. apart. The material is scanty and fragmentary but seems identical with that from the Batesville sandstone which was doubtfully referred to this species by Weller.

From localities M 16, F 4, F 13, P 7, P 8, and P 10.

Genus CYCLOCERAS McCoy.

CYCLOCERAS RANDOLPHENSIS Worthen?

1861. *Orthoceras annulo-costatum,* Meek and Worthen, Proc. Acad. Nat. Sci. Phila., p. 147. (Not *O. annulo-costatum* Bull. 1857)

1882. *Orthoceras Randolphensis,* Worthen, Bull. Ill. State Mus. Nat. Hist., No. 1, p. 38.

1884. *Orthoceras Randolphensis* (?), Walcott, Mon. U. S. Geol. Survey, vol. 8, p. 265, pl. 18, fig. 17.

1911. *Orthocerus randolphense,* Morse, Proc. Ohio Acad. Sci., vol. 5, p. 415 fig. 35.

Remarks.—Fragmentary specimens from localities F 2, P 3, and P 8 are referred to this species with some doubt. They are marked by strong, slightly oblique, annular costae, about four occupying a distance equal to the transverse diameter of the shell.

CYCLOCERAS SEQUOYAHENSIS n. sp.

Pl. VII, Figs. 12-13.

Description.—Shell straight, very gradually tapering. Living chamber not known. Cross section sub-elliptical, almost circular, maximum diameter shown about 13 mm. Septa nearly straight, about 6 in a distance equal to the diameter of the shell. Siphuncle central.

The weak annular costae are more widely spaced than the septa, about 4 in a distance equal to the diameter, inclined at a low angle to the axis of the shell.

Remarks.—This species is based on two fragmentary specimens in collection F 2 and one in P 2 (from northeast of Gore, Sequoyah County). The less development of the costae and the close spacing of the septa distinguish it from *C. randolphensis.*

Genus LEUROCERAS Hyatt.

LEUROCERAS? SP.

Remarks.—Two incomplete specimens of a coiled cephalopod from locality P 3 probably belong to this genus. The sutures are very slightly lobed. One specimen shows faint longitudinal ridges.

Genus GLYPHIOCERAS Hyatt.

GLYPHIOCERAS KENTUCKIENSIS Miller.

1889. *Goniatites Kentuckiensis*, Miller, N. A. Geol. and Pal., p. 439, fig. 470.
1896. *Goniatites Kentuckiensis*, Miller and Gurley, Bull. Ill. State Mus. Nat. Hist., No. 11, p. 40, pl. 5, fig. 1.

Remarks.—One incomplete specimen from locality M 16 is referred to this species.

CRUSTACEA.

TRILOBITA.

Genus GRIFFITHIDES Portlock.

GRIFFITHIDES PUSTULOSUS n. sp.

Pl. VII, Figs. 14-16.

Description.—Head semi-elliptical. Width approximately one and one-half the length along the median line. Length of genal spines not shown. Glabella widest at about one-fourth the length from the anterior margin, strongly convex toward the front and descending abruptly to the narrow anterior margin which is the continuation of the curvature of anterior end of the glabella, standing nearly vertical. Dorsal furrows well defined, with a distinct pit or depression about two-thirds the distance from the eyes to the anterior margin. The two anterior pairs of glabellar furrows are almost obsolete, showing as very slight and indistinct depressions a little in front of the eyes. The posterior furrows are well developed, extending backward and inward, stopping short of the occipital furrow. Basal lobes prominent, sub-ovate. Occipital furrow deep, with the anterior slope very abrupt and the posterior slope gentle and extending to the posterior margin of the segment.

Eye lobes small, semi-circular, well elevated, slightly convex on top, situated about one-third the length of the cranidium from the posterior margin, opposite the anterior part of the basal lobes of the glabella.

Free cheeks not found attached to the glabella, but judging from detached specimens, about one-half the width of the glabella. A ridge parallels the base of the eye laterally and is separated from it by a narrow, rounded depression. Opposite the posterior margin of the eye this ridge bends abruptly outward and backward, bisecting the angle between the lateral and posterior margins. The slope from the ridge is steep, but flattens out or even becomes concave before joining the margin. Margin strongly convex and directed vertically.

