Marine Fossils

FROM THE

Coal Measures of Arkansas.

James Perrin Smith.

Prefatory Note.

This memoir is the ninth of a series designed to illustrate the investigations and explorations of the Hopkins Seaside Laboratory, an adjunct of the biological laboratories of the Leland Stanford Junior University. The series is issued under the patronage of Timothy Hopkins, Esq., of Menlo Park, California. The present paper is published by the American Philosophical Society, appearing simultaneously in its present form and as a part of the Proceedings of that Society.

CHARLES H. GILBERT,
OLIVER P. JENKINS,
Editors.

DATE OF PUBLICATION: JANUARY 7, 1897.

Marine Fossils from the Coal Measures of Arkansas.

BY

JAMES PERRIN SMITH.

Reprinted, January 7, 1897, from the Proceedings of the American Philosophical Society, Vol. xxxv., No. 152.

CONTENTS.

PREFACE.

The Coal Measures cover an area of 14,700 square miles in the State of Arkansas. The greater part of this area lies in the geosyncline of the Arkansas Valley. The total thickness of the sediments in this geosyncline is enormous—24,000 feet. These conditions, taken in connection with the occurrence in these sediments of both land plants (coal beds) and of marine fossils seem to show that the beds were deposited upon a subsiding (for the most part) floor, and that the land stood near the sea level, below which it occasionally sank.

The marine fossils from the Coal Measures area, so far as they were collected by the Geological Survey of Arkansas, are listed and described in the following paper kindly prepared at my request by Dr. J. P. Smith, of Stanford University. It is volunteer work done originally for the State Survey, and was to have been published in a volume upon the paleontology of Arkansas. Upon the abolition of the Survey by the Legislature in 1893 several volumes of reports were left unpublished, and among them one on the paleontology of the State.

JOHN C. BRANNER,

Late State Geologist of Arkansas.

Stanford University, California, July 10, 1896.

INTRODUCTION.

Marine fossils afford the best means of correlating strata of different regions, but in the Coal Measures they are usually rare, and therefore of especial interest and value when found.

Of all the Paleozoic systems the Carboniferous is most subject to facies variations, which make it difficult and often impossible to recognize with certainty the minor subdivisions at any great distance from the place where they were first established This is true even of the Mississippian formation, whose limestones were deposited under comparatively uniform conditions, so that one would expect the faunal relations to be the same over the whole area where the Mississippian facies prevails. But the American Coal Measures were formed under conditions not favorable to uniformity either of rock character or of life, hence the correlation of these strata becomes more difficult. And in these geologists have been more prone to rely on lithologic characters and unaided stratigraphy. Such correlations have only a local value, and cannot be extended over any wide scope of territory. For this reason no divisions of the Coal Measures into zones has every been carried out, nor can it be done, in the present state of our knowledge.

Previous to the collections made by the Geological Survey of Arkansas, marine fossils were known from but a single locality in the Coal Measures of Arkansas. Dr. David Dale Owen, in his *Geological Reconnoissance of Arkansas*, Vol. i, p. 68, says: "Three miles north-

west of Searcy, at a 'bald point,' in the vicinity of the widow Gilbert's farm, sixty feet of shaly strata are exposed, dark or nearly black, in its lower part, and reddish yellow and ferruginous towards the top. The shale includes numerous segregations of carbonate of iron and carbonate of lime; the latter containing several fossil marine shells, amongst which the *Nautilus ferratus* was discovered, a species which occurs in the ferruginous shales of Nolin, in Edmonson county, Ky." The locality mentioned is now known to be in the Lower Coal Measures, and is situated not three but thirteen miles northwest of Searcy.

F. B. Meek, in the *Final Report of the U. S. Geological Survey of Nebraska,** mentions *Hydreinocrinus (Zeacrinus) mucrospinosus* McChesney, from the Coal Measures of Arkansas, but he does not cite any authority for the statement, nor does he say he has seen this fossil from Arkansas, or give any locality. In all the other literature where this species is mentioned, nothing is said about Arkansas. It is, therefore, concluded that this species was never found in the State. It was, however, found by the Geological Survey, in strata of the Upper Coal Measures, on Poteau mountain, Indian Territory, two miles west of the line of Scott county, Arkansas.

Featherstonhaugh† mentioned a "new species of pentremite in the old red sandstone of Maumelle." The strata of Maumelle mountain, Pulaski county, are of Lower Coal Measure age, and it is not likely that a pentremite was ever found there, since the systematic searches of the Survey failed to find any fossils in this region.

Localities Discovered by the Survey.

Marine Coal Measure fossils were found by the Survey at twenty-one different places, besides that mentioned by Owen. These extend from Independence county westward to Indian Territory, giving a total of forty-eight genera and ninety species, forty-eight in the Lower Coal Measures, and fifty-two in the Upper, with ten species common to both. It is not thought that this small number of species represents the entire fauna, or that only ten species are common to the two divisions, for the collections were much too scattered and meagre to exhaust the possibilities. But the fauna is a poor one, such as one would expect to wander in from deeper waters whenever a slight subsidence made the shallow waters a little more habitable. The faunas could not become well established, because the conditions soon reverted to their old state, and the inhabitants of the seas were forced to migrate or be exterminated.

There is, therefore, in this region no gradual transition from the fauna of the Lower Carboniferous limestone, and the fossils of the Lower Coal Measures are just as different from those of the Lower Carboniferous as are those of the Upper Coal Measures.

It is not attempted to carry the division further than into Upper and

* Op. cit., p. 149.

† *Geolog. Rep. Elevated Country between the Missouri and Red Rivers*, p. 61.

Lower Coal Measures, and even this division is often uncertain, for in most cases the relations of the fossiliferous beds to each other could not be determined with any degree of certainty. Also in most of this region the stratigraphy is difficult; the rocks vary so little, and are so folded and faulted that by stratigraphy alone it was often impossible to locate a bed within several hundred feet.

In addition to this, the number of the species is usually too small, and their character too indecisive to enable one to say with certainty to which division the strata belonged. Therefore, in enumerating the localities there are given only the character of the rocks, the fossils found in them, and the place in the section where these strata are thought to belong.

Lower Coal Measures.

Of these localities there were seventeen discovered, and they will be given in order from east to west.

No. 1. Independence county, 11 N., 5 W., section 9, centre of the section. Soft brownish sandstone with *Euomphalus* (*Straparollus*) sp.; near the middle of the Lower Coal Measures. Collector, J. C. Branner.

No. 2. White county, 8 N., 7 W., section 26, Bee Rock on Little Red river. Massive yellowish sandstone, over one hundred feet exposed, nearly horizontal; at the top with marine fossils, at the bottom with plants. Near the base of the Lower Coal Measures. Collector, J. P. Smith.

Crinoid stems.
Productus semireticulatus Martin.
Spirifer rockymontanus Marcou.
Aviculopecten carboniferus Stevens.
Bellerophon sp.
Plant remains, undetermined.

No. 3. White county, 8 N., 7 W., section 33, east half of southeast quarter, south of Norton's field, on the road from Searcy to Griffin Springs. Hard yellowish and in places ferruginous sandstone, with a dip of about 30° south. Horizon same as the last locality. Collector, J. P. Smith.

Fenestella sp.
Orthis conf. *resupinoides* Cox.
Productus semireticulatus Martin.
Rhynchonella sp.
Spirifer rockymontanus Marcou.
Schizodus conf. *amplus* Meek and Worthen.
Bellerophon sp.

No. 4. White county, 9 N., 4 W., section 6. Soft pinkish sandstone. Near middle of Lower Coal Measure. Collector, J. C. Branner.

Phillipsia (*Griffithides*) *scitula* Meek and Worthen.
Euomphalus (*Straparollus*) *subquadratus* Meek and Worthen.
Athyris subtilita Hall.
Prestwichia sp. or a new genus closely allied to *Prestwichia*.

No. 5. White county, 9 N., 5 W., section 1. Soft reddish sandstone, similar to that of locality No. 4, containing also *Phillipsia* (*Griffithides*) *scitula* Meek and Worthen. Collector, J. C. Branner.

No. 6. Lonoke county, 4 N., 10 W., section 12, southeast quarter of northwest quarter. Gray quartzite conglomerate seen in a well by the roadside to dip 45° south. Towards base of Lower Coal Measure. Collector, J. P. Smith.
Crinoid stems, undetermined.

No. 7. Conway county, 6 N., 16 W., section 29, southwest quarter of southwest quarter, on east bank of Arkansas river, about one mile below the Old Lewisburg ferry. A brown ferruginous shale near the top of the Lower Coal Measures and probably a few hundred feet above the shales of locality No. 8. Collector, J. F. Newsom.
Productus punctatus Martin.
Derbyia crassa Meek and Hayden.
Orthis pecosii Marcou.
Spirifer cameratus Morton.
Spiriferina cristata Schlotheim.
Athyris subtilita Hall.
Terebratula hastata Sowerby.
Aviculopecten occidentalis Shumard.

No. 8. Conway county. 5 N., 16 W., section 17, two hundred yards west of the centre of northwest quarter, west of the Arkansas river, and four miles south of Morrillton. The horizon is near the top of the Lower Coal Measures. Reddish ferruginous shale. Collector, J. F. Newsom.
Phillipsia (*Griffithides*) *ornata* Vogdes.
Zaphrentis sp.
Nucula parva McChesney.
Nucula ventricosa Hall.
Macrodon carbonarius Cox.
Conocardium aliforme Sowerby.
Aviculopecten occidentalis Shumard.
Aviculopecten carboniferus Stevens.
Pleurophorus oblongus Cox.
Bellerophon carbonarius Cox.
Bellerophon crassus Meek and Worthen.
Pleurotomaria sp.
Macrocheilus (*Soleniscus*) conf. *primigenius* Conrad.
Macrocheilus conf. *fusiformis* Hall.
Goniatites (*Paralegoceras*) *iowensis* Meek and Worthen.

Nautilus (*Ephippioceras*) *ferratus* Cox.
Nautilus (*Endolobus*) *missouriensis* Swallow.

No. 9. Conway county, 7 N., 16 W., section 8, northeast quarter of northeast quarter, about two hundred yards east of the centre; one hundred yards northwest of the iron bridge. Ferruginous, porous sandstone, full of poorly preserved casts of fossils, that could not be specifically identified. This horizon lies about one thousand feet below that of locality No. 7, near Old Lewisburg, and is probably the same as that of locality No. 10, Cook's quarry, near Hattieville. Collector, J. F. Newsom.

Zaphrentis (*?*).
Crinoid stems.
Spirifer sp.
Euomphalus sp.

No. 10. Conway county, 8 N., 17 W., section 33, northeast quarter of northeast quarter, Cook's quarry, near Hattieville. Hard yellowish sandstone. Upper part of Lower Coal Measures. Collector. J. F. Newsom.

Orthoceras sp.
Astartella newberryi Meek.
Aviculopecten occidentalis Shumard.
Edmondia unioniformis Phillips.
Schizodus wheeleri Swallow.
Schizodus cuneatus Meek.
Bellerophon carbonarius Cox.
Pleurotomaria harii S. A. Miller.
Pleurotomaria sp.
Euomphalus sp.
Orthoceras sp.
Orthis resupinoides Cox.
Orthis sp.
Terebratula hastata Sowerby.

No. 11. Pope county, 10 N., 20 W., section 8, southeast quarter of northwest quarter. Ferruginous shale like that near Morrillton. Collector, H. E. Williams.

Crinoid stems.
Pleurotomaria sp.
Goniatites (*Gastrioceras*) *excelsus* Meek.

No. 12. Johnson county, 11 N., 24 W., section 26, southwest quarter of southwest quarter. Brownish ferruginous sandstone. Collector, A. G. Taff.
Phillipsia sp.

No. 13. Franklin county, 11 N., 27 W., section 4, southeast quarter of

northeast quarter. Weathered ferruginous sandstone. Collector, A. G. Taff.

Crinoid stems.

Spirifer sp.

No. 14. Franklin county, 10 N., 26 W., section 2, southeast quarter of southeast quarter. Ferruginous sandstone. Collector, A. G. Taff.

Bellerophon carbonarius Cox.

No. 15. Franklin county, 11 N., 28 W., section 27, northeast quarter of southeast quarter Ferruginous sandstone. Collector, A. G. Taff.

Pleurotomaria sp.

No. 16. Crawford county, 12 N., 30 W., section 17, northeast quarter of southeast quarter. Brownish sandstone, very like that of Bee Rock, White county. Collector, E. C. Buchanan.

Spirifer rockymontanus Marcou.

No. 17. Carroll county, 17 N., 19 W., northeast corner of section 18; Pilot mountain, three and a half miles southwest of Valley Springs. Millstone grit, about sixty feet above a brownish limestone supposed to represent the Chester horizon. Collector, Stuart Weller.

Gastrioceras branneri n. sp. J. P. Smith.

Pronorites cyclolobus Phillips, var. *arkansiensis* nov. var. J. P. Smith.

Upper Coal Measures.

In the Upper Coal Measures, three localities were discovered by the Survey, giving fifty-two species, of which thirty-two were found on Poteau mountain, Indian Territory.

No. 1. Scott county, 1 N., 28 W., section 4, southeast quarter of southeast quarter. Yellow ferruginous shale, with fossils in hard nodules. This horizon is probably equivalent to the Canyon division of Texas, lower part of Upper Coal Measures, since many similar fossils were found in that horizon by the Geological Survey of Texas. Collector, C. E. Siebenthal.

Cyathocrinus (*?*).

Conularia conf. *crustula* White.

Naticopsis sp.

Nuculana aff. *bellistriata* Stevens.

Pleurophorus sp.

Goniatites (*Gastrioceras*) sp. indet.

Goniatites (*Gastrioceras*) *globulosus* Meek and Worthen.

Goniatites (*Gastrioceras*) *marianus* Verneul.

Goniatites (*Pronorites*) sp.

Orthoceras conf. *rushense* McChesney.

While the stratigraphy seems to place these beds in the Lower Coal Measures, the fossils are decidedly Upper Coal Measure forms, and are characteristic of that horizon in Texas, Kansas, etc.

No. 2. Crawford county, 10 N., 30 W., section 10, southeast quarter of northwest quarter. Soft ferruginous shale. Collector, C. E. Siebenthal.

Zaphrentis sp.
Rhynchonella sp.
Macrodon sp.
Dentalium conf. *meekianum* Geinitz.
Polyphemopsis inornatus Meek and Worthen.
Pleurotomaria modesta Keyes.
Nautilus sp.

No. 3. Sebastian county, 8 N., 32 W., section 12. Ferruginous shale near Mr. Wilson's house. High up in Upper Coal Measures. Collector, Arthur Winslow.

Crinoid stems.
Fistulipora nodulifera Meek.
Athyris subtilita Hall.
Productus splendens Norwood and Pratten.
Retzia mormonii Marcou.
Spirifer cameratus Morton.
Spiriferina cristata Schlotheim.
Macrodon obsoletus Meek.
Nucula parva McChesney.
Bellerophon carbonarius Cox.
Bellerophon marcouanus Geinitz.
Naticopsis nana Meek and Worthen.
Pleurotomaria sp.

No. 4. Poteau mountain, Indian Territory, two miles west of the Scott county, Arkansas, line, on the east fork of Sugar creek, 150 feet below the southern crest of the mountain. The fossiliferous bed is a soft gray shale about four inches thick. About 1000 feet of shales lie above this, but no fossils were found in them. The fossiliferous bed is several hundred feet above the highest bed of coal known in that region.

The following fossils were collected here by C. E. Siebenthal:

Lophophyllum proliferum McChesney.
Erisocrinus (*Ceriocrinus*) *inflexus* Geinitz.
Hydreinocrinus mucrospinosus McChesney.
Poteriocrinus (*?*).
Orthis pecosii Marcou.
Derbyia crassa Meek and Hayden.
Productus cora d'Orbigny.
P. splendens Norwood and Pratten.
Rhynchonella uta Marcou.
Terebratula hastata Sowerby.
Retzia radialis Phillips.
Athyris subtilita Hall.
Spirifer cameratus Morton.

Spiriferina cristata Schlotheim.
Fistulipora nodulifera Meek.
Rhombopora lepidendroides Meek.
Septopora biserialis Swallow.
Aviculopecten coxanus Meek and Worthen.
A. germanus Miller and Faber.
Lima retifera Shumard.
Macrodon carbonarius Cox.
M. tenuistriatus Meek and Worthen.
M. obsoletus Meek.
Astartella vera Hall.
A. newberryi Meek.
Edmondia nebrascensis Geinitz.
Pleurotomaria tenuicincta Meek and Worthen.
P. conf. *speciosa* Geinitz.
Orthoceras cribrosum Geinitz.
Phillipsia cliftonensis Shumard.
Calamites sp.

A fauna of probably the same age has been described from the upper part of the Wyoming Valley limestones of the Upper Productive Coal Measures of Pennsylvania.*

Fayetteville Shale.