The entire surface of the head is pustulose. The pustules are very fine over the anterior portion of the glabella and over the greater part of the free cheeks. On the posterior portion of the glabella there is a development of strong tubercles irregularly distributed. The occipital segment has a line of tubercles on the posterior margin, with pustules decreasing in size toward the occipital furrow, and a single strong tubercle on the axis about one-third the distance from the posterior margin to the furrow. The ridge around the base of the eye carries a row of pustules. The lateral and anterior margins are ornamented by 6 or 8 sharp raised lines.

Thoracic region not known.

Pygidium semi-elliptical in outline, slightly wider than long. The axis occupying a little less than one-third the width anteriorly, sharply rounded posteriorly and terminating at the inner boundary of the marginal border. A lateral groove-like depression parallels the axial furrow nearly at the top of the steep slope on either side of the axis. Above these depressions the axis is broadly arched transversly. The axis is divided into 13 or 14 segments decreasing in size posteriorly, all fairly well defined. The anterior slope of each segment is longer and more gentle than the posterior, giving the crests of the segments the appearance of being inclined backwards. The portion of the segments between the lateral depressions and the axial furrows is directed posteriorly. Pleural lobes strongly convex transversely. with segments numbering three less than those in the axial lobe. The inner portion of the lobe is flattened while the outer slopes very steeply to the marginal border. The segments continue from the axial furrow in the direction of the lower part of the axial segments and stop abruptly at the marginal border. They decrease rapidly in size posteriorly. The cross-section is the same as that of the axial segments, i. e., with an apparent backward inclination which is not so pronounced as in the axial segments. The marginal border continues the steep slope of the outer portion of the pleural segments. It is broadest at the extreme posterior portion, where it is concave outwards, and decreases regularly in width anteriorly. The axial and pleural segments are ornamented by a row of tubercles which decrease regularly in size in both directions from the highest portion of the segment. The marginal border is very finely pustulose.

Dimensions of one of the largest glabellae: length along median line, 15 mm.; greatest width, 12.5 mm. Maximum width of free cheeks, 9 mm. Length of genal spine not known. Length of a complete pygidium, 15 mm.; width, 20 mm. Length of largest pygidium observed, 20 mm.

Remarks.—The material representing this species is very abundant in the Mayes limestone in the southern part of the area, but is all fragmentary. The association of the glabellae, free cheeks, and pygidia described above is such that there can be no doubt as to their belonging to the same species. The species is referred to *Griffithides* rather than to *Phillipsia*, for, although they can be determined on some glabellae, the anterior glabellar furrows are generally obsolete, and because the eyes are semi-circular rather than elongate.

The species can be separated from *G. mucronatus* as described by Girty* from the lower Fayetteville shale of Arkansas by the configuration of the anterior margin of the glabella and the number of segments in the pygidium.

Abundant at localities M 3, M 4, M 6, M 8a, and P 9. The specimens from P 9 are smaller but otherwise no distinction can be made between them and those from the limestone of the Mayes.

*Girty, G. H., Ann. N. Y. Acad. Sci., vol. 20, No. 3, pt. 2, p. 238.

PLATE III.

Paleacis cuneata n. sp. (p. 70).

Figures 1-3. Side, edge, and top views of a specimen of about average size.
4-6. Side, edge, and top views of one of the larger specimens.

Pachypora oklahomensis n. sp. (p. 72).

Figure 7. Surface of a fragment of a small branch.
8. Surface of a fragment of a branch of nearly the maximum size.

Michelinia meekana Girty. (p. 71).

Figure 9. Side view of a small specimen attached to a shell of *Productus inflatus.*
10. Side view of a small conical specimen with very small area for attachment.
11. Portion of the surface of a large bifoliate expansion.

Chonetes oklahomensis n. sp. (p. 76).

Figures 12-15. Pedicle and brachial views of two complete specimens with the brachial valves slightly crushed.

Chonetes cherokeensis n. sp. (p. 77).

Figures 16-17. Views of two perfect pedicle valves.
18. An imperfect specimen showing portions of both valves.
19-20. Two imperfect pedicle valves.
21. Interior of a small brachial valve.

Productus cherokeensis Drake. (p. 80).

Figures 22-24. Front, side, and posterior views of a nearly complete pedicle valve.

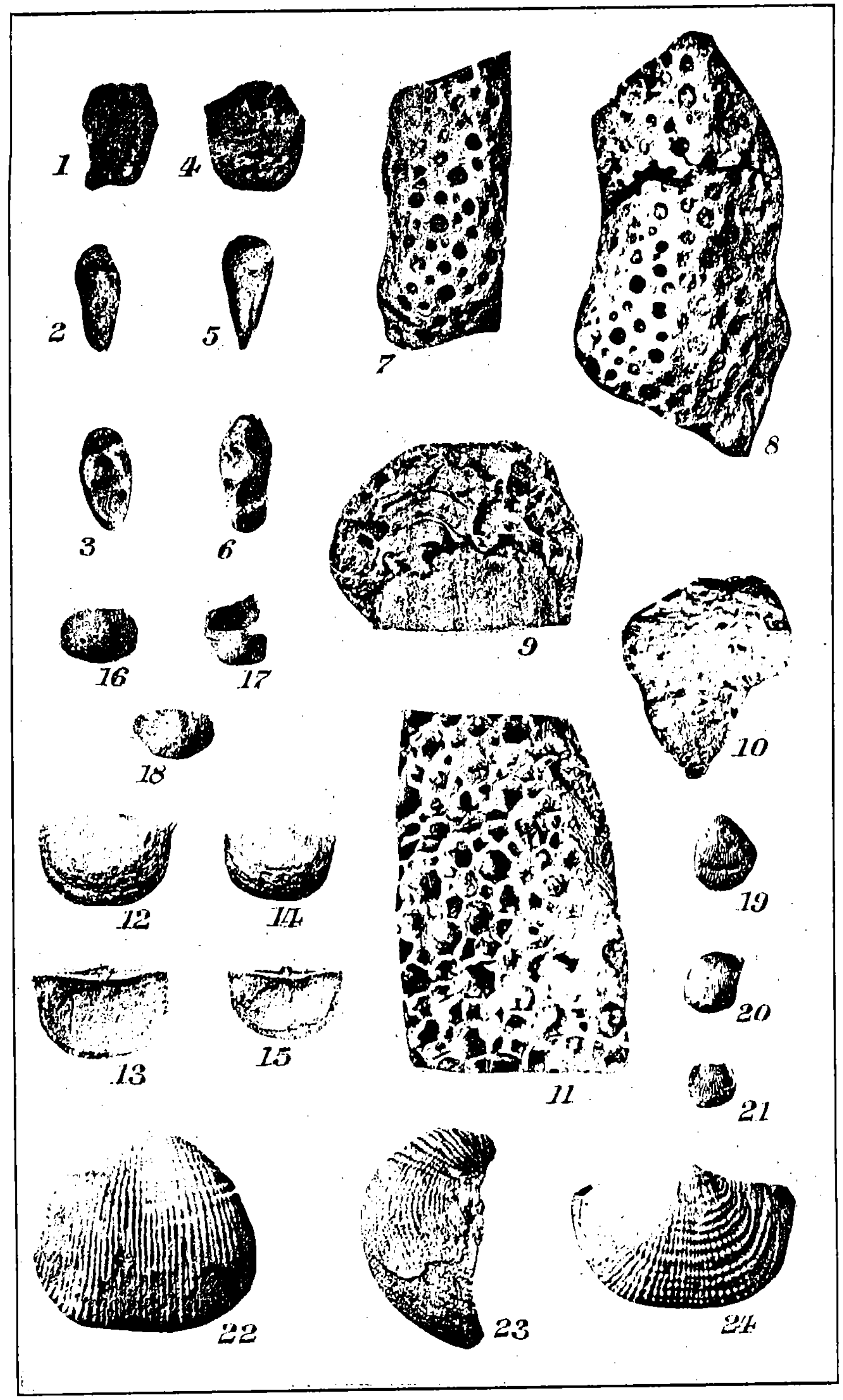

PLATE III.