In Scott county, 2 N., 29 W., section 36, near the centre, C E. Siebenthal and J. F. Newsom discovered a bed of brown thinly laminated shale, with some sandy layers, containing pyritiferous nodules in which *Goniatites* (*Glyphioceras*) conf. *sphæricus* Martin was found in a good state of preservation. In the shale itself were found many poorly preserved specimens of the *Goniatites* conf. *sphæricus*, and countless specimens of *Posidonomya* (*Lunulicardium*) conf. *fragosum* Meek, also many specimens of *Orthoceras* sp.

These were at first thought to belong to the Coal Measures, but a very similar bed of shale, with the same fossils in the identical state of preservation, were found at Moorefield, Independence county, in the Fayetteville shale, which probably corresponds to the Warsaw group of the Lower Carboniferous.

COMPARISON WITH THE PERMO-CARBONIFEROUS OF KANSAS AND NEBRASKA.

It will readily be seen that the fauna of the Upper Coal Measures of Arkansas bears a strong resemblance to that of the youngest Paleozoic beds of Nebraska, described as Permian by Prof. Geinitz in his monograph, "Carbonformation and Dyas in Nebraska."

F. B. Meek† redescribes this fauna, and comes to the conclusion that

* *Penna. Geol. Survey Ann. Rep.*, 1885, pp. 437-458, C. A. Ashburner and A. Heilprin, "Report on the Wyoming Valley Limestone Beds."

† *Final Report U. S. Geol. Survey Nebraska*, p. 128, *et seq.*

the rocks in question are not to be referred to the Permian, because he can find no paleontologic or stratigraphic break in the series. He finds sixteen genera characteristic of the Carboniferous and seven genera not thought to antedate the Permian in Europe, but associated with genera not thought to occur later than the Carboniferous. Meek * says that Fusulina, which occurs in great numbers in the Upper Coal Measures of Nebraska, is considered in Europe to be mainly a Lower Carboniferous genus. In this, however, he was mistaken ; his opinion dates from the time when geologists were inclined to place all Carboniferous limestone in the Lower Carboniferous. But it is now known that Carboniferous limestone occurs in the Upper Carboniferous about as often as in the Lower, and that the Fusulina limestones of Sicily and Russia grade over into beds of undoubted Permian age.

This is also true of corresponding beds in the upper part of the Carboniferous of Texas, since the line between Permian and Coal Measures is purely arbitrary.

Although undoubtedly believing in continuity of life and formations, Meek seems to have based his reasoning somewhat upon the old idea of catastrophies, since he thought that the absence of a paleontologic or stratigraphic break was a sufficient reason for calling the beds in question Upper Coal Measures rather than Permian. A large majority of the genera and species are characteristic of the Carboniferous, and this Meek thinks sufficient to offset the fact that several genera previously considered typical of Permian are present. But some of these doubtful strata have at last been acknowledged to be Permian† by Williams and Tschernyschew, and Prof. Hyatt has described in the *Fourth Annual Report of the Geological Survey of Texas* several cephalopods that are common to the Permian of Texas and of Kansas.

In the Upper Coal Measures of Arkansas, out of fifty-two species, there are twenty-five in common with the doubtful strata of Nebraska, and eleven other species are common to the Nebraskan Permo-Carboniferous and the Lower Coal Measures of Arkansas, but have not yet been found in the Upper Coal Measures of the latter state. But of the genera mentioned by Meek as being not considered to antedate the Permian of Europe only two are found in the Arkansas strata, namely, *Synocladia*‡ and *Lima*.

There is not sufficient reason for classing the Poteau mountain beds with the Permian, but their fauna, as well as stratigraphic position, place them very high in the Coal Measures, since they are like the fauna and position of the Mississippi Valley Upper Coal Measures.

These beds derive an additional interest from the fact that on Poteau

* P. 133, *op. cit.*

† *Trans. Kansas Acad. Sci.*, Vol. xiii, p. 38.

‡ Waagen has shown in *Pal. Indica, Salt Range Fossils* i, *Productus Limestone Fossils*, p. 802, that *Synocladia* is not found in America, the species described by Swallow as *Synocladia biserialis* being a *Septopora*. There is also some doubt as to whether *Lima retifera* is a true *Lima*.

mountain, 1000 feet of shale, in which no fossils were sought for, lie above the thin layer from which the entire collection was taken; thus the chances of finding true Permian beds in that region are very good.

Relations to the Texas Upper Carboniferous.

The most philosophical presentation of the Permian problem in America has been given by Dr. C. A. White.* He finds the fauna of the upper Paleozoic beds of northern Texas, discovered by Prof. W. F. Cummins, to be analogous to that of the Fusulina Limestone of Sicily, the Artinsk stage of Russia, and the upper Productus Limestone of the Salt Range in India. These strata all show that peculiar commingling of ordinary Coal Measure fossils with ammonite genera, such as *Popanoceras, Medlicottia* and *Waagenoceras,* which seems to be characteristic of open sea facies of the Permian.

None of the characteristic ammonite genera were found in the Arkansas region, but nearly every fossil found in these Coal Measures was also found in Texas. And in the Texas Permian nearly all the species excepting the ammonites were found in the underlying Upper Coal Measures. This makes the analogy between the Upper Coal Measures of the two regions very strong.

Nearly all these fossils are also found in Illinois, Iowa, etc., in beds that have never been thought to be other than Coal Measures.

We are, therefore, safe in concluding that while some of the beds in western Arkansas are very high up in the Coal Measures, none that belong above them are as yet certainly known, and the Poteau mountain syncline, across the line in Indian Territory, is the only place where there is any likelihood of finding Permian deposits. These beds may turn out to be the equivalents of the Wichita division of the Texas Permian, which, as Prof. W. F. Cummins has told the writer, contains the exact fauna of his Albany division. The Albany beds were formerly thought to be Coal Measures; and Prof. Cummins' work in determining them by paleontology as well as stratigraphy to be the equivalents of the Wichita division will be of great help in the study of the doubtful so-called uppermost Coal Measure strata all over the Mississippi Valley. Many of these strata are very probably the homotaxial equivalents of the Albany division, and of the Artinsk stage of the Ural mountain region.

Comparison with Foreign Upper Carboniferous.

The Lo-ping Fauna of China.

The descriptions of the fauna of this Lo-ping district of China by Prof. E. Kayser† throw great light on the relations of American Carboniferous faunas to those of Asia. Near Lo-ping, in eastern China, are

* Bulletin 77, *U. S. Geol. Survey.*

† Richtofen's *China,* Vol. iv.

found in beds overlying the coal beds numerous marine fossils of Upper Coal Measure age. Kayser has described fifty-five species, ten not specifically identified, fifteen cosmopolitan species, and eleven forms that are typically American, and belong chiefly to the Upper Coal Measures.

Macrocheilus anguliferus.
Schizodus wheeleri.
Macrodon carbonarius.
Aviculopecten maccoyi.
Retzia compressa.
Orthis pecosii.
Productus mexicanus.
Rhombopora lepidendroides.
Lophophyllum proliferum.
Lophophyllum proliferum var. *sauridens.*
Fusulina cylindrica var. *gracilis.*

Also the *Nautilus orientalis* Kayser is most closely related to *N. occidentalis* Swallow, and *Nautilus mingshanensis* Kayser resembles the same American species. *Myalina trapezoidalis* Kayser finds its nearest representative in *M. subquadrata* Shumard. The fifteen cosmopolitan species are also nearly all found in the American Upper Coal Measures, so that of the entire Lo-ping fauna nearly all the species are either found in America, or they have their nearest relatives there. The two regions belong to the same zoölogical province, the Pacific Carboniferous sea.

Many of these species that are very common in America and Asia are unknown or rare in Europe, which fact would tend to prove a connection with Asia by water, and the separation of the European and the American Upper Coal Measure deposits by a land barrier.

The Carboniferous plants collected by Baron von Richthofen numbered about forty species, and are nearly all identical with European Carboniferous plants. The natural inference is that in those times Asia was connected by land with Europe, while the sea opened out to the east.

Prof. J. S. Newberry * described a small collection of Carboniferous plants from China, and found nearly all of them to belong to well-known European species. This is in perfect agreement with the conclusions drawn above.

The Salt Range Beds of India

In the Salt Range, in northwest India, are found Upper Carboniferous deposits, some of which resemble those of Lo-ping, China, and the Lower Productus Limestone of India is probably of the same age as the beds of Lo-ping, and the western American Uppermost Coal Measures. These deposits and their fauna are described by Prof. W.

* *American Journal of Science*, Vol. cxxvi, 1883, p. 123 *et seq.*

Waagen, in the *Paleontologia Indica*, and in the volume on *Geological Results* he draws some very interesting parallels between the faunas of the Upper Carboniferous in different countries. Many of the American species that are found at Lo ping are also found in the Salt Range beds. This same type of Carboniferous is found on Sumatra, where it has been described by Ferd. Roemer,* and on Timor, where it was described by E. Beyrich.†

This is the furthest southward that the Indian or northern type of Upper Carboniferous is known, and indeed the deposits of Sumatra and Timor begin to show already a greater affinity for the Australian or southern deposits.

Waagen‡ divides the Carboniferous into two types—the northern, or Asiatic, and the southern, or Australo-African. The northern type is found in western Europe, Russia, the Himalayas, China, the Arctic regions, and North America. The southern type is developed in South Africa and Australia, and extends into Peninsular India and Afghanistan. Brazil probably belongs to this type, but is to a certain extent transitional.

The Itaitúba Fauna, Brazil.

A comparison of the Brazilian Upper Carboniferous fauna, as described by Prof. O. A. Derby,§ shows that of twenty-seven species of Brachiopoda twelve are identical with American forms, although most of these are cosmopolitan. The genus *Strophalosia* is common in these beds, and as Prof. Derby‖ says, the species shows affinity with the Permian. Many of the new species are closely related to European forms. Prof. W. Waagen,¶ says that the beds of Itaitúba are of the same age as the Middle Productus Limestone of India, that is of the Permo-Carboniferous transition beds. The Brazilian *Strophalosia* is closely related to Australian forms, indicating a closer connection with the Australian or southern Carboniferous region than with the Pacific province.

Classification and Age of the Arkansas Coal Measures.**

Provisional Classification.

The Coal Measures of Arkansas have been temporarily classified by the Survey, for the sake of convenience, as Upper or Productive, and Lower or Barren Coal Measures. The division is not based on any

* *Palæontographica*, Vol. xxvii, 1880.

† *Abhandlungen der Berliner Akademie der Wissenschaften*, 1865.

‡ *Salt Range Fossils, Geological Results*, p. 239.

§ *Bulletin Cornell University*, Vol. i, No. 2, and *Journal Geol.*, Vol. ii, pp. 480–501.

‖ *loc. cit.*, p. 60.

¶ *Salt Range Fossils, Geological Results*, p. 207.

** The writer is greatly indebted to Messrs. E. T. Dumble and W. F. Cummins of the Geological Survey of Texas, for their kindness and courtesy to him in the Texas Museum, also for valuable aid in the correlation of the Coal Measures of Arkansas and Texas.

paleontologic or stratigraphic break, but merely on the occurrence or non-occurrence of coal.

The divisions that are recognized in Pennsylvania could not be recognized in Arkansas, but the strata of the two sections are correlated as far as possible, with the scanty data now at hand.

The Lower Coal Measures.

Of the age of the Lower Coal Measures we have only stratigraphic evidence, their position above the limestones of the Lower Carboniferous and below the coal-bearing beds of the Upper Coal Measures being unmistakable. But their known fauna and flora have been too limited and indecisive to enable us to correlate the stages with those of other Carboniferous areas, since collections have been made in but few places, and these chiefly in sandstones, where the preservation of fossils is usually unsatisfactory, and the determination uncertain.

But the Lower Coal Measures correspond in a general way to the Strawn and the lower part of the Canyon division of Texas, to the Pottsville Conglomerate series, the Lower Productive Coal Measures, and part of the Lower Barren Coal Measures of Pennsylvania. The series corresponds in the main to the Middle Carboniferous limestone of eastern Russia.

The Upper Coal Measures.

The Arkansas Upper Coal Measures correspond to the upper part of the Canyon and the whole of the Cisco division of Texas,* and below the transitional Permo-Carboniferous or Artinsk stage, to which latter age the lower part of the Wichita and Albany divisions of Texas belong. The Lower Permo-Carboniferous beds of Kansas and Nebraska are also probably to be correlated with the Artinsk† stage, although Waagen‡ classes the entire series with the ammonite-bearing beds of northern Texas, described by Dr. C. A. White, in Bulletin 77 of the U. S. Geological Survey. Most of the latter Texas beds belong rather above the Artinsk stage, and in the true Permian, and are probably of the same age as the *Middle* and *Upper Productus Limestone* of the Salt Range.

Waagen, in *Salt Range Fossils, Geological Results*, p. 238, gives a comparative table, showing the relationship of the upper Paleozoic strata all over the world. While the position assigned some of the American deposits does not agree with that accepted by most American geologists, still the table is very useful for comparison, and it has been freely used in compiling the comparative table accompanying this paper.

* The writer, in *Journal Geology*, Vol. ii, p. 194, following Karpinsky, placed the *Popanoceras parkeri* beds in the lower Permian or Artinsk, but in this he was mistaken. Prof. W. F. Cummins told the writer that these beds are not in the Upper Cisco, but in the Strawn division, and therefore are Lower Coal Measures.

† Karpinsky, *Ammoneen der Artinsk-Stufe*, p. 92.

‡ *Salt Range Fossils, Geological Results*, p. 204.

The beds of Poteau mountain, Indian Territory, are probably of the age of the Lo-ping strata, while the yellow shales of Scott county, Arkansas, 1 N., 28 W., section 4, southeast quarter of southeast quarter, are probably of the age of the Upper Carboniferous Limestone of Moscow, and the west slope of the Urals,* if we can judge by the occurrence of *Gastrioceras* conf. *marianum* and *Pronorites* in them. This would make them older than the Poteau mountain shales, which is very likely the case. They are the probable equivalents of the Canyon division of Texas.

Paleobotanic Evidence.

Our knowledge of the paleobotany of the Coal Measures of Arkansas has been up to the present time very limited, depending almost entirely on the publications of Lesquereux in the *Second Annual Report of a Geological Reconnoissance of the Middle and Southern Counties of Arkansas*, 1860, and in the *Second Geological Survey of Pennsylvania*, "Report of Progress, P. Description of the Coal Flora of the Carboniferous Formation in Pennsylvania, and throughout the United States," 1884.

The joint monograph† of H. L. Fairchild and David White on the *Fossil Flora of the Coal Measures of Arkansas* throws much new light on the stratigraphic and regional distribution of species, and has been of material aid in correlating the Arkansas strata with those of other regions. They prove that all the Coal Measure plants‡ published from Arkansas belong to the horizon of the Upper or Productive Coal Measures. The Van Buren plant bed is thought from paleobotanic evidence to belong above the horizon from which most of the coal of Arkansas is obtained, that of the Ouita coal, and this agrees with the evidence given by the stratigraphy and the marine fossils. The Van Buren plant bed occurs below the Poteau mountain marine beds, and above those in 8 N., 32 W., section 12, Sebastian county, near Fort Smith; and these latter marine beds occur above the horizon of the Ouita coal.

The Poteau mountain marine beds are of about the same age as the Wyoming Valley limestones§ of the Upper Productive Coal Measures of Pennsylvania, and these belong below the Dunkard creek series of the Upper Barren Coal Measures. The Dunkard creek beds have lately been proved by Prof. I. C. White‖ to be of the same age as the Permian of northern Texas, on the basis of plant remains that occur towards the top of the Texas beds in which marine Permian fossils were found.¶

But the paleobotanic evidence aids in establishing the age of the

* C2 of Tschernischew, *Mém. Com. Géol. Russie*, Vol. iii, No. 4, p. 353.

† An unpublished report of the Geol. Survey of Arkansas.

‡ The work of the Survey shows that the plants described by Lesquereux from Washington county as Subconglomerate belong to the Lower Carboniferous.

§ Upper part of C2, Tschernischew, *Mém. Com. Géol. Russie*, Vol. iii, No. 4, p. 353.

‖ *Bull. Geol. Soc. America*, Vol. iii, p. 217.

¶ Bull. 77, *U. S. Geol. Survey.*

Upper Coal Measures only; plants are not reported on from any horizons of the Lower Coal Measures, although they are known from a few localities.

Owen* mentions *Stigmaria ficoides* as occurring at Patterson's mill, near Bee Rock, on Little Red river, White county. In August, 1892, a few plants were found by the Survey in the Bee Rock sandstone near the base of the series and below most of the marine fossils, but none of these could be identified.

Mr. D. McRae, of Searcy, informed the Survey that in 7 N., 7 W., section 4, White county, were found shales containing numerous *Lepidodendra* and ferns. These shales are above the Bee Rock sandstones.

In a well at Dr. Griffin's, 5 N., 10 W., section 5, near El Paso, White county, specimens of *Lepidodendron* were collected by Dr. J. C. Branner, in micaceous flaggy sandstone, thought to be of about the same age as the shales of Searcy. About fifty feet above the flaggy sandstone was found a thin bed of coal, and thirty feet higher was another coal bed with numerous ferns and *Calamites*.