PLATE IV.

PRODUCTUS ARKANSANUS Girty. (p. 81).

Figures 1-3. Front, side, and posterior views of pedicle valve.

AVONIA OKLAHOMENSIS n. sp. (p. 83).

Figures 4-7. Pedicle, side, posterior and brachial views of the largest specimen observed.

8-11. Pedicle, side, posterior and brachial views of a specimen of medium size.

MARGINIFERA ADAIRENSIS Drake. (p. 84).

Figures 12-13. Front views of two nearly complete pedicle valves.

14. Interior of a fragmentary brachial valve.

CAMAROPHORIA CESTRIENSIS n. sp. (p. 85).

Figures 15-26. Brachial, pedicle, side, and anterior views of three perfect specimens.

DIELASMA COMPRESSA n. sp. (p. 87).

Figures 27-29. Brachial, pedicle and side views of the type specimen.

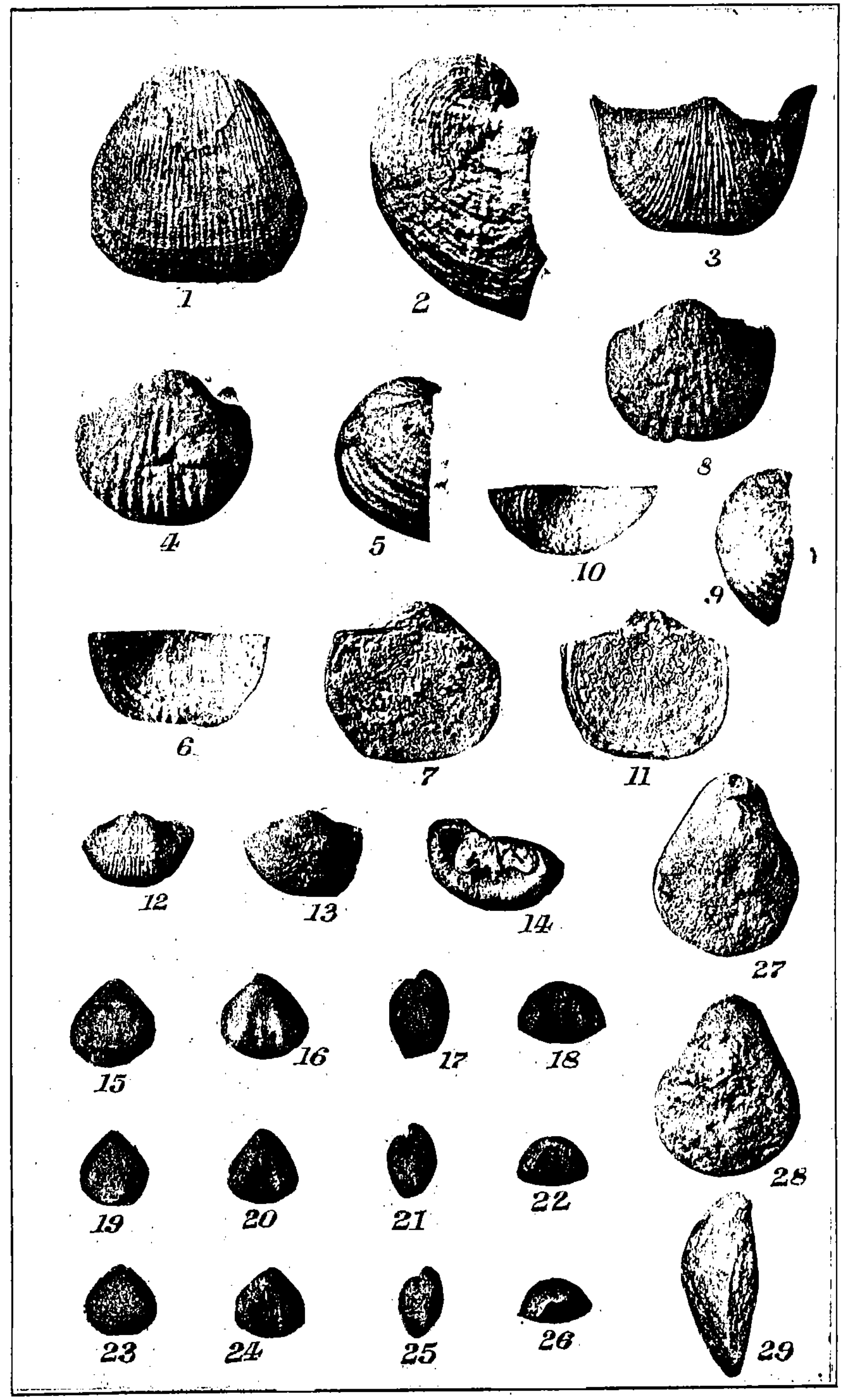

PLATE IV.

PLATE V.

SPIRIFER FAYETTEVILLENSIS n. sp. (p. 89).

Figures 1-2. Two incomplete pedicle valves.

BRACHYTHYRIS OZARKENSIS n. sp. (p. 90).

Figure 3. Pedicle valve of large specimen.
4. Brachial valve of specimen of medium size.
5-6. Pedicle and brachial views of small specimen.

HUSTEDIA MULTICOSTATA Girty. (p. 93).

Figures 7-9. Pedicle, brachial, and side views of large specimen.
10-12. Pedicle, brachial, and side view of specimen of medium size.

EUMETRIA LATA n. sp. (p. 95).

Figures 13-14. Two incomplete and exfoliated brachial valves.

EUMETRIA PITKINENSIS n. sp. (p. 95).

Figures 15-18. Front and side views of two complete pedicle valves.

ATHYRIS CESTRIENSIS n. sp. (p. 96).

Figures 19-21. Pedicle, brachial, and side views of a large specimen.
22-24. Pedicle, brachial, and side views of a specimen of medium size.

COMPOSITA ROTUNDA n. sp. (p. 98).

Figures 25-28. Pedicle, brachial, side, and anterior views of the type specimen.