C. S. Prosser† mentions plants supposed to be of Lower Carboniferous age, from Shinall mountain, in 2 N., 14 W., section 17; also from section 20 of the same township.

In quarries in the sandstones of Big Rock, near the city of Little Rock, are found plant remains of indeterminable character. The stratigraphy of the Survey places the three last localities in the Lower Coal Measures, and probably above the fossiliferous sandstones of Bee Rock, on Little Red river.

The Pacific Carboniferous Sea.

Revolution in Devonian Time.

In Paleozoic times there have been many revolutions and alternations of continents and seas, and consequent readjustment of their inhabitants to new surroundings. One of the greatest of these revolutions was that which broke up a large zoölogical province, and put in direct connection regions that before were separated.

Dr. A. Ulrich‡ has shown that in Lower and Middle Devonian the faunas of Bolivia, Brazil, the Falkland Islands and South Africa were very similar to those of North America, and that they were very different from the faunas of Europe and Asia. This state lasted until the end of the Middle Devonian, when the revolution began. Prof. H. S. Williams§ has shown that with the beginning of the Upper Devonian in America there came in a fauna, many species of which were not the direct descendants of those immediately preceding them. This new

* *Second Geol. Reconn. Ark.*, Vol. i, p. 68.

† *Ark. Geol. Survey Ann. Rep.*, Vol. iii, 1890, p. 423.

‡ *Beiträge zur Geologie und Paläont. Südamerika, I,* "Paläozoische Versteinerungen aus Bolivien."

§ *Bull. Geol. Soc. Amer.*, Vol. i, "The Cuboides Zone and Its Fauna."

fauna was, however, closely related to forms known in Europe and Asia, but unlike those of the southern regions. Prof. Williams* afterwards elaborated this theory and followed out closely the changes that were inaugurated towards the close of the Devonian. The culmination of these changes produced the Pacific† Carboniferous sea.

The Carboniferous Sea.

From Chapter v, in Suess' *Antlitz der Erde,* Vol. ii, we get many valuable suggestions as to the outlines of the Pacific Carboniferous ocean. The Subcarboniferous was the time of greatest transgression of sea over the present land areas, while the sea in which the *Fusulina* beds of Europe and America were formed was more circumscribed.

The Waverly group when traced towards the west gradually takes on the character of deep water formations; it is persistent through Nevada and California,‡ and has been shown by the writer§ to have a similar fauna in these two states. The Waverly probably persisted much longer in the west than in the east, for in northern Missouri Dr. C. R. Keyes‖ has observed that in the midst of an undoubted Burlington fauna a well-marked Kinderhook or Waverly fauna reappears. This he explains by Barrande's theory of colonies. It is probably an incursion of the inhabitants of a deeper western sea, where the Waverly had persisted longer, into the shallower eastern waters. The work of the Geological Survey of Arkansas shows that a similar phenomenon occurs in that state. The Fayetteville shale, which is of Warsaw or St. Louis age, contains a fauna that differs markedly from those of the limestones above and below it. A recent paper by Prof. Henry S. Williams¶ shows the occurrence in the Fayetteville shale of several species that occur in a doubtful Upper Devonian or Lower Carboniferous black shale in the White Pine district, Nevada. Along with these Devonian or Waverly species occur others that belong much higher, as *Productus semireticulatus* and *Goniatites* conf. *sphæricus.* Below the Fayetteville shale is the Boone chert, which at the base contains a decided Burlington fauna, and at the top probably belongs to the Warsaw. This has been observed in so many places that there is no possibility of mistake in the sequence of the strata.

We have therefore in Arkansas an incursion similar to that in Missouri, except that in Arkansas the incursion came considerably later. This is evidence that somewhere in the west the Waverly fauna persisted throughout the Osage and possibly a part of the St. Louis. This

* *Proc. Amer. Assoc. Adv. Sci.*, 1892, Section E, Address, "The Scope of Paleontology and Its Value to Geologists."

† See also Tschernischew, *Mém. Com. Géol. Russie*, Vol. iii, No. 4, p. 364, on the physical geographic changes that occurred in Europe towards the end of the Carboniferous.

‡ Zoe, Vol. iii, p. 274, *Proc. Calif. Acad. Sci.*, Oct. 17, 1892.

§ *Journ. Geol.*, Vol. ii, No. 6, Metamorphic Series of Shasta County, California.

‖ *American Journal of Science*, December, 1892, p. 447.

¶ *Amer. Journal of Science*, Vol. xlix, 1895, pp. 94–101.

is in accordance with the phenomenon described by Prof. C. D. Walcott in Monograph viii, U. S. Geological Survey, from the Eureka district, Nevada, where a Waverly fauna occurs three thousand feet above the base of the Carboniferous formation. The same thing has been observed by the writer in the Carboniferous of Shasta county, California.*

The Lower Carboniferous limestones can be traced all through the West and the Mississippi valley, to the base of the Appalachian mountains, where they are replaced by conglomerates and other coarse sediments.

Upper Carboniferous in the West.

Of the Upper Carboniferous all that we know west of Indian Territory takes on a decidedly marine character, containing thick beds of limestones. There are however some thin beds of coal in Texas, and some carbonaceous seams with a few land plants in New Mexico and Nevada. The coal in Texas was probably deposited near the southern shore line of the Carboniferous sea, and the carbonaceous seams in the far West probably belong to the insular areas. The fossils described from the western Carboniferous are all marine, with the slight exception that Walcott† mentions a few specimens of pulmonate Gasteropoda that were found along with brachiopods, corals and land plants, evidently washed in from a distance, since no terrestrial Carboniferous deposits are known near the Eureka district.

The Pawhuski Limestone.

In the the eastern part of Indian Territory are found large deposits of coal in the Upper Coal Measures, but further west the same horizon is represented by marine limestone. In 1892, Mr. H. C. Hoover, of the Geological Survey of Arkansas, found at the Government lime-kiln, three miles northwest of Pawhuski, Oklahoma Territory, Osage agency, a bed of massive limestone about 100 feet thick, lying horizontally on heavily bedded sandstones. The limestone is fossiliferous, but the sandstones are not. The fossils collected were placed at my disposal, and on examination they proved to be;

Spirifer cameratus Morton.
Athyris subtilita Hall sp.
Productus semireticulatus Martin, sp.
Productus nebrascensis Owen.
Productus splendens Norwood and Pratten.
Derbyia crassa Meek and Hayden.

These are plainly of Upper Carboniferous age. The limestones cap the hills in that region, and spread over a great area, but fossils were collected at this place only.

* *Journal of Geology*, Vol. ii, No. 6, pp. 588–612.
† *Mon. viii. U. S. Geol. Survey*, p. 262.

Interchange of Life Between East and West.

The many beds of marine fossils in the Productive Coal Measures are simply transgressions from the western sea, and reach no further east than Pennsylvania and West Virginia. The Appalachian system was the western border of the ancient Atlantis* which separated the European from the Pacific waters, while the great Indo-Australian† continent bounded the Pacific ocean on the south. This ocean must have stretched from the American Coal Measures to Eastern China, the Salt range in India, the Ural mountains on the borders of Russia, and into the Arctic regions, for we find related faunas in all these places. Whatever we have of western European Coal Measure species must have migrated from this direction, since on the east there was no direct communication with European waters. An example of this is *Productus giganteus*‡ Martin, which is common in Europe, and is found in the Lower Carboniferous of the McCloud river, Shasta county, but is not found east of that place, unless *P. latissimus* Sowerby, from Montana, west of the main chain of the Rocky mountains, be an equivalent. Another example is *Omphalotrochus whitneyi* Meek, which was first described from the Carboniferous limestone of Shasta county, California, but is also very common in the Lower Coal Measure limestone (C2) of eastern Russia.§

On the other hand, many species seem to be confined to, or characteristic of, this ocean; among them may be mentioned *Productus cora* d'Orbigny, which Waagen‖ says is not found in Europe, its nearest representative being *Productus riparius* Trautschold; it was however first described from South America.

Goniatites marianus Verneul is found in the Artinsk region of the Urals and in Arkansas. The genus *Pronorites*, while found in western Europe, is rare in it, and is much more common in the Pacific region. *Pronorites* is found in the Artinsk region and in Arkansas, while the ammonite genus *Medlicottia*, the direct descendant of *Pronorites*, is found in the Permo-Carboniferous strata of Sicily, the Urals, the Salt range, and Texas.

It is impossible to suppose that the same genus and species originated at different localities, and since we have both ancestors and descendants in places so widely separated, we can only suppose that there was free interchange of life between those places at that time, or in other words an open sea, on the borders of which these fossiliferous deposits were laid down, and along the margin of which the cephalopods and other marine animals could migrate.

* Suess, *Antlitz der Erde*, ii, p. 17.

† Suess, *Ibid.*, ii, p. 316.

‡ See *Annual Report U. S. Geog. and Geol. Surv. Terr.*, 1883, Part i, p. 132, and *Bull. Geog. and Geol. Surv. Terr.*, Vol. ii, No. 4, p. 354.

§ See *Journal Geol.*, Vol. ii, No. 6, pp. 598–600.

‖ *Pal. Indica*, Salt Range Fossils, Brachiopoda, p. 677.

Replacement of Limestones by Coal-bearing Formations in Western Europe.

On tracing the Upper Carboniferous deposits of the Ural region towards the west, we find the limestones thinning out, and the Coal measures and Culm formations taking their places; we find also that the transgression of marine on terrestrial deposits takes place from the east, just the reverse of what is seen in America.

Land Areas in the West.

It is not thought that the Pacific Carboniferous sea was an unbroken expanse of water in western America; on the contrary there are many evidences of large isolated land areas and archipelagos. Dr. Joseph Le Conte* has argued that the Basin range, during much of Paleozoic and Mesozoic time, was a continent, off the western shores of which the sediments that afterwards became the Sierra Nevada and Coast range were laid down. Clarence King† thought that the great thickness of Paleozoic littoral deposits in the Great Basin region proved the existence of a large body of land further west; he thought that the eastern shore of this continent was in Nevada, and east of this stretched the Carboniferous sea, which covered all but the island chain of the Rocky Mountain region. King‡ further concluded that the Carboniferous in California, west of the old shore line, indicated shallow bays that permitted the western extension of the upper Paleozoic deposits, while the bulk of them was stopped by the bold coast. There are evidences of land areas in the Rocky mountains, Wahsatch mountains, New Mexico, and Nevada, but from the facts now known it seems more probable that these were large islands or archipelagos, rather than continents.

THE PERMIAN PACIFIC OCEAN.

The outlines of the great western ocean can be traced in Permian times also, but with much more circumscribed limits. Open-sea deposits of this age are known in Texas, in the Salt range, on the west slope of the Urals, on the island of Sicily, and in scattering places in Central Asia. In all these the genera are nearly the same, except that the *Arcestes* types are confined to the more southern regions. This similarity indicates plainly a connection of these deposits.

Suess§ argues that the open-sea Permian fauna wandered in from the south, and that the Mesozoic types of ammonites were foreign to the northern regions. Karpinsky,‖ on the contrary, holds that they were autochthonous, at least in the Ural region, since he could trace the descent of all the ammonites except the *Popanocerata* from goniatites that

* *American Journal of Science*, iii, Vol. 16, p. 108.
† *U. S. Geol. Explor. Fortieth Parallel*, Vol. i, p. 534.
‡ *Op. cit.*, p. 535.
§ *Antlitz der Erde*, ii, p. 316.
‖ *Ammoneen der Artinsk-Stufe*, p. 86.

were found in the underlying Carboniferous. As has been already mentioned, the ammonite genus *Medlicottia* is not a foreigner on this side of the Permian Pacific ocean, because its ancestor, *Pronorites*, is found here too.

The Triassic Pacific Ocean.

Our knowledge of the Triassic Pacific ocean is based on the work of Mojsisovics, *Arktische Triasfaunen.** We find that in this period the American part of the great western ocean has mostly become land, and only on the western border of America do we find marine Triassic beds, in Nevada, California, Idaho, and along the coast region in widely separated places, from Alaska through British America to Peru.

These deposits, with similar faunas, can be traced on the other side of the Pacific from New Zealand, Timor, New Caledonia, to Japan, and Siberia. This sea stretched out on one side over the Himalayas to the eastern Alps, forming what Neumayr† called the "central Mediterranean sea." On the other side the sea stretched up to Spitzbergen, but did not reach the Atlantic region. The Triassic was a continental period for the greater part of the present continents.‡ After the Trias the outlines of the western ocean had changed entirely, and no resemblance to the original boundaries can be traced.

Time of the Ouachita Uplift.

The youngest rocks known to take part in the Ouachita Mountain system belong to the Upper Coal Measures, and the disturbance must have taken place at the border between Carboniferous and Permian. Still, it is not unlikely that deposits of Permo-Carboniferous age may yet be found at some places in the region.

Another fact that makes this time for the uplift probable is that the Permo-Carboniferous beds of Kansas and Nebraska are not of the open-sea type, but belong to the northern European or Zechstein type of deposits. The beds of Texas, presumably of nearly the same age, are of the Artinsk or open-sea facies, and are characterized by the occurrence of ammonites, commingled with ordinary Upper Coal Measure fossils.

This uplift may be of the same age as that movement in the Appalachians§ which cut off the Upper Barren Coal Measures of Pennsylvania and West Virginia‖ entirely from the western sea; in those deposits no marine fossils are found, but only land plants and fresh-water Crustaceans,¶ and a few fresh-water mollusks.

* *Mem. Acad. Imper. Sci. St. Petersbourg*, Tome 33, No. 6.

† *Denkschrift Wiener Akad.*, 1885, "Die geographische Verbreitung der Juraformation."

‡ Suess, *Antlitz der Erde*, ii, p. 147.

§ *Penna. Second Geol. Survey*, P. P., p. 120.

‖ I. C. White, *Bull. 65th U. S. Geol. Survey*, p. 41.

¶ *Penna. Second Geol. Survey*, P. P., Permian Flora, W. M. Fontaine and I. C. White, p. 116.

CORRELATION TABLE OF THE COAL MEASURES OF ARKANSAS.

		ARKANSAS.	INDIAN TERRITORY	TEXAS.	MISSISSIPPI VALLEY	PENNSYLVANIA	CHINA AND OTHER PARTS OF ASIA	RUSSIA AND URAL MTS.	INDIA	SOUTH AMERICA
PERMIAN			Permo-Carboniferous	Permian { Wichita and Albany Series	Permo-Carbonifer's of Kansas & Nebraska	Upper Barren Coal Measures	Bokhara Cephalopod Beds	Kostroma Permian Artinsk Stage	Productus Limestones	Itaitúba Beds
COAL MEASURES OR PENNSYLVANIAN	UPPER COAL MEASURES	Poteau Mountain Marine Beds. . . . Van Buren Plant Beds. . . . . Fort Smith Marine Beds . . . . Ouita Coal Horizon with Plants . . . Boles, Scott County, Beds with *Goniatites marianus* and *Pronorites*. . . .	Productive Coal Measures | Pawhuski Limestone	Cisco Canyon	Upper Coal Measures	Upp. Prod. Coal Meas. | Wyoming Valley Limestones Lower Barren Coal Meas.	Marine Beds of Lo-ping Productive Coal Measures of China	North. Russia Nova Zembla Upper Carboniferous Limestone	Spiti Limestones	Plant Beds
	LOWER COAL MEASURES	Morrillton Marine Beds . . . . Conway County Millstone Grit, with Marine Fossils. . . . . Big Rock, Pulaski County, Plant Beds El Paso, White County, Plant Beds . Searcy, Bee Rock, Marine Beds . . . Searcy, Bee Rock, Plant Beds		Strawn	Lower Coal Measures	Lower Prod. Coal Meas. Pottsville Conglomerate		Middle Carboniferous Limestone	Muth Quartzites Limestones	
LOWER CARBONIFEROUS OR MISSISSIPPIAN.		Lower Carboniferous Limestone . . .	Lower Carboniferous Limestone	Bend Division	Lower Carboniferous Limestone	Mauch Chunk Series	Lower Carboniferous Limestone	Lower Carboniferous Limestone	Crinoidal	

DESCRIPTIONS OF THE COAL MEASURE MARINE FOSSILS.

The lists of fossils given above establish beyond question the age of the species described in this paper, and enable us, even without the aid of stratigraphy, to assign them to their proper horizon, by a study of the accompanying faunas. Of the goniatites only one, *Gastrioceras branneri* J. P. S., is thought to be a new species, although all are new to Arkansas. *Gastrioceras marianum* Verneul, and *Pronorites cyclolobus* Phillips, have never before been found outside of Europe; *Gastrioceras globulosum* Meek and Worthen is found here for the first time outside of Illinois; *Gastrioceras excelsum* Meek is found for the first time outside of Kansas; *Paralegoceras iowense* Meek and Worthen is found here for the third time, being known elsewhere only in Iowa and in Texas, and shows on the Arkansas specimen the internal lobes, features that have never before been seen in this species and genus.

Both stocks or families are represented in the collection, and genera that probably were the ancestors of important genera and families in the Permian and the Mesozoic, and thus as transitional forms, or links in genetic series, they command especial interest. All species described in this paper are deposited in the geological museum at Stanford University, except the originals of *Gastrioceras branneri* J. P. S., and *Pronorites cyclolobus* Phillips, var. *arkansiensis* J. P. S., which are deposited in the U. S. National Museum.