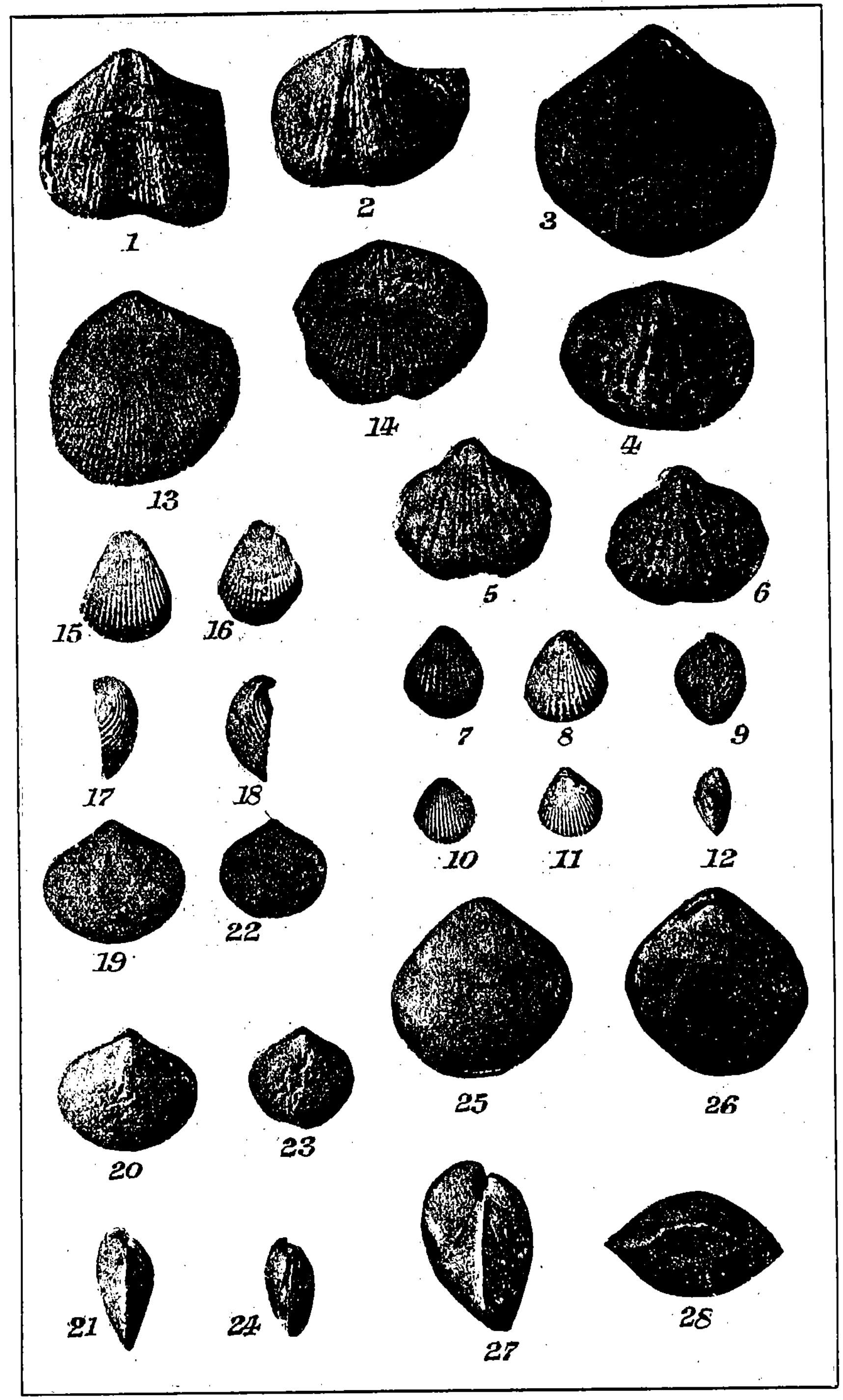

PLATE V.

PLATE VI.

SPHENOTUS CHEROKEENSE n. sp. (p. 99).

Figure 1. Right valve.

SPHENOTUS OKLAHOMENSE n. sp. (p. 100).

Figure 2. Left valve.

SPHENOTUS QUADRIPLICATUM n. sp. (p. 100).

Figure 3. Left valve.

SPHENOTUS WASHINGTONENSE Girty. (p. 101).

Figure 4. Left valve.

SPHENOTUS GIBSONENSE n. sp. (p. 101).

Figure 5. Right valve.

EDMONDIA PITKINENSIS n. sp. (p. 102).

Figure 6. A nearly complete left valve.
7. Right valve of a somewhat larger specimen.

MYALINA COMPRESSA n. sp. (p. 105).

Figures 8-9. Views of the right valves of two nearly complete specimens.

MYALINA LONGICARDINALIS n. sp. (p. 106).

Figure 10. Left valve of nearly complete specimen.
Figure 11. Top view of same specimen.

DELTOPECTEN TAHLEQUAHENSIS n. sp. (p. 108).

Figure 12. Complete right valve.
Figure 13. Body of right valve.

AVICULOPECTEN MORROWENSIS Girty. (p. 110).

Figure 14. Incomplete right valve.

AVICULOPECTEN OZARKENSIS n. sp. (p. 111).

Figure 15. Nearly complete left valve.

AVICULOPECTEN PITKINENSIS n. sp. (p. 112).

Figures 16-18. Three incomplete right valves.