Subkingdom COELENTERATA.

Class *Anthozoa*.

Genus FISTULIPORA, McCoy. *Fistulipora nodulifera* Meek, *U. S. Geol. Survey Nebraska*, p. 143, Pl. v, Fig. 5.

This species, which is common in the Upper Coal Measures of Nebraska, Iowa, Illinois, etc., was found in corresponding strata on Poteau mountain, Indian Territory.

Genus LOPHOPHYLLUM, Milne-Edwards and Haime. *Lophophyllum proliferum* McChesney sp., McChesney, *Descript. New Pal. Foss.*, 1860, p. 75; F. B. Meek, *U. S. Geol. Survey Nebraska*, p. 144.

Several specimens agreeing with the typical *L. proliferum* were found in the Upper Coal Measures of Poteau mountain, Indian Territory. Specimens closely resembling this species were also found in the Boone Chert, Lower Carboniferous, of Boone county, 17 N., 19 W., section 2, near Valley Springs. The latter specimens are more like *Lophophyllum proliferum* var. *sauridens* White, C. A. White, *U. S. Geog. Surv. W. of 100th Meridian*, iv, p. 101, Pl. vi, Fig. 4, from Carboniferous strata, New Mexico and Colorado.

Genus ZAPHRENTIS, Rafinesque. *Zaphrentis*, sp. indet.

In Crawford county, 10 N., 30 W., section 10, southeast quarter of northwest quarter, in strata of the Lower Coal Measures, and in the same

formation in Conway county, 5 N., 16 W., section 17, near centre of the north half, were found specimens of this genus, too poorly preserved to allow the species to be determined.

Subkingdom ECHINODERMATA.

Class *Crinoidea.*

Genus CYATHOCRINUS, Miller.

In the Upper Coal Measures of Poteau mountain, Indian Territory were found a great many stems that seem to belong to *Cyathocrinus,* but no other parts were found, to make the identification more certain.

Genus ERISOCRINUS, Meek and Worthen. *Erisocrinus (Ceriocrinus) inflexus* Geinitz, sp. *Cyathocrinus inflexus* Geinitz, *Carbonformation und Dyas in Nebraska,* p. 62. *Poteriocrinus hemisphæricus* Shumard, *Trans. St. Louis Acad. Sci.,* i, p. 221. *Scaphiocrinus hemisphæricus* Shumard, sp., F. B. Meek, *U. S. Geol. Survey Nebraska,* p. 147. *Erisocrinus (Ceriocrinus) inflexus* Geinitz, sp., C. A. White, *Twelfth Ann. Rept. Hayden's U. S. Geol. Survey Wyoming and Idaho,* Part i, p. 128, Pl. xxxiv, Fig. 9.

This species which is common in the Coal Measures of Nebraska, Utah, etc., was found in the Upper Coal Measures of Poteau mountain, Indian Territory.

Genus HYDREINOCRINUS, De Koninck. *Hydreinocrinus mucrospinosus* McChesney, sp. *Zeacrinus mucrospinosus* McChesney, *Descr. New Pal. Foss.,* p. 10. *Hydreinocrinus mucrospinosus* McChesney, F. B. Meek, *U. S. Geol. Survey Nebraska,* p. 149.*

Found in the Upper Coal Measures of Poteau mountain, Indian Territory.

Genus POTERIOCRINUS, Miller. *Poteriocrinus,* sp. indet.

In the Upper Coal Measures of Poteau mountain, Indian Territory, were found numerous crinoid stems that seem to belong to Poteriocrinus.

Crinoidea, genus undetermined.

In the Lower Coal Measures of White county, 8 N., 7 W., section 33, southeast quarter, and section 26, southeast quarter, and in beds of the same age in Pope county, Point mountain spur, 10 N., 20 W., section 8, southeast quarter of northwest quarter, were found numerous crinoid stems, which could not be identified since they were mostly in the form of moulds or casts.

* Meek cites this species from Arkansas, but gives no locality, or authority for the statement.

Subkingdom MOLLUSCOIDEA.

Class *Bryozoa.*

Genus FENESTELLA, Lonsdale. *Fenestella shumardi* Prout., *Trans. St. Louis Ac. Sc.*, i, p. 232; F. B. Meek, *U. S. Geol. Survey Nebraska*, p. 153, Pl. vii, Fig. 3.

This species was found in the Upper Coal Measures of Poteau mountain, Indian Territory, and one very closely resembling it, if not identical, was found in the Boone Chert, Lower Carboniferous, at several places in northwestern Arkansas.

Genus RHOMBOPORA, Meek. *Rhombopora lepidendroides*, F. B. Meek, *U. S. Geol. Survey Nebraska*, p. 141, Pl. vii, Fig. 2; C. A. White, *U. S. Geol. Survey W. of 100th Meridian*, iv, p. 99, Pl. vi, Fig. 5.

This Bryozoan is common and characteristic in the Upper Coal Measures of Nebraska, and is found in the same horizon in Utah and Arizona, and was also found in the Upper Coal Measures of Poteau mountain, Indian Territory. The same, or a very similar species, occurs in the Boone Chert, Lower Carboniferous, of northern Arkansas.

Genus SEPTOPORA, Prout. *Septopora biserialis* Swallow, sp. *Synocladia biserialis* Swallow, *Trans. St. Louis Ac. Sci.*, i, p. 179; F. B. Meek, *U. S. Geol. Survey Nebraska*, p. 156, Pl. vii, Fig. 5; C. A. White, *Survey W. of 100th Meridian*, iv, p. 107, Pl. vii, Fig. 3.

This species is common in the Upper Coal Measures, or Permo-Carboniferous, of Nebraska and Kansas, and in the true Coal Measures of Illinois, and in the Upper Carboniferous of Arizona. It has also been found in the Chester and the St. Louis Limestone, Lower Carboniferous, of Illinois. Waagen* says that the true genus *Synocladia* has not been found in America, and that in Europe or Asia it is characteristic of the Permian. He refers the American forms to the genus *Septopora* of Prout.

Class *Brachiopoda.*

Genus ORTHIS, Dalman. *Orthis pecosii* Marcou, *Geol. North Amer.*, p. 48. *O. carbonaria* Swallow, *Trans. St. Louis Ac. Sci.*, i, p. 218. *O. carbonaria* Meek, *U. S. Geol. Survey Nebr.*, p. 173. *O. pecosii* Marcou, C. A. White, *U. S. Geol. Survey W. of 100th Merid.*, iv, p. 125, Pl. ix, Fig. 5. *Orthis*, sp. indet., Meek, *Pal. Cal.*, i, p. 10, Pl. ii, Fig. 5, a, b, c.

A single specimen was found in the Upper Coal Measures of Poteau mountain, Indian Territory; it agrees best with Dr. C. A. White's figures. The species is of frequent occurrence in the Upper Coal Measures of Iowa, Nebraska, Kansas, Illinois, Texas and in the Upper

* *Pal. Indica*, Salt Range Fossils, I. Productus Limestone Fossils, p. 802.

Carboniferous of New Mexico, and in the Lower Carboniferous of California. Dr. C. A. White * mentions a small Orthis, similar to this species, from the Keokuk of Iowa and Illinois. In the Boone Chert, Lower Carboniferous, of northern Arkansas, probably Keokuk, was also noticed a small Orthis of this type, but the preservation was not good enough for the identification to be certain.

Orthis conf. *resupinoides* Cox, *Geol. Surv. Kentucky*, Vol. iii, p. 570, Pl. ix, Fig. 1; C. A. White, *U. S. Geog. Survey West of 100th Merid.*, Vol. iii, Appendix, p. 23, Pl. iii, Fig. 2.

This type of Orthis is exceedingly rare in the Carboniferous, being rather characteristic of the Devonian. *O. resupinoides* is found in the Coal Measures of Kentucky and the Upper Carboniferous of New Mexico. Dr. C. A. White compares the species to *Orthis iowensis* Hall, *O. tulliensis* Vanuxem and *O. propinqua* Hall of the Devonian.

A few poorly preserved specimens were found in White county, 8 N, 7 W., section 33, southeast quarter, east half, in the Lower Coal Measures; also in Conway county, 8 N., 17 W., section 33, northeast quarter of northeast quarter.

Genus DERBYIA, Waagen. *Derbyia crassa* Meek and Hayden. *Orthisina crassa* M. and H., *Proc Ac. Nat. Sci. Phil.*, 1858, p. 260. *Streptorhynchus crassus* M. and H., F. B. Meek, *U. S. Geol. Surv. Nebraska*, p. 174. *Derbyia crassa* M. and H., Waagan, *Salt Range Fossils, Brachiopoda*, p. 592.

This species is widely distributed in the Coal Measures of Kansas, Nebraska, Illinois, Texas, etc., and was found in the Upper Coal Measures of Poteau mountain, Indian Territory, and in the Lower Coal Measures of Conway county, Arkansas, 6 N., 16 W., section 29, southwest quarter of southwest quarter. It is also very common in the Lower Carboniferous of the Mississippi valley.

Genus PRODUCTUS, Sowerby. *Productus cora* d'Orbigny, *Paleont. de l'Amer. Merid.*, 1842, p. 48. *P. cora* d'Orbigny, C. A. White, *Geol. Survey Indiana*, 1883, p. 126, Pl. xxvi, Fig. 1, 2, 3, = *P. prattenianus* Norwood.

This species is almost world-wide in its distribution in the Coal Measures, and is also found in the Productus Limestone of the Salt Range, India. Waagen, in *Paleontologia Indica, Salt Range Fossils, Brachiopoda*, p. 677, says that the true *Productus cora* is probably not found in Europe, its nearest representative being *P. riparius* Trautschold.

In America the typical species is very common in both Coal Measures and Lower Carboniferous. It was found in the former horizon on Poteau mountain, Indian Territory, and in the latter in numerous places; Fayetteville shale, probably Warsaw, Independence county, 13

* *U. S. Geog. Survey W. of 100th Merid.*, iv, p. 126.

N., 6 W., section 13, southeast quarter of southeast quarter, near Moorefield; Marshall shale, probably Warsaw division, Independence county, 12 N, 6 W., section 12, and Stone county, Blue mountain, 14 N., 11 W.; Archimedes Limestone, probably of St. Louis age, Independence county, 12 N., 6 W., section 14.

Marcy (*Expl. Red River of Louisiana*, p. 187) cites this species from Subcarboniferous limestone of Washington and Crawford counties, but does not give the localities.

Productus (*Marginifera*) *splendens* Norwood and Pratten. *Productus splendens* Norwood and Pratten, *Jour. Acad. Nat. Sci. Phil.*, 1854, Vol. iii, p. 11, Pl. i, Fig. 5. *P. wabashensis* Norwood and Pratten, *Jour. Acad. Nat. Sci. Phil.*, 1854, p. 13, Pl. i, Fig. 6. *P. longispinus* Meek (non Sowerby), *Final Report U. S. Geol. Survey Nebraska*, p. 161. *Marginifera splendens* N. and P., Waagen, *Palæontologia Indica, Salt Range Fossils, Productus Limestone Fossils, Brachiopoda*, p. 714.

This typical Upper Coal Measure and Permian species is a probable descendant of *Productus longispinus* Sowerby, and so closely are these two related, that for many years they were considered identical. But the *Marginifera* type of Productus seems to be confined to the Upper Carboniferous and Permian, while *P. longispinus* Sowerby is also found in the Lower Carboniferous. The Arkansas specimens agree perfectly with specimens from Indiana and Illinois. This species is very common in the Coal Measures and Permian of North America, and probably occurs also in Asia. A very similar small species occurs in the Lower Carboniferous limestone, Stone county, 14 N., 11 W., on Blue mountain, but this lacks the ventral sinus, and has fewer spines, and therefore probably belongs to the true *P. longispinus* Sowerby.

P. (*Marginifera*) *splendens* N. and P. was found in the Upper Coal Measures of Sebastian county, Arkansas, 8 N., 32 W., section 12, and on Poteau mountain, Indian Territory, in strata that are either of uppermost Coal Measure or of Lower Permian age.

Productus punctatus Martin. *Anomites punctatus* Martin, *Petrif. Derb.*, Pl. 37, Fig. 6. *Productus punctatus* Martin, Davidson, *Mon. Brit. Carb. Brachiopods*, p. 172.

This species is cosmopolitan in the Coal Measures and Lower Carboniferous, although more common in the latter horizon. It is very seldom that the shell is so preserved that the internal characteristics can be seen. In the figured specimen the arm impressions, adductor muscle scars, median septum, and the cardinal process are all perfectly preserved.

The dorsal valve is somewhat squarer than those figured by Davidson (*Mon. Brit. Carb. Brach.*, Pl. 44, Figs. 9–17), but the internal markings are the same in every detail, except that Davidson's figure makes the

cardinal process a little longer. The internal characteristics are imperfectly illustrated by McChesney (*Trans. Chicago Acad. Sci.*, Pl. i, Figs. 10, 11).

Occurrence.—Productus punctatus was found in great numbers in the upper part of the Lower Coal Measures of Conway county, 6 N., 16 W., section 29, on the east bank of Arkansas river, about one mile below the Old Lewisburg ferry. It was also found in the Lower Carboniferous at several places in the State.

Productus semireticulatus Martin, sp., *Petrifacta Derbiensia*, p. 7.

This well-known cosmopolitan species was found in the Barren or Lower Coal Measures in White county, 8 N., 7 W., section 33, southeast quarter, and in section 26, southeast quarter. It was also found in the Lower Carboniferous, in the Fayetteville shale, probably Warsaw, in Searcy county, 16 N., 17 W., section 1, southwest quarter of southwest quarter; in the Boone Chert, upper Burlington or lower Keokuk, in Searcy county, 17 N., 18 W., section 28, and at various other places in northern Arkansas; in the Marshall shale, probably Warsaw, in Stone county, on Blue mountain, 14 N., 11 W., south of Mountain View.

Genus RHYNCHONELLA, Fischer de Waldheim. *Rhynchonella uta* Marcou. *Terebratula uta* Marcou, *Geol. of N. Amer.*, p. 58. *Rhynchonella osagensis* Swallow, *Trans. St. L. Ac. Sci.*, 1858, p. 219. *Rhynchonella osagensis*, F. B. Meek, *U. S. Geol. Surv. Nebraska*, p. 179. *Rhynchonella uta* Marcou, C. A. White, *U. S. Geol. Expl. W. of 100th Merid.*, iv, p. 128.

This characteristic Coal Measure species, found in Kansas, Nebraska, Iowa, Missouri, Illinois, Texas and South America (?), was found in the Upper Coal Measures of Sebastian county, 8 N., 32 W., section 12; also in the same horizon on the Poteau mountain, Indian Territory.

Rhynchonella, sp. indet.

In the Lower Coal Measures of White county, 8 N., 7 W., section 33, southeast quarter, and of Crawford county, 10 N., 30 W., section 10, southeast quarter of northwest quarter, were found several Rhynchonellas that could not be specifically determined.

Genus TEREBRATULA Lhwyd. *Terebratula hastata* Sowerby, *Mineral Conchology*, Vol. v, p. 446. *Terebratula bovidens* Morton, *Am. Journ. Sc.*, Vol. xxix, p. 150. *Terebratula bovidens*, F. B. Meek, *U. S. Geol. Surv. Nebraska*, p. 187, Pl. i, Fig. 7.

Meek (*loc. cit.*) speaks of the strong resemblance of *T. bovidens* to *T. elongata* Schlotheim, sp., and *T. hastata* Sowerby, sp., but is strongly inclined to believe in the specific difference. Davidson (*Monograph Brit. Carb. Brach.*, Appendix, p. 226) is inclined to unite *T. elongata, T. hastata* and *T. sufflata*. If *Dielasma bovidens* is really identical with *T.*

hastata, it is an example of one species ranging from the Devonian up into the Permian. This species ranges through the Coal Measures in Nebraska, Kansas, Illinois, Texas, New Mexico, etc. It is very common in the Upper Coal Measures of Poteau mountain, Indian Territory, and was also found in the Fayetteville shale, Lower Carboniferous, probably Warsaw, of Independence county, 13 N., 6 W., section 13, southeast corner, near Moorefield; also in the Lower Coal Measures of Conway county, 8 N., 17 W., section 33, northeast quarter of northeast quarter.

Genus ATHYRIS, McCoy. *Athyris subtilita* Hall. *Terebratula subtilita* Hall, *Stansbury's Expl. Gt. Salt Lake*, p. 409. *Athyris subtilita* Hall, sp., F. B. Meek, *U. S. Geol. Surv. Nebraska*, p, 180, Pl. i, Fig. 12, Pl. viii, Fig. 4.

This species is found nearly all over the world in the Coal Measures. It is also found in various places in the Lower Carboniferous, as in England and India

It was found to occur frequently in the Upper Coal Measures of Sebastian county, 8 N., 32 W., section 12, and of Poteau mountain, Indian Territory; in the Boone Chert, Burlington or lower Keokuk, of Stone county, 14 N., 10 W., section 9, northwest quarter.

Marcy (*Expl. Red River of Louisiana*, p. 189) cites *Athyris subtilita* from the Subcarboniferous limestone of Washington county.

Genus RETZIA, King. *Retzia radialis* Phillips. *Terrebratula mormonii* Marcou, *Geol. N. Amer.*, p. 51, Pl. vi, Fig. 1. *Retzia punctilifera* Shumard, *Trans. St. Louis Ac. Sci.*, i, p. 220. *Retzia subglobosa* McChesney, *New Pal. Foss.*, p. 45, Pl. i, Fig. 1. *Retzia compressa* Meek, *Pal. Calif.*, i, p 14, Pl. ii. Fig. 7.

R. radialis is common in the Western Coal Measures and Lower Carboniferous; it was found in great numbers in the Upper Coal Measures of Sebastian county, 8 N., 32 W., section 12, and of Poteau mountain, Indian Territory.

Genus SPIRIFER, Sowerby. *Spirifer cameratus* Morton, *Am. Journ. Sc.*, Vol. xxix, p. 150. *Spirifer meusibachianus* Rœmer, *Kreidebildung von Texas*, p. 88. *Spirifer triplicatus* Hall, *Stansbury's Expl. Gt. Salt Lake*, p. 410. *Spirifer cameratus* Morton, C. A. White, *U. S. Expl. W. of 100th Merid.*, iv, p. 132, Pl. x, Fig. 1.

This species is distributed throughout the Coal Measures from Pennsylvania and West Virginia to Arizona; it is also found in the Permo-Carboniferous of Kansas;* Meek, in *Geol. Expl. 40 Parallel*, iv, p. 8, cites the species from the Upper Carboniferous of the White Pine Mining district of Nevada. It was found in great numbers in the Upper Coal Measures of Sebastian county, 8 N., 32 W., section 12, and of Poteau mountain, Indian Territory; also in the Lower Coal Measures

* F. B. Meek, *U. S. Geol. Surv. Nebraska*, p. 184.

of Conway county, 6 N., 16 W., section 29, southwest quarter of southwest quarter.

Spirifer rockymontanus Marcou, *Geol. of N. Amer.*, p. 50, Pl. vii, Fig. 4. *Spirifer opima* Hall, *Geol. Surv. Iowa*, Vol. i, Part ii, p. 711. *Spirifer subventricosa* McChesney, *Desc. New Pal. Foss.*, p. 44. *Spirifer rockymontanus* Marcou, C. A. White, *U. S. G. Expl. W. of 100th Merid.*, iv, p. 134, Pl. xi, Fig. 9.

S. rockymontanus occurs in the Upper Carboniferous from Pennsylvania to New Mexico.

It was found in the Lower Coal Measures of White county, 8 N., 7 W., section 33, southeast quarter, in the form of well-preserved casts, also in section 26, on Bee Rock; also in the same horizon, Crawford county, 12 N., 30 W., section 17. These specimens agree with Dr. White's figures and descriptions so well that no further description is necessary.

Genus SPIRIFERINA, d'Orbigny. *Spiriferina cristata* Schlotheim. *Terebratulites cristatus* Schlotheim, *Beiträge Nat. Verst. Muenchen*, Pl. i, Fig. 3. *Spiriferina kentuckensis* Shumard, *Geol. Surv. Missouri*, 1858, p. 203. *Spirifer octoplicatus* Hall, *Stansbury's Expl. Gt. Salt Lake*, p. 409, Pl. xi, Fig. 4. *Spirifer laminosus* Geinitz, *Carbonformation und Dyas in Nebraska*, p. 45, Pl. iii, Fig. 11. *Spiriferina kentuckensis* Shumard, sp., F. B. Meek, *U. S. Geol. Surv. Nebraska*, p. 185, Pl. vi, Fig. 3, Pl. viii, Fig. 11.

Dr. C. A. White, in *U. S. Geog. Expl. W. of 100th Merid.*, iv, p. 140, egards *S. octoplicatus* Hall and *S. kentuckensis* Shumard as distinct species. C. D. Walcott, *Pal. Eureka District*, p. 218, regards them both, as well as *S. spinosa* Norwood and Pratten, as synonyms of *S. cristata* Schlotheim, sp. If this reference is correct, then the species ranges from the Upper Devonian of the White Pine Mining district into the Upper Carboniferous of the Eureka district.

Davidson (*Monograph Brit. Carb. Brach.*, p. 267) regards *Spiriferina octoplicata* Sowerby, sp., as synonymous with *S. cristata* Schlotheim, sp., which ranges from the Carboniferous into the Permian. Taken in these broader limitations, the species ranges from the Devonian, through the Lower Carboniferous of the West, and through the entire Coal Measures from Kentucky to Nevada.

Hall (*Geol. Survey Iowa*, Vol. i, Part ii, p. 706, Pl. xxvii, Fig. 5) describes and figures *Spiriferina spinosa* N. and P. from the Kaskaskia group of Iowa. He states that *S. spinosa* differs from *S. kentuckensis* in being more robust and in possessing the tubular spines.

But specimens of *S. kentuckensis* from the Upper Coal Measures of Arkansas are equally robust and possess the spines that are thought to be characteristic of *S. spinosa*.

A comparison of specimens from the Upper Coal Measures of Sebas-

tian county, 8 N., 32 W., section 12, shows the perfect resemblance between the two so-called species. There are five distinct but rather rounded plications on each side of the mesial fold and sinus, but no concentric striations or lamellæ were observed. The entire surface is thickly covered with short spines, which seem to be unusually well preserved.

This species was found in the Lower Coal Measures of Conway county, 6 N., 16 W., section 29, southwest quarter of southwest quarter, and in the Upper Coal Measures at the locality mentioned in Sebastian county; also on Poteau mountain, Indian Territory; in the Lower Carboniferous, Boone Chert, upper Burlington or lower Keokuk, at St. Joe, in Searcy county.

Subkingdom MOLLUSCA.

Class *Lamellibranchiata.*

Genus AVICULOPECTEN, McCoy. *Aviculopecten carboniferus* Stevens, *Amer. Journ. Sc.*, Vol. xxv, p. 261.

Two imperfect specimens from the Lower Coal Measures, White county, 8 N., 7 W., section 26, southeast quarter, agree fairly well with the figures and descriptions of this species. Another specimen was found in the Lower Coal Measures of Conway county, 5 N., 16 W., section 17, northwest quarter.

Aviculopecten coxanus Meek and Worthen, *Proc. Acad. Nat. Sc. Phil.*, 1860, p. 453; *Geol. Surv. Ill.*, ii, p. 326, Pl. xxvi, Fig. 6; F. B. Meek, *U. S. Geol. Surv. Nebraska*, p. 196, Pl. ix, Fig. 2.

This species is found in the Upper Coal Measures of Illinois and Nebraska, and was also found in the same horizon on Poteau mountain, Indian Territory.

Aviculopecten germanus Miller and Faber, *Journ. Cin. Soc. Nat. Hist.*, July, 1892, p. 79.

This species was described from the Coal Measures of Elkhorn creek, Kentucky, and was compared by the authors to *A. rectilaterarius* Cox sp., *Geol Surv. Kentucky*, iii, p. 571, Pl. ix, Fig. 2, but it resembles more closely *A. edwardsi* Worthen, *Bull. 2 State Mus. Nat. Hist. of Ill.*, p. 22; both species were founded on left valves, the right being unknown. They are both very similar to *A. segregatus* McCoy, *British Pal. Fossils*, p. 489, Pl. iii, E, Fig. 1, of the Carboniferous limestone of Northumberland, although the latter has from two to three secondary intermediate ribs, instead of one.

A single small left valve was found in the Upper Coal Measures of Poteau mountain, Indian Territory. It agrees in the main points with Miller and Faber's description, except that the intermediate rib is sometimes obsolete, and distinct concentric lines of growth are seen on the shell.

The beak is sharp, and projects beyond the cardinal margin; the ribs number about twelve, and are rather coarser than those shown in Miller and Faber's figures.

Aviculopecten occidentalis Shumard, *Geol Survey Missouri*, 1855, Part ii, p. 207, Pl. C, Fig. 18.

This species is very common in the Coal Measures from Pennsylvania to Arizona; in Arkansas it was found in the Lower Coal Measures of Conway county, 5 N., 16 W., section 17, northwest quarter; about four miles southeast of Morrillton, and 6 N., 16 W., section 29, east bank of Arkansas river, about one mile below the Old Lewisburg ferry, in the Lower Coal Measures.

Genus LIMA. *Lima retifera* Shumard. *Lima retifera* Shumard, *Trans. St. Louis Ac. Sc.*, i, p, 214. *Crenipecten retiferus* Shumard, sp., S. A. Miller, *N. Amer. Geol. and Pal.*, 1889, p. 473.

Lima retifera is characteristic of the Coal Measures in Kansas, Illinois, Nebraska, Texas, etc., and was also found in the Upper Coal Measures of Poteau mountain, Indian Territory.

Genus MACRODON, Lycett. *Macrodon carbonarius* Cox, sp. *Arca carbonaria* Cox, *Geol. Surv. Kentucky*, iii, p. 567, Pl. viii, Fig. 5. *Macrodon carbonarius* Cox sp., F. B. Meek, *Pal. Ohio*, ii, p. 334.

This species resembles so closely *M. obsoletus* Meek, *Pal. Ohio*, ii, p. 334, Pl. xix, Fig. 9, as to raise doubts as to their being different species. They are both found in the Coal Measures, in the upper part of which several specimens of *M. carbonarius* were found on Poteau mountain, Indian Territory. This species was also found in the Lower Coal Measures of Conway county, Ark., 5 N., 16. W., section 17, northwest quarter.

Macrodon obsoletus Meek, *Pal. Ohio*, ii, p. 334, Pl. xix, Fig. 2.

This species, which is found in the Coal Measures of West Virginia and Ohio, also occurs in the Upper Coal Measures of Sebastian county, 8 N., 32 W., section 12, and on Poteau mountain, Indian Territory.

Macrodon tenuistriatus Meek and Worthen, *Proc. Chicago Ac. Sc.*, i, p. 17. *Arca striata* Geinitz, *Carb. u. Dyas in Nebraska*, p. 20, Pl. i, Fig. 32. *Macrodon tenuistriatus* M. and W., F. B. Meek, *U. S. Geol. Surv. Nebraska*, p. 207, Pl. x, Fig. 20.

This is a characteristic Upper Coal Measure species, being found in that horizon in Nebraska, Illinois and Iowa; it is quite common in the Upper Coal Measures of Poteau mountain, Indian Territory.

Macrodon sp.

In the Upper Coal Measures of Crawford county, 10 N., 30 W., sec-

tion 10, southeast quarter of northwest quarter, were found specimens of *Macrodon* too poorly preserved to be identified with any species.

Genus NUCULA, Lamarck. *Nucula parva* McChesney, *Proc. Chicago Ac. Sc*, i, p. 39, Pl. ii, Fig. 8. *Nucula parva* McChesney, Meek and Worthen, *Geol. Surv. Illinois*, v, p. 589.

This diminutive *Nucula*, which is found in the Coal Measures of Illinois, was found in the form of casts in ferruginous shale of the Lower Coal Measures of Conway county, 5 N., 16 W., section 17, centre of the north half, and in similar strata of the Upper Coal Measures in Crawford county, 10 N., 30 W., section 10, northwest quarter.

Nucula ventricosa Hall, *Geol. Survey Iowa*, Vol. i, Part ii, p. 716, Pl. 29, Figs. 4 and 5.

This species is common in both Lower and Upper Coal Measures from Pennsylvania to Texas. In Arkansas it was found in the Lower Coal Measures in Conway county, 5 N., 16 W., section 17, northwest quarter, about four miles southeast of Morrillton.

Genus NUCULANA, Link. *Nuculana* aff. *bellistriata* Stevens.

This specimen, found in the form of a mould, showing very distinctly the hinge teeth and the surface markings, resembles in general form *Nuculana bellistriata* Stevens, *Am. Journ. Sc.*, 1858, Vol. xxv, p. 261, but differs from it in having the concentric ribs much coarser and less numerous.

Locality, Scott county, 1 N., 28 W., section 4, southeast quarter of southeast quarter, in the Upper Coal Measures.

Genus SCHIZODUS, King. *Schizodus cuneatus* Meek, Pl. xxii, Fig. 3. *Schizodus cuneatus* Meek, *Pal. Ohio*, Vol. ii, p. 336, Pl. xx, Fig. 7.

An internal cast from the Upper Coal Measures of Crawford county, 10 N., 30 W., section 10, southeast quarter of northwest quarter, agrees in shape with the species described by Meek from the Lower Coal Measures of Ohio. The strongly elevated beak without any backward curve is very characteristic. It being an internal cast, the obscure lines of growth seen on the specimens from Ohio do not show, but the muscle scar is distinct, and indications of the hinge teeth can also be seen. In *Paleontology of Ohio*, Vol, ii, p. 337, Meek mentions a similar *Schizodus* from the Upper Coal Measures of Nebraska, but thinks it is probably a distinct species, on account of the small size, more nearly central beaks and more prominent central and anterior margins. The specimen from Arkansas really agrees better with this description than it does with the undoubted *Schizodus cuneatus*, but the Nebraska specimen was never figured and named. *Schizodus cuneatus* was also found in the Lower Coal Measures of Conway county, 8 N., 17 W., section 33, northeast quarter of northeast quarter.

Schizodus wheeleri Swallow, Pl. xxii, Fig. 4. *Cypricardia* (?) *wheeleri* Swallow, *Trans. St. Louis Acad. Sci.*, Vol. i, p. 96. *Schizodus wheeleri* Swallow, F. B. Meek, *Final Rept. U. S. Geol. Survey Nebraska*, p. 209.

This species is very common in the Coal Measures from Pennsylvania to New Mexico, in both Upper and Lower Coal Measures. It has been figured and described so often that nothing new can be added. Our specimens agree best with those from Iowa, described by F. B. Meek, *Final Report of the U. S. Geological Survey Nebraska*, p. 209, Pl. x, Fig. 1, c.

Occurrence.—Several specimens, both right and left valves, were found in the Lower Coal Measures of Conway county, 8 N., 17 W., section 33, northeast quarter of northeast quarter, at Cook's stone quarry, near Hattieville. This horizon is in the so-called Millstone Grit, and near the middle of the Lower Coal Measures. All the fossils in these strata are preserved in the form of casts.

Schizodus conf. *amplus* Meek and Worthen, *Proc. Ac. Nat. Sci. Phil.*, 1870, p. 41; *Geol. Survey Illinois*, Vol. v, p. 579, Pl. xxvii, Fig. 6.

This large *Schizodus* is found in the Coal Measures of Pennsylvania and Illinois, and an imperfect specimen, probably belonging to the same species, was found in the Lower Coal Measures of White county, 8 N., 7 W., section 33, east half of the southeast quarter, in ferruginous sandstone, on the road from Searcy to Griffin Springs.

Genus ASTARTELLA, Hall. *Astartella newberryi* Meek, *Pal. Ohio*, ii, p. 340, Pl. xix, Fig. 1.

This characteristic species is common in the Upper Coal Measures of Poteau mountain, Indian Territory, and in the Lower Coal Measures of Conway county, Arkansas, 8 N., 17 W., section 33, northeast quarter of northeast quarter.

Astartella vera Hall, *Geol. Survey Iowa*, i, Part ii, p. 715, Pl. xxix, Fig. 1.

This species occurs in the Coal Measures of Iowa, Indiana, Illinois and Pennsylvania, and was found in the upper division of the same series on Poteau mountain, Indian Territory.

Genus PLEUROPHORUS, King. *Pleurophorus oblongus* Meek, *U. S. Geol. Surv. Nebraska*, p. 212, Pl. x, Fig. 4.

This was described by Meek from the Upper Coal Measures of Nebraska, and was found in the Lower Coal Measures of Conway county, 5 N., 16 W., section 17, centre of the north half.

Pleurophorus, sp., C. A. White, *Bull. 77 U. S. Geol. Survey*, p. 27, Pl. iv, Figs. 5–10.

This *Pleurophorus* was described and figured but not named by Dr.

C. A. White (*loc. cit.*), from the Permian of Texas. No analogous form was found in the true Coal Measures of Texas, which is not at all surprising, since their fauna is so little known. In the Upper Carboniferous* beds of Scott county, Arkansas, 1 N., 28 W., section 4, northeast quarter of southeast quarter, was found a single specimen that agrees perfectly with the *Pleurophorus* of Dr. White. It is nothing unusual to find a Permian species in the Carboniferous, but the identification is uncertain, owing to the poor preservation of Dr. White's original and of the Arkansas specimen.

Genus CONOCARDIUM Bronn. *Conocardium aliforme* Sowerby, sp., Pl. xxii, Figs. 1 and 2. *Cardium aliforme* Sowerby, *Min. Conch.*, Vol. vi, p. 100, Table 552, Fig. 2. *Conocardium aliforme* Sowerby, sp., Bronn, *Leth. Geogn.*, i, p. 420, Pl. iii, Fig. 9. *Pleurorhynchus minax* Phillips, *Geol. of Yorkshire*, p. 210, Pl. v, Fig. 27.