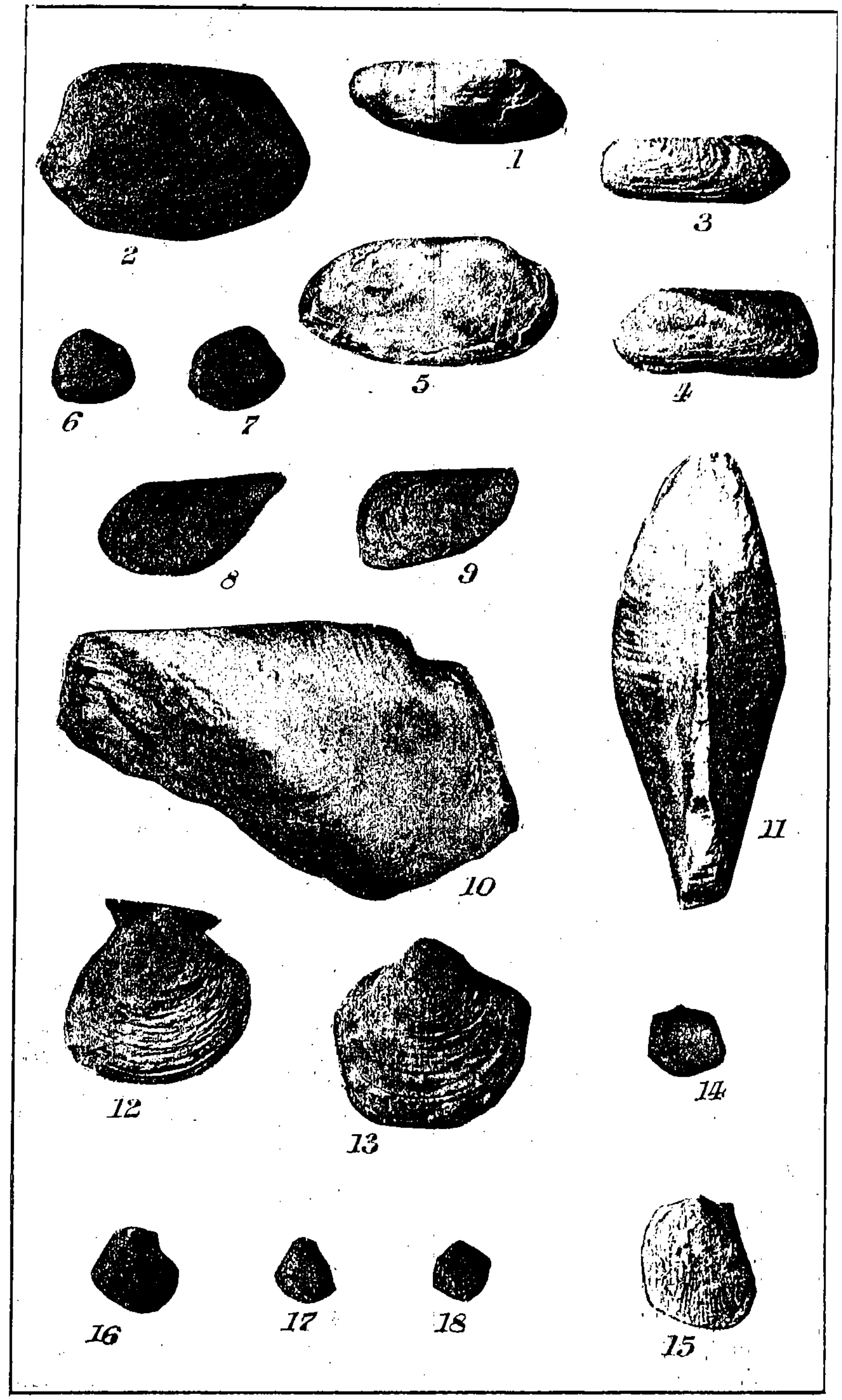

PLATE VI.

PLATE VII.

AVICULOPECTEN MAYESENSIS n. sp. (p. 109).

Figure 1. Nearly complete left valve of medium size.

AVICULOPECTEN KEOUGHENSIS n. sp. (p. 112).

Figure 2. Left valve.

STREBLOPTERIA SIMILIS Walcott. (p. 113).

Figure 3. A perfect right valve.

ALLORISMA WALKERI Weller. (p. 114).

Figure 4. A practically complete left valve of a specimen of medium size.
5. A larger fragmentary specimen.

BELLEROPHON PITKINENSIS n. sp. (p. 115).

Figure 6. Side view.
7. Front view.

ORTHONYCHIA MAYESENSE n. sp. (p. 118).

Figure 8. Side view.
9. Front view.

PLATYCERAS SUBROTUNDUM n. sp. (p. 118).

Figure 10. Side view.
11. Front view.

CYCLOCERAS SEQUOYAHENSIS n. sp. (p. 119).

Figure 12. Side view of a fragment showing annulations.
13. End view of a fragment showing position of siphuncle.