This genus is rare in the American Carboniferous, and especially so in the Coal Measures, being represented there by only two other species, *C. obliquum* Meek and Worthen, *Geol. Surv. Illinois*, Vol. vi, p. 529, and *C. parrishi* Worthen, *Geol. Surv. Illinois*, Vol. viii, p. 112. The former is more nearly related to *C. aliforme*, but differs from it in its much smaller size, greater obliquity of the shell, and shorter hinge line. The surface of *C. oliquum* is marked by narrow radiating ribs, while those of *C. aliforme* are wider than the depressions between them.

The intermediate spaces are occupied by a secondary rib only on the rounded anterior side of *C. aliforme*, while the same thing occurs even on the posterior side of *C. obliquum*. *C. aliforme* also has the hinge line longer, and the space between the incurved beaks wider; also the ribs on the anterior cordate space are much finer, and this area is bounded by a rather distinct carina, being slightly concave near the rounded border, and rising toward the anterior rostrum, which is preserved on some of our specimens. The shell has its greatest convexity at the anterior end, where the broad carina cuts off the cordate area. Behind this is a distinct furrow, which shades off into the posterior compression of the shell, and dies out in a gentle curve toward the rounded gaping margin. The ribs are broader and the concentric growth lines more distinct towards the posterior end. The concentric lines are not visible on the cordate area. The posterior portion of the shell, next to the hinge line, is not ribbed, but marked with fine, radial lines.

Goldfuss, in *Petrifacta Germaniæ*, Part ii, p. 203, Pl. cxlii, Fig. 1, describes and figures *Conocardium aliforme*, but according to McCoy† he has confused two species, one of which is a Devonian species from the Eifel. The true *C. aliforme* is that described by Phillips, *Geol. of Yorkshire*, Vol. ii, p. 210, Pl. v, Fig. 2, as *Pleurorhynchus minax*, of the Carboniferous Limestone, and by Goldfuss, Pl. cxlii, Fig. 1, *e*, *f*, *h*, *i*, *l*,

*By the stratigraphy these beds are Barren Coal Measures, but the fossils sh ow close relations to the Upper Coal Measures.

† *British Palæozoic Fossils*, p. 517.

and *m*, the others under Fig. 1 belonging to the Devonian species, which McCoy proposes should retain the name *C. hystericum* Schlotheim. Phillips* proposed to transfer the name *C. aliforme* to the Devonian species, but the type originally described by Sowerby under that name is undoubtedly the Carboniferous species.

This species is found all over Europe, in the Carboniferous, chiefly Mountain Limestone, but owing to the confusion that exists on the Continent one cannot usually tell whether this means Upper or Lower Carboniferous or both.

Nine specimens were found in the Lower Coal Measures of Conway county, 5 N., 16 W., section 17, centre of the north half. They were found in a ferruginous shale, and although in the form of casts they show the sculpture of the surface with unusual clearness, even the delicate, wavy growth lines being as sharply defined as on the original shell. The specimens all had a length of more than one inch, the dimensions of the largest being : length, 1.30 inch ; diameter, 0.88 inch ; width of the cordate area, 0.62 inch.

Genus EDMONDIA de Koninck. *Edmondia nebrascensis* Geinitz, Meek, *U. S. Geol. Survey Nebraska*, p. 214, Pl. x, Fig. 8. *Astarte nebrascensis* Geinitz, *Carbon. und Dyas in Nebraska*, p. 16, Pl. i, Fig. 25.

A few poorly preserved specimens from the Upper Coal Measures of Poteau mountain, Indian Territory, seem to belong to Meek's Nebraska species.

Edmondia unioniformis Phillips, *Geol. Yorkshire*, Vol. ii, p. 209. *Edmondia unioniformis* (?) Meek and Worthen, *Paleont. Illinois*, Vol. ii, p. 346, Pl. xxvii, Fig. 6.

An imperfect cast from the Upper Coal Measures of Illinois was doubtfully referred by Meek and Worthen to the European species. The Arkansas specimens agree fairly well with Meek's figures and much better with his descriptions, except that they have the concentric ribs coarser.

Occurrence.—Numerous casts were found in the Lower Coal Measures, "Millstone Grit," of Conway county, 8 N., 17 W., section 33, northeast quarter of northeast quarter at Cook's stone quarry.

Class *Glossophora.*

Subclass *Scaphopoda.*

Genus DENTALIUM Linnæus. *Dentalium* conf. *meekianum*, Geinitz, *Carbon. u. Dyas in Nebraska*, p. 13.

This species was described from the Permo-Carboniferous of Nebraska, and was also found in the undoubted Upper Coal Measures of Illinois. Imperfect specimens were also found in the Upper Coal Measures of Crawford county, Arkansas, 10 N., 30 W., section 10, southeast quarter of northwest quarter.

* *Pal. Foss. Cornwall, Devon, and West Somerset*, p. 33.

Subclass *Gastropoda.*

Genus BELLEROPHON. *Bellerophon carbonarius* Cox, *Geol. Surv. Kentucky,* Vol. iii, p. 574, Pl. x, Fig. 2. *B. urii* C. R. Keyes, *Proc. Ac. Nat. Sc. Phila.,* July 31, 1888, p. 14.

In the Lower Coal Measures of Conway county, Ark., 5 N., 16 W., section 17, centre of north half, were found specimens of this characteristic Coal Measure species, but poorly preserved. Better ones were found in the Lower Coal Measures of Conway county, 6 N., 16 W., section 29, southwest quarter of southwest quarter.

Bellerophon crassus Meek and Worthen, *Geol. Surv. Illinois,* ii, p. 385, Pl. xxxi, Fig. 16.

This species is found in the Upper and Lower Coal Measures of Indiana, in the Subcarboniferous and the Coal Measures of Pennsylvania, and the Upper Carboniferous limestone of Nevada, etc. Good specimens of it were found in the Lower Coal Measures of Conway county, Ark., 5 N., 16 W., section 17, centre of the north half.

Bellerophon marcouanus Geinitz, *Carbon. u. Dyas in Nebraska,* p. 7.

This species in the Upper Coal Measures of Kansas, Nebraska and Iowa, in the Coal Measures of Illinois and West Virginia, and was found in the Upper Coal Measures of Sebastian county, Ark., in 8 N., 32 W., section 12.

Bellerophon sp.

In the Lower Coal Measures of White county, 8 N., 7 W., section 33, southeast quarter, and section 26, southeast quarter in the massive sandstone, were found several large imperfect specimens of a *Bellerophon* that resembles *B. crassus,* but it is probably a different species; it is too imperfectly known for specific identification and description.

Genus PLEUROTOMARIA, Defrance. *Pleurotomaria modesta* Keyes, *Proc. Ac. Nat. Sc. Phila.,* 1888, p. 238, Pl. xii, Fig. 2. *P. depressa* Cox, *Geol. Surv. Kentucky,* iii, p. 569, Pl. viii, Fig. 10.

A single specimen of this exceedingly delicate and beautiful species, showing all the markings, was found in the Upper Coal Measures of Crawford county, Ark., 10 N., 30 W., section 10, southeast quarter.

Pleurotomaria conf. *speciosa* Meek and Worthen, *Proc. Ac. Nat. Sci. Phila.,* 1860, p. 459; *Geol. Surv. Illinois,* Vol. ii, p. 352, Pl. xxviii, Fig. 5.

One small imperfect specimen from the Upper Coal Measures of Poteau mountain, Indian Territory, shows the characters of the Illinois species, although very much smaller. The well-defined suture and fine ornamentations are similar on both and serve to make their identity probable.

Pleurotomaria tenuicincta Meek and Worthen, *Proc. Ac. Nat. Sci. Phila.*, 1860, p. 459; *Geol. Surv. Illinois*, Vol. ii, p. 355, Pl. xxviii, Fig. 3.

This species was described from the Upper Coal Measures of Illinois, and a similar specimen was found in the same horizon on Poteau mountain, Indian Territory.

Pleurotomaria harii S. A. Miller, *Seventeenth Annual Report State Geologist of Indiana*, p. 693, Pl. xiv, Figs. 3, 4.

This species was recently described from the Upper Coal Measures of Kansas City, Mo., and until now has not been found anywhere else. It is a very striking form and easily recognized. The rather rounded whorls are about five in number and marked with numerous rather coarse revolving ribs, which show traces even on the cast.

A single cast, and mold showing the surface markings, was found in the Lower Coal Measures, so-called "Millstone Grit," of Conway county, 8 N., 17 W., section 33, northeast quarter of northeast quarter, at Cook's quarry, near Hattieville.

Pleurotomaria sp.

In the Lower Coal Measures of Conway county, 5 N., 16 W., section 17, centre of the north half; in Franklin county, 12 N., 28 W., section 27, southeast quarter of northwest quarter; and in Pope county, on Point mountain, 10 N., 20 W., section 8, southeast quarter of northwest quarter, were found numerous specimens of *Pleurotomaria*, that while they seem to belong to several distinct species could not be more accurately identified. They are all preserved as casts and usually badly weathered.

Genus EUOMPHALUS, Sowerby. *Euomphalus* (*Straparollus*) *subquadratus* Meek and Worthen, *Geol. Surv. Illinois*, Vol. v, p. 605, Pl. xxix, Figs. 12, 13.

This very common species was found in the Lower Coal Measures of White county, Ark., in 9 N., 4 W., section 6, and 9 N., 5 W., section 1, in a soft pinkish sandstone, along with *Phillipsia* (*Griffithides*) *scitula* Meek and Worthen.

Euomphalus (*Straparollus*) sp.

In the Lower Coal Measures of Independence county, Ark., 11 N., 5 W., centre of section 9, was found a specimen of *Euomphalus* that seemed to be different from *E. subquadratus* but could not be determined with certainty.

Genus NATICOPSIS, McCoy. *Naticopsis nana* Meek and Worthen. *Platyostoma nana* Meek and Worthen, *Proc. Ac. Nat. Sc. Phila.*, 1860, p. 463. *Natacopsis nana* Meek and Worthen, *Geol. Surv. Ill.*, ii, p. 365, Pl. xxxi, Fig. 4. *Naticopsis nana* Meek and Worthen, C. A. White, *U. S. Expl. W. of 100th Merid*, iv, p. 159, Pl. xii, Fig. 4.

This characteristic Upper Carboniferous species is distributed from

Illinois to Nevada; it was found in the Upper Coal Measures of Sebastian county, Ark., 8 N., 32 W., section 12, associated with numerous other fossils characteristic of the same horizon.

Naticopsis sp.

In the Upper Coal Measures of Scott county, Ark., 1 N., 28 W., section 4, southeast quarter of southeast quarter, was found a specimen of *Naticopsis* that resembles somewhat *N. shumardi* McChesney, found by Dr. White in the Permian of Texas, Bull. 77, *U. S. Geol. Surv.*, p. 24, Pl. iii, Fig. 11, but it is too imperfect to justify a reference to this species.

Genus MACROCHEILUS, Phillips. *Macrocheilus* conf. *fusiformis* Hall, *Geol. Surv. Iowa*, i, Part ii, p. 718, Pl. xxix, Fig. 7.

In the ferruginous shale of the Lower Coal Measures of Conway county, Ark., 5 N., 16 W., section 17, centre of the north half, were found a few specimens that probably belong to Hall's Coal Measure species.

Macrocheilus (*Soleniscus*) *primigenius* Conrad, Hall, *Geol. Surv. Iowa*, Vol. i, Part ii, p. 720, Pl. xxix, Fig. 11.

This species is widely distributed in the Coal Measures of the Mississippi Valley states, and was also found in the Lower Coal Measures, in Conway county, Ark., 5 N., 16 W., section 17, centre of the north half.

Genus POLYPHEMOPSIS, Portlock. *Polyphemopsis inornata* Meek and Worthen, sp. *Loxonema inornata* Meek and Worthen, *Proc. Ac. Nat. Sc. Phila.*, 1860, p. 463. *Polyphemopsis inornata* M. and W., *Geol. Surv. Illinois*, ii, p. 374, Pl. xxxi, Fig. 8.

This species, originally described from the Upper Coal Measures of Illinois, was found in the same horizon in Crawford county, Ark., 10 N., 30 W., section 10, southeast quarter of northwest quarter.

Subclass *Pteropoda*.

Genus CONULARIA, Miller (Sowerby). *Conularia* conf. *crustula* White, *XII Am. Rep. U. S. Geol.* and *Geog. Surv. of Terr.*, 1878, p. 170, Pl. xlii, Fig. 4; *U. S. Expl. W. of 100th Merid.*, iii, Appendix, p. 28, Pl. iii, Fig. 4.

The genus *Conularia* is not common in the Lower Carboniferous, but is exceedingly rare in the Coal Measures, so much so that Dr. White mentions this species as being the only representative in that series. Dr. White found it in the Coal Measures near Kansas City, and also near Taos, N. M. The species has been found in the Coal Measures of Texas, and also in the Coal Measures of Scott county, Ark., 1 N., 28 W., section 4, southeast quarter of southeast quarter.

Class *Cephalopoda.*

Order *Tetrabranchiata.*

Suborder *Nautiloidea.*

Genus ENDOLOBUS, Meek and Worthen. *Endolobus* (*Nautilus*) *missouriensis* Swallow, sp., Pl. xxi, Figs. 1–3. *Nautilus missouriensis* Swallow, *Trans. St. Louis Ac. Sc.*, 1857, p. 198. *Endolobus missouriensis* Swallow, sp., C. A. White, *Indiana Geol. Survey*, 1883, p. 166, Pl. xxxv, Figs. 1, 2.

This species resembles very closely *Endolobus spectabilis* Meek and Worthen, *Geol. Surv. Illinois*, ii, p. 308, Pl. xxv, Fig. 18, and, as Dr. C. A. White* remarks, almost the only reason for regarding them as distinct species is their occurrence in such different horizons as the Chester Limestone of the Subcarboniferous, and the Coal Measures. Also Dr. White's specimen was poorly preserved, and he thought it might possibly have had the nodes originally. It is really impossible to recognize the species by Swallow's imperfect original description, but Dr. White's description is very useful in determining this species, which in the Coal Measures of Arkansas does not have nodes on the sides of the shell; the difference is all the more probable, because in the Fayetteville shale, Lower Carboniferous, of Independence county, near Moorefield, was found an *Endolobus*, with very strongly marked nodes, resembling, if not identical with, *E. spectabilis.*

This species also resembles *Endolobus* (*Solenocheilus*) *indianensis* Worthen, *Geol. Surv. Illinois*, viii, p. 150, Pl. xxviii, Fig. 1, but on the Arkansas specimens the whorls are more embracing, are broader and not so high.

In *E. gibbosus* Hyatt, *Second An. Rept. Geol. Survey, of Texas*, p. 353, the whorls are much more flattened, and the umbilicus is narrower, and the umbilical shoulder subangular, while in *E. missouriensis* the shoulders are round. In both, as in *E. spectabilis*, in adult specimens the outer whorl embraces nearly one-half of the next inner whorl. The septa are like those of *E. spectabilis*, and are far apart, gently sinuous and deeply concave. The internal lobe is deep and funnel-shaped. The siphon is slightly nearer the internal than the external side, and is slender.

The casts are smooth, but some specimens have the shell partly preserved. It is ornamented with fine, sharp, spiral lines crossed by finer lines of growth, about one-half as far apart as the spiral lines, giving a finely reticulated appearance to the shell; these transverse lines bend sharply backward on the outside of the whorl.

In our collections are septate fragments of specimens that must have been at least four inches in diameter, and the body chamber would have added about one-half of another revolution, so this species attained a diameter of not less than six inches.

* *Geol. Surv. Indiana*, 1883, p. 166.

The best preserved specimens are small, being only the inner whorls of large individuals, since the body chamber is not seen on any of them.

Dimensions of a small specimen, figured on Pl. xxi, Fig. 2:

Dimensions.	MM.
Diameter	28
Height of the last whorl from umbilicus	19
Height of the last coil from the top of the inner whorl	11

Position and Locality.—Several specimens of this species were found in the Lower Coal Measures of Conway county, Ark., 5 N., 16 W., section 17, centre of the north half.

Genus EPHIPPIOCERAS, Hyatt. *Ephippioceras ferratum* Cox. *Nautilus ferratus* Cox, *Geol. Surv. Kentucky*, iii, Fig. 574, Pl. x, Fig. 2. *Ephippioceras ferratum* Cox, A. Hyatt, *Proc. Boston Soc. Nat. Hist.*, 1883, p. 290.

A single large specimen that probably belongs to this species was found in the Lower Coal Measures of Conway county, Ark., 5 N., 16 W., section 17, centre of the north half. Owen, in his *Report on a Geol Recon. Arkansas*, Vol. i, p. 68, cites *Nautilus ferratus* from a bold point three (?) miles northwest of Searcy, White county. The rocks of that region are now known to belong to the Lower Coal Measures.

Nautilus sp.

In the Upper Coal Measures of Crawford county, Ark., 10 N., 30 W., section 10, southeast quarter of northeast quarter, were found fragments of a *Nautilus* too imperfect even for reference to any of the genera into which the old genus *Nautilus* has been split up.

Genus ORTHOCERAS, Breynius. *Orthoceras cribrosum* Geinitz, *Carbon. u. Dyas in Nebraska*, p. 4. *Orthoceras cribrosum* Geinitz, Meek, *U. S. Geol. Surv. Nebraska*, p. 234, Pl. xi, Fig. 18.

In the Upper Coal Measures of Poteau mountain, Indian Territory, were found specimens of *Orthoceras*, showing the peculiar indentations of surface supposed to be characteristic of this species. The markings seem to be due to the growth of a bryozoön on the shell, for when magnified they show six-sided cells. Meek, *op. cit.*, p. 234, stated his belief that this marking is accidental.

Orthoceras conf. *rushense* McChesney, *New Pal. Foss.*, p. 68. *Orthoceras rushense*, C. A. White, *Bull.* 77, *U. S. Geol. Survey*, p. 22, Pl. ii, Figs. 14–16.

This species was described originally from the Coal Measures of Indiana and Illinois, and Dr. C. A. White found it in the Permian of

Texas. Some imperfect specimens that probably belong here were found in the Upper Coal Measures of Scott county, Ark., 1 N., 28 W., section 4, southeast quarter of southeast quarter.

Orthoceras sp.

A long slender form with very close chamber walls could not be identified with any species known from the Carboniferous, but the specimens found were not perfect enough for specific description.

Locality.—This species was found in the Lower Coal Measures of Conway county, 8 N., 17 W., section 33, northeast quarter of northeast quarter, at Cook's quarry, near Hattieville.

Suborder *Ammonoidea.*

The *Cephalopoda* alone, of all animals, preserve in the individual a complete record of their larval and embryonic history, the protoconch and early chambers being enveloped and protected by the later stages of the shell. And by breaking off the outer chambers the naturalist can in effect cause the shell to repeat its life history in inverse order, for each stage of growth represents some extinct ancestral genus. These genera appeared on the scene in the exact order of their minute imitations in the larval history of their descendants, and by a study of adult forms in the order of their appearance the naturalist finds the key to the stages of growth of later forms, and is thus enabled to arrange species and genera in genetic series. Studied in this way, paleontology becomes a biologic science.

It has long been known that the goniatites were the ancestors of the ammonites, and the researches of Branco, Hyatt and Karpinsky have traced out these lines of descent in many cases, by studying the successive genera of adult shells in comparison with stages of growth in the individual. Each ammonite is known to begin its life as a goniatite, and only by gradually increasing complication to reach the ammonitic stage. This advance took place in some stocks much earlier than in others, since some show ammonitic characteristics even in the Carboniferous, while others persist in their goniatitic characteristics even in the Trias. In the great majority of cases, however, the transition was made near the end of Paleozoic time, that is, somewhere during the Carboniferous or Permian.

Classification of Goniatites.—The goniatites have been divided into two great stocks or families, *Goniatitidæ* and *Prolecanitidæ*, both of which persist from the Devonian to the Permian. This classification, while the best at present possible, is by no means satisfactory, for it is certain that some of the forms ascribed to the *Prolecanitidæ* descended from genera classified as *Goniatitidæ*.

The *Goniatitidæ* of the Carboniferous consist of the genera *Branco-*

ceras, Glyphioceras, Gastrioceras, Paralegoceras, Nomismoceras, Pericyclus, Dimorphoceras, with numerous subgenera. They comprise many rough-shelled species, and on this account they are thought by Steinmann* to have given rise to the trachyostracan *Ceratitidæ* and *Tropitidæ* of the Trias. In this opinion also concurs Dr. K. A. von Zittel,† as far as the *Tropitidæ* are concerned, for these, he thinks, have been developed out of *Gastrioceras* and *Pericyclus.*

The *Prolecanitidæ* of the Carboniferous comprise the genera *Prolecanites, Pronorites, Agathiceras;* all of which live on into the Permian and branch out during that period into a number of genera and subgenera. Some of these genera live on into the Trias, and branch out during that period into numerous families, whose Jurassic and Cretaceous descendants made up the bulk of the cephalopod faunas.

Besides the *Goniatitidæ* and the *Prolecanitidæ* of the Carboniferous, the *Ammonoidea* are represented already in the Coal Measures of America by the families *Arcestidæ,* in *Popanoceras parkeri*‡ Heilprin, of the Strawn division, Lower Coal Measures of Texas.

In the European Coal Measures the *Tropitidæ* are represented by *Thalassoceras looneyi* Phillips. *Thalassoceras* was described by Gemmellaro§ to include certain species of the Carboniferous and Permian, and referred to the *Tropitidæ;* this genus, along with *Paraceltites* Gemmellaro, *Gastrioceras,* and some Permian forms referred to *Glyphioceras,* are said by Mojsisovics‖ to be the Paleozoic representatives of the *Tropitidæ.*

Family *Goniatitidæ* von Buch (Zittel).
Subfamily *Glyphioceratidæ* Hyatt.

This group includes a series of forms that range from the Upper Devonian into the Permian. The older members have the siphonal lobe undivided, thus showing their relationship to the older *Prolecanitidæ.* The form may be compressed and discoidal as in *Brancoceras* of the Devonian and Carboniferous; or broadly rounded and involute, with semilunular cross-section, as in most species of *Glyphioceras;* or evolute, with wide umbilicus, trapezoidal cross-section, and umbilical ribs, as in most species of *Gastrioceras.* The sutures are simple, consisting of a siphonal lobe, which may or may not be divided by a secondary siphonal saddle, and one or two pairs of lateral lobes, which are somewhat pointed, also usually a pair of short lobes on the umbilical shoulders. The internal lobes consist of a long and rather pointed antisi-

* *Elemente der Palæontologie,* 1890, p. 393.

† *Grundzüge der Palæontologie,* 1895, p. 405.

‡ The writer, in *Journ. Geol.,* Vol. ii, No. 2, p. 194, following Karpinskŷ in *Ammoneen d. Artinsk-Stufe,* p. 92, referred the *Popanoceras parkeri* beds to the Artinsk stage, but Prof. W. F. Cummins, of the Geological Survey of Texas, has pointed out to the writer the true horizon of this species.

§ *Giornale Sci. Nat. Econom.,* Vol. xix, 1888, p. 67.

‖ *Das Gebirge um Hallstadt,* Bd. ii, p. 10

phonal lobe, and a pair of pointed lateral lobes. The saddles, both external and internal are usually rounded, although even they may become angular, as in old specimens of *Glyphioceras sphæricum* Martin. The surface in most of the older members of the group is ornamented only with striæ, but in many, especially the later members, umbilical ribs are developed, which in *Pericyclus* cross the abdomen. Periodic constrictions, or varices, representing temporary cessations of growth, are found on most of the genera.

Hyatt * says that the *Glyphioceratidæ* are derived directly from the group *Magnosellaridæ*, as represented by *Parodiceras* of the Devonian. And, in fact, the development of *Glyphoceras diadema* Goldfuss, as worked out by Branco,† shows at 2.25 millimetres diameter a decided resemblance to the adult sutures of *Tornoceras*. The younger larval sutures of this form show derivation from a radicle like *Anarcestes*. Pl. xix, Fig. 5, shows the development of *Tornoceras* (*Parodiceras*) *retrorsum* Buch, after Branco, in *Palæontographica*, Vol. xxvii, Pl. v, Fig. 7. We thus have probably the complete genealogy of the *Glyphioceratidæ* in the larval stages of the two genera, *Glyphioceras* and *Tornoceras*. Pl. xix, Fig. 4, shows the development of *Glyphioceras diadema* Goldfuss, after Branco, in *Palæontographica*, Vol. xxvii, Pl. iv, Fig. 1.

Genus GASTRIOCERAS, Hyatt.

This genus was originally established by Hyatt (*Proc. Boston Soc. Nat. Hist.*, Vol. xxii, 1883, p. 327) to include evolute species with open umbilicus, trapezoidal or semilunular cross-section, and usually ribs or tubercles on the sides; the species included by Hyatt in this genus all have prominent siphonal saddles, first lateral saddle broadly rounded, second lateral saddle broad but inclined to be pointed; the siphonal lobes are long, narrow and pointed, and the lateral lobes broad and pointed. In all the species cited by Hyatt (*loc. cit.*) as belonging to *Gastrioceras* there is but a single pair of lateral lobes visible, that is, on the sides of the shell; and in the *Second Annual Report Geol. Survey of Texas*, 1891, p. 355, Hyatt limits *Gastrioceras* to forms with a single pair of lateral lobes and with the second pair on the umbilical shoulders. Hyatt (*loc. cit.*) refers *G. russiense* Zwetajew to his genus *Paralegoceras*, because that species has the second pair of lateral lobes on the sides of the shell and not on the umbilical shoulders. But *Gastrioceras russiense* has just the same number of lobes as all other known species of *Gastrioceras*, namely nine in all, and lacks the lobe on the umbilical border, which is characteristic of *Paralegoceras*. Another species, *Gastrioceras baylorense* White (Bull. 77, *U. S. Geol. Survey*, p. 19, Pl. ii, Figs. 1–3), also has two pairs of lateral lobes. White's figures and description do not show whether the umbilical lobe is present or not; if it is, *G. baylorense* rightfully belongs with *Paralegoceras*, but it most probably belongs in

* *Proc. Boston Soc. Nat. Hist.*, Vol. xxii, 1883, p. 322.
† *Palæontographica*, Vol. xxvii, Pl. iv, Fig. 1.

the same group as *G. russiense*. Dr. K. von Zittel, in *Grudzüge der Palæontologie*, 1895, p. 399, confines *Gastrioceras* to forms with a single pair of lateral lobes. But the relations of *Gastrioceras*, *Glyphioceras* and *Paralegoceras* have been best worked out by Karpinsky,* who shows that there is no marked distinction between *Glyphioceras* and *Gastrioceras;* that both have the same number of lobes and saddles—nine of each; that the second pair of lateral lobes may be on the umbilical shoulders or on the sides of the shell, thus differing from *Paralegoceras*, in which the third pair of lateral lobes is on the umbilical shoulders. *Gastrioceras* usually has a trapezoidal cross-section and umbilical ribs; but some species lack the ribs, as *G. globulosum* M. and W., while some species of *Glyphioceras* have umbilical ribs and, in their youth, also the elliptical cross-section, as *Glyphioceras diadema* Goldfuss. But the two extremes are widely separated from each other, as *Gastrioceras jossæ* Verneul and *Glyphioceras sphæricum* Martin.

This genus has been looked upon by Steinmann† as the ancestor of the trachyostracan families of the Trias, the *Ceratitidæ* and the *Tropitidæ*. Dr. K. von Zittel ‡ agrees with this opinion as to the origin of the *Tropitidæ*, but thinks the *Ceratitidæ* developed out of the *Prolecanitidæ*.

Gastrioceras branneri sp. nov. J. P. Smith, Pl. xxiii, Figs. 1–6.

The adult shell is discoidal, with low, narrow whorls of semilunular cross-section; the adult whorl is very evolute, embracing not more than a third of the preceding one, and the increase in height and breadth is extremely slow. The young whorls are proportionally broader and more involute, so that the umbilicus of the younger part of the shell is deeper, but widens rapidly with age, as the involution decreases. *G. branneri* is the most evolute species of *Gastrioceras* known in the Carboniferous, and approaches the narrow evolute Permian type, described by Gemmelaro§ from Sicily; but the Sicilian form still retains the strong constrictions, and has also acquired the spiral striæ that are characteristic of Permian *Gastrioceras*.

Dimensions.	MM.
Diameter	39.5
Height of last whorl	10.5
Width of umbilicus	19.0
Breadth	15.0
Height of last whorl from top of preceding	8.0

The specimen shows nine whorls at the diameter of 39.5 mm.

Sutures.—The sutures consist of three external lobes and as many

* *Mém. Acad. Impér. Sci.*, St. Petersburg, vii Ser., Tome xxxvii, No. 2, "Ammoneen d. Artinsk-Stufe," pp. 45–48.

† *Elemente d. Palæontologie*, 1890, p. 393.

‡ *Grundzüge d. Palæontologie*, 1895, p. 405.

§ *Giorn. Sci. Nat. ed. Econ.*, Vol. xx, 1890, p. 31, Pl. D, Figs. 24–26, *Gastrioceras waageni* Gemm.

saddles. The siphonal lobes are long, narrow, and pointed; the first lateral broadly pointed, and on the umbilical shoulder is another shallow lobe, broad and pointed. The siphonal saddle is narrow, with the usual indentation at the end; the first lateral saddle is broadly rounded and deep, the second lateral saddle shallow and inclined to be pointed. The inner lobes are three in number, a long, narrow, pointed antisiphonal lobe, and a pair of shorter, pointed lateral lobes; the four internal saddles are rounded. The figures on Pl. xxiii, Fig. 5, *a* and *b*, show the sutures to be characteristic of *Gastrioceras;* but the second lateral lobe, while on the umbilical shoulders, is plainly visible from the outside. Thus the species might be referred to the genus *Paralegoceras* of Hyatt; but it has only nine lobes and nine saddles, while *Paralegoceras* has eleven of each. For a discussion of this see p. 256 under description of the genus *Gastrioceras.*

Surface Characters.—The shell is preserved on only a small portion of the specimen, but the cast shows the generic and specific characters quite as well. Obscure and somewhat doubtful constrictions were observed, but the preservation is such that their interval could not be ascertained. The umbilical shoulders are marked with rather weak nodes or ribs, which on the outer whorls reach up nearly to the abdominal shoulders; on the young shell they are relatively much stronger.

Affinities.—*Gastrioceras branneri* belongs to the group of *G. listeri* Martin, *G. jossæ* Verneul, and *G. marianum,* all characterized by trapezoidal cross-section, umbilical ribs, pointed lobes and rounded saddles, and evolute whorls. From the above-mentioned species *G. branneri* differs in the narrowness of its whorls, and wide, shallow umbilicus; it seems to depart further from the *Glyphioceras* stock than any other Carboniferous species of the genus *Gastrioceras.*

Occurrence.—*Gastrioceras branneri* was found along with *Pronorites cyclolobus* Phillips, var. *arkansiensis* J. P. Smith, in Arkansas, on Pilot mountain, Carroll county, three and a half miles southwest of Valley Springs, in 17 N., 19 W., section 18, northeast corner, in the Lower Coal Measures, so-called "Millstone-Grit" (A10 of Prof. H. S. Williams' section). About fifty-five feet below this horizon lie coarse, reddish brown, fossiliferous limestone supposed to be the Chester beds of the Lower Carboniferous.

The type, for the use of which the writer is indebted to Prof. H. S. Williams, is the property of the U. S. Geological Survey (National Museum), catalogue number Sta. 1275.

Gastrioceras globulosum Meek and Worthen. Pl. xviii, Figs. 1–6. *Goniatites globulosus* Meek and Worthen, *Proc. Acad. Nat. Sci. Phila.,* 1860, p. 47. *Goniatites globulosus* Meek, *Geol. Surv. Illinois,* ii, p. 390, Pl. xxx, Fig. 2. *Gastrioceras globulosum* M. and W., sp., A. Hyatt, *Proc. Boston Soc. Nat. Hist.,* 1883, p. 327.

This species resembles *Goniatites* (*Gastrioceras*) *baylorensis* White, of

the Texas Permian, but the lobes of the latter are alone sufficient to separate the species, exceeding by one the number on the sides of *G. globulosum*. The Texas species also has the umbilicus much wider and more open, and is not so globose.

The angle of the umbilicus is 45°, which remains constant notwithstanding the fact that the shell grows more involute with age, being in its youth a comparatively open coil. In youth the whorls are flattened, but with age they become more rounded, until the shell reaches almost the form of *Glyphioceras sphæricum* Martin. As many as six whorls are known.

The deeply marked constrictions, that are so common in the family of the *Glyphioceratidæ*, are seen on the casts, about four to a whorl.

Sutures.—The sutures show nine lobes and nine saddles; the siphonal lobes are narrow and pointed, the first lateral lobe is broad, but pointed, and on the umbilical shoulder is a small, pointed "suspensive" lobe. There are three pointed, internal (concealed by the involution) lobes, of which the antisiphonal (dorsal) is the longer.

The siphonal saddle is rather deeply notched, long and narrow; the two lateral saddles are broad and rounded. The two internal saddles are rather pointed and long, as is the case with most species of this genus. The internal lobes and saddles have never been seen before in this species.

The septa are exactly like those figured by Meek and Worthen, so that no further description of them is necessary; they are typical of the genus *Gastrioceras*, as characterized by Hyatt, although, as Karpinsky* remarks, the sutures alone are not sufficient to separate the genera *Glyphioceras*, and *Gastrioceras*, since a comparison of the sutures of *Gastrioceras jossæ* Verneul and *Glyphioceras diadema* Verneul (not Goldfuss) shows the almost perfect similarity of the two.

The surface of the shell was unknown to Meek and Worthen, but some of the Arkansas specimens have the shell partially preserved. It is marked with fine, sharp, doubly arcuate, sickle-shaped striæ or ribs, with the sinus on the ventral portion pointing backwards. This surface ornamentation resembles that of *Glyphioceras obtusum* Phillips, *Geol. of Yorkshire*, ii, p. 235, Pl. xix, Figs. 10–13, but the form is much more globose, and the lobes unlike those of Phillips' species.

Dimensions.—One of the fragments shows a diameter of over two inches; on this only the body whorl was seen, it being at least one coil in length.

Dimensions of the Largest Figured Specimen.

	MM.
Diameter	36
Breadth	27
Height of last whorl	14

*"Ueber die Ammoneen der Artinsk-Stufe," *Mém. Ac. Imper. Sci. St. Petersburg*, vi Series, Tome xxxvii, No. 2, p. 46.

	MM.
Height of last whorl from centre of umbilicus	19
Height of last whorl from top of the inner one	8
Width of umbilicus	9

These measurements show the adult shell to be very globose.

Position and Locality.—Several specimens of this very interesting species were found in the Upper Carboniferous of Scott county, Arkansas, 1 N., 28 W., section 4, southeast quarter of southeast quarter, in beds supposed to belong to the Barren Coal Measures; but from this and associated fossils seem more likely to belong to the Upper Coal Measures. This species is also found in the Cisco division of the Texas Upper Coal Measures.

Gastrioceras excelsum Meek, Pl. xvii, Fig. 1. *Goniatites globulosus* var. *excelsus* Meek, Bull. *U. S. Geol. and Geog. Survey Terr.*, No. 6, second series, p. 445. *Goniatites globulosus* Meek and Worthen (pars), *Geol. Surv. Illinois*, Vol. ii, p. 390, Fig. 38.

This species was originally described from the Upper Coal Measures of eastern Kansas, from Osage, associated with *Spirifer cameratus* Morton, and *Athyris subtilita* Hall, and other species characteristic of that horizon.

It resembles closely in everything but size *Gastrioceras globulosum* Meek and Worthen of the Upper Coal Measures of Illinois, and we know too few specimens of the latter species to say that it did not grow to the immense size of the Kansas species.

In the Lower Coal Measures of Pope county, Arkansas, 10 N., 20 W., section 8, southeast quarter of northwest quarter, was found a large septate fragment of a specimen that must have been five or six inches in diameter, since the body chamber is at least one coil in length on all nearly related species. The ventral (external) portion of the shell is higher and not so rounded as in *G. globulosum*, but as has already been noticed on that species the coil becomes with age rounder and more elevated, and this may be only an advanced stage of growth not seen on any of the smaller specimens. The lobes are almost exactly like those of the small *Gastrioceras globulosum* of Meek and Worthen.

Gastrioceras marianum Verneul, Pl. xvi, Figs. 1–5. *Goniatites marianus* Verneul, *Geol. of Russia*, ii, p. 369, Pl. xxvii, Fig. 2. *Goniatites jossæ* Verneul (pars), Eichwald, *Leth. Ross.*, i, p. 1324. *Goniatites listeri* Martin (pars), var. *mariæ*, Gurow, *Abhandl. d naturf. Gesell. Charcow*, 1873, p. 87. *Gastrioceras marianum* Verneul; Karpinsky, *Ammoneen der Artinsk-Stufe*, p. 49.

This is easily distinguished from all other American species by its low, broad whorl, wide and deep umbilicus, and the strong ribs on the umbilical shoulders. These together with its sutures make it a most typical

representative of the genus *Gastrioceras*. But there are species of *Gastrioceras* that are globose and not flattened, and without the umbilical ribs or nodes ; also certain species have their sutures very angular. On the other hand certain species of *Glyphioceras* have weak umbilical nodes and rounded sutures.

This species is so closely related to *Gastrioceras listeri* Martin, sp., *Petrif. Derb.*, Pl. xxxv, Fig. 3, that they have been united by Gurow. Others still are inclined to unite it with *Glyphioceras diadema* Goldfuss, while many would join it with *Gastrioceras jossæ* Verneul.

From *G. jossæ* it differs in the almost total absence of spiral ribs or striæ, and in the wider and more angular umbilicus, but they are so similar that *G. marianum* may be considered the ancestor of *G. jossæ*.

The best mark of separation from *G. listeri* is the greater number of coils which *G. marianum* has, as many as seven being known on a specimen of less than one inch in diameter.

G. kingii Hall and Whitfield, *U. S. Expl. Fortieth Parallel*, iv, p. 279, Pl. vi, Fig. 9–14, is a closely related form, but differs in having the umbilical slope a little more gentle, the angle with the axis of the shell being 40–45°, while that of *G. marianum* is about 37°. *G. kingii* has fewer whorls to the same diameter. *G. marianum* also has the external saddle not so deeply divided, and the two siphonal lobes are wider and become somewhat broadened at the ends. The ribs on the sides of *G. marianum* are much stronger. Weak spiral striæ are seen on the inner whorls.

The transverse lines of growth form incipient undulations on the ventral portion of the shell. Strong constrictions occur both on the cast and on the shell, on the body chamber, as well as on the rest of the chambers, becoming weaker with age ; their number is about three to a whorl, and they curve forward, with a gentle sinus pointing backward.

The ribs are strong on the sides, forming sharp nodes or tubercles, and are continued across the ventral portion by fine undulations. Towards the centre or umbilicus the ribs weaken very suddenly. The sutures are like those figured by Verneul, but show also the small "suspensive" lobe on the umbilical border, as described and figured by Karpinsky.

The body chamber is at least one coil in length.

Dimensions.—Some fragments indicate a size of not less than two and a half inches in diameter. The most perfect specimen has the following dimensions :

	MM.
Height of last whorl	9
Diameter	30
Width of umbilicus	14

The breadth of the last whorl is about two-thirds of the diameter of

the shell. Angle of umbilicus with the axis of the shell about 37°. These measurements agree very well with those given by Karpinsky.

The smallest of the Arkansas specimens gave the following dimensions:

	MM.
Diameter	8.5
Height of last whorl	2.5
Width of umbilicus	4.5
Breadth of last whorl	6.0

These measurements agree closely with the measurements Karpinsky gives of small specimens from the Urals. The proportions would be

Diameter	1.00
Height of last whorl	0.29
Width of umbilicus	0.53
Breadth of last whorl	0.70

These proportions agree very well with those given by de Verneul, *Geol. Russie d'Europe et des Mont. de l' Oural*, Vol. ii, p. 369.

Occurrence.—This species was originally described by Verneul from the Upper Carboniferous limestone of Schartymka in eastern Russia, C2, and does not occur in the Artinsk or Lower Permian deposits, although it has been confused by many authors with *Gastrioceras jossæ*, which is characteristic of those strata. Karpinsky, in his monograph on the *Ammoneen der Artinsk-Stufe*, pp. 50 and 51, describes the differences that separate *G. marianum* from *G. jossæ* and *G. listeri;* the most striking of these distinctions is that on *G. marianum* the constrictions have a weak sinus pointing backward, while on the others it is forward.

We have therefore at least some evidence of an Upper Carboniferous sea, stretching from the Ural mountains eastward to the Mississippi valley. This would help to explain the fact that our marine Carboniferous fauna has more analogy to the Asiatic than to the western European fauna of the same age.

G. marianum was found in the Upper Coal Measures in Scott county, Ark., 1 N., 28 W., section 4, southeast quarter of southeast quarter. This, or a very closely related species, occurs also in the Cisco division of the Upper Coal Measures of Texas.

Gastrioceras, sp. indet. Pl. xx, Fig. 1.

In the young stages this species resembles closely *G. marianum* Verneul, but the umbilicus is narrower. The young whorl has also a trapezoidal cross-section, each succeeding whorl becoming more highly arched, until all resemblance to the Ural species is lost in the adult stage.

The coil, too, shows decidedly the phenomenon called by Mojsisovics

"egression," by which is meant a change in the direction of the spiral accompanied by widening of the umbilicus, so that with age it flares open. Even with the wide umbilicus of the adult stage, this species is easily distinguished from *G. marianum* by its narrower and more highly arched whorls.

The sides of the whorl are ornamented with strong tubercles, which on the young stages are like those of *G. marianum*, but on the adult form ribs reach halfway from the umbilical shoulders to the ventral portion of the shell.

Constrictions are seen on the cast, about three or four to a revolution. The surface of the shell is not known. The sutures are like those of *G. marianum*, but the siphonal or external lobes are somewhat broader, and the lateral lobes are longer, narrower and more pointed.

The lateral saddle is broad, rounded and considerably shorter than the lateral lobes. There is also a small auxiliary or "suspensive" lobe on the umbilical shoulders, like that of *G. marianum*. The sutures resemble still more closely those of *Glyphioceras diadema* Goldfuss as figured and described by DeKoninck in *Description des Animaux Fossiles Terr. Carbonif. Belgique*, p. 574, Pl. 1, Fig. 1, e. But the Belgian species is considerably more involute, has a lower whorl, and proportionally narrower umbilicus. Also the umbilical ribs are much weaker than on the Arkansas species.

Verneul, in *Géol. Russie d'Europe et des Mont. Oural*, Vol. ii, p. 367, has described a goniatite as *G. diadema*, but this form is less like the Arkansas species than the Belgian form. In addition to this, there is no likelihood that all the forms referred to *G. diadema* are really one species. It is quite possible that the Arkansas species may be identical with one of the many varieties ascribed to *G. diadema*, but at present it is impossible to prove this.

Occurrence.—Several badly broken casts and moulds were found in the Upper Coal Measures of Scott county, Arkansas, 1 N., 28 W., section 4, southeast quarter of southeast quarter, associated with *Gastrioceras marianum* Verneul, *G. globulosum* Meek and Worthen, *Pronorites* sp., etc.

Genus PARALEGOCERAS, Hyatt. *Paralegoceras iowense* Meek and Worthen, Pl. xix, Figs. 1–3. *Goniatites iowensis* Meek and Worthen; *Geol. Surv. of Illinois*, Vol. ii, p. 392, Pl. xxx, Fig. 3. *Paralegoceras iowense* M. and W., Hyatt, *Proc. Boston Soc. Nat. Hist.*, Vol. xxii, 1883, p. 327. *Paralegoceras iowense* M. and W., Hyatt, *Geol. Survey of Texas, Fourth Ann. Report*, 1893, p. 474, Figs. 52–55. *Goniatites missouriensis* Miller and Faber, *Journ. Cincin. Soc. Nat. Hist.*, Vol. xiv, p. 164, Pl. vi, Fig. 1.

The genus *Paralegoceras* is extremely rare, being known heretofore only from the Coal Measures of Iowa, the Upper Carboniferous and Artinsk beds of Russia, and the Bend Formation of Texas, and in the Upper Coal Measures near Kansas City, Missouri.

The Arkansas specimen is a septate cast that when complete must have been at least four inches in diameter. The whorl is broader and rounder than on the Iowa specimen, but this is to be expected on a young individual since the evolution of most of these forms takes place after this manner. The whorls are quite involute and the umbilicus is narrow on the young shell, becoming wider as the shell grows older. The surface of the cast is smooth, no constrictions or other ornamentations appearing on the older shell. But on the younger shell the umbilical shoulders show faint ribs, that shade off into fine undulations on the sides. Hyatt has shown the same thing in *Geol. Survey Texas, Second Ann. Report,* p. 355. But in Texas specimen the ribs persist to a much later stage than on that from Arkansas.

Dimensions.—Although the specimen was not well preserved, the measurements of the entire form could be taken. They were as follows:

	MM.
Diameter	55.5
Height of last whorl from umbilicus	25.5
Height of last whorl from top of inner whorl	17.0
Width of umbilicus	13.5

An inner coil taken out of the same specimen gave the following measurements:

	MM.
Diameter	28.5
Height of last whorl from umbilicus	12.0
Height of last whorl from top of inner whorl	7.5
Width of umbilicus	6.0

These show the inner coils to be much lower, less highly arched, and less embracing than the outer ones.

Surface Markings.—On the inner whorls a trace of the shell is preserved, and is like that figured by Hyatt. The undulating striæ are like those common on the *Glyphioceratidæ.*

Sutures.—The sutures are like those figured by Meek and Worthen, but the siphonal saddle is notched by a small siphonal lobe. The three external lateral saddles are broadly rounded, while the lobes are sharply pointed. The lobes are eleven in number, three on each side, one on each umbilical shoulder (suspensive lobe) and three internal, that is, covered by the involution. The interior lateral lobes and the antisiphonal lobe (dorsal) are very sharp and long. These have not been seen before on this species. The sutures approach very closely to those of *Gastrioceras russiense* Zwetajew, but *Paralegoceras iowense* has one more pair of lobes than the Russian species and has also a suspensive lobe on the umbilical shoulders. In the latter characteristic *Paralegoceras iowense* resembles *P. tschernyschewi* Karpinsky (*Ammoneen der Artinsk-Stufe,* p. 62, Pl. iii, Fig. 1). Karpinsky (*loc. cit.*), has emended Hyatt's

genus to embrace those forms with two lateral lobes and a "suspensive" lobe on the umbilical shoulders. Hyatt, in the *Geological Survey of Texas, Second Annual Report*, 1891, p. 355, emended the genus *Paralegoceras* to include those forms with the second lateral lobe on the umbilical shoulders, and he included in it *Gastrioceras russiense* Zwetajew. But the Russian species has the suspensive lobe on the side and has only nine lobes in all, and thus ought to remain in the group characterized as *Gastrioceras*.

In the *Fourth Annual Report of the Geological Survey of Texas*, 1893, p. 474, Hyatt has described under the name of *Paralegoceras iowense* Meek and Worthen, a goniatite from the Bend Formation of Texas. But the lobes are not exactly like those of the Iowa Coal Measures species, the third lateral saddle is on the umbilical shoulders, and the young shell is marked with ribs which form well-defined tubercles, even on the older shell. These differences were explained by the supposition that the Texas specimen was the young of *Paralegoceras iowense*, and might thus naturally show them. But since the Arkansas specimen is a young one and still shows all the characteristics of the adult, it becomes very likely that the Texas specimen belongs to another species.

There is also another reason why this is probable. The Bend Formation is called Coal Measures by the Geological Survey of Texas, but its fauna seems to be identical with that of the Fayetteville shale of Arkansas, which belongs to the Lower Carboniferous, and probably to the Warsaw or St. Louis division. Species that are almost certainly identical with *Glyphioceras incisum* Hyatt and *G. cumminsi* Hyatt have been collected in the Fayetteville shale of Arkansas. And since these goniatites have unusually only a limited stratigraphic range, it is very probable that the species from the Bend Formation is not identical with that from the Coal Measures.

Occurrence.—A single specimen of *Paralegoceras iowense* was found in Arkansas, in the Lower Coal Measures of Conway county, 5 N., 16 W., section 17, near centre of north half. The species was originally described from the Coal Measures of Iowa and since then has not been cited from any other locality up to the present occurrence, unless the Texas species of Hyatt should be the same. There can, however, be very little doubt that *Goniatites missouriensis* Miller and Faber (*Journ. Cincinnati Soc. Nat. Hist.*, Vol. xiv, p. 164, Pl. vi, Fig. 1), from the Upper Coal Measures of Missouri, near Kansas City, is identical with *Paralegoceras iowense* Meek and Worthen.

Family *Prolecanitidæ* Hyatt.

The *Prolecanitidæ*, as originally described by Hyatt,* included certain elements that do not belong to this stock; but, as revised by Karpinsky,† it forms the most perfect genetic series known, radiating from

* *Proc. Boston Soc. Nat. Hist.*, Vol. xxii, p. 331.

† *Ammoneen der Artinsk-Stufe*, pp. 41-45.

the common radicle, *Ibergiceras*, in several parallel series or subfamilies, including the *Medlicottinæ*, the *Noritinæ*, and the *Lecanitinæ* of the Permian and Trias, the *Pinacoceratidæ* of the Trias, and the *Amaltheidæ* of the Trias, Jura and Cretaceous.

Dr. K. von Zittel* says that this family probably also gave rise to the *Ceratitidæ* of the Permian and Trias.

Genus PRONORITES, Mojsisovics.

In the adult stage *Pronorites* is discoidal, has high, narrow whorl, with nearly parallel sides, is very involute, and has narrow umbilicus.

The siphonal lobe is three-pointed, the first lateral lobe divided into two or three parts by secondary sinuses. In addition to these there are several auxiliary lateral lobes, three to six, all slightly pointed, while all the saddles are rounded. No constrictions or other surface ornamentations are known, except that on the adult body-chamber faint ribs have been observed.

The first septum of *Pronorites* is latisellate, and the broad sinus is soon divided by a siphonal lobe into two lateral sinuses (Pl. xxiii, Fig. 7). This is the end of the embryonic stage, in which the shell is seen to belong to an ammonoid cephalopod, but the family is not yet indicated.

In the next stage the lateral sinuses are subdivided by broad, rounded lobes; the sutures then resemble those of *Goniatites* (*Ibergiceras*) *tetragonus* Roemer of the Upper Devonian, and the shell is in the beginning of the larval or nepionic stage (Pl. xxiv, Fig. 9*a*); a little further on the sutures are like those of a *Prolecanites* (*P. serpentinus* Phillips), and the larval stage is approaching