GRIFFITHIDES PUSTULOSUS n. sp. (p. 120).

Figure 14. Pygidium.
15-16. Two nearly complete glabellae.

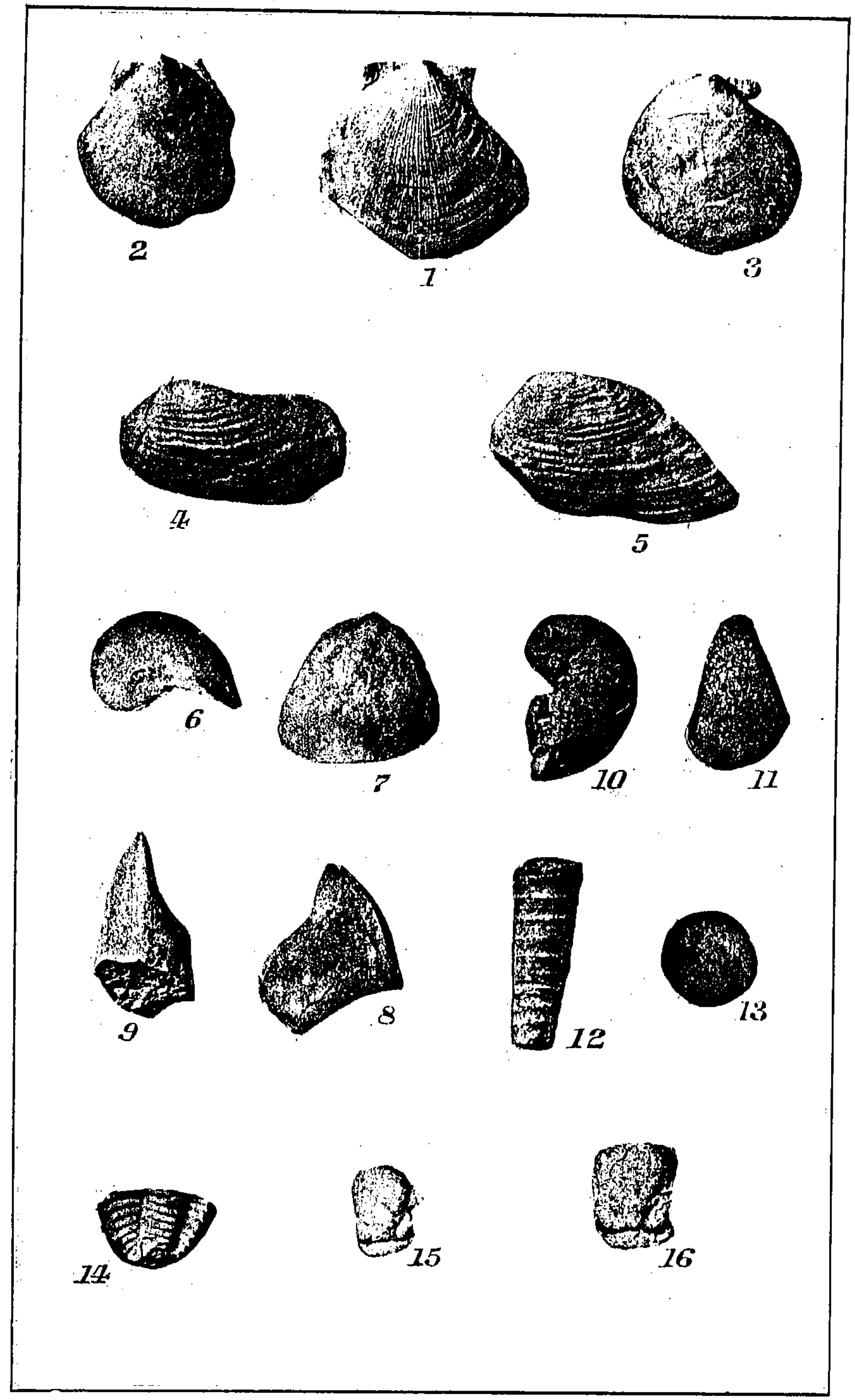

PLATE VII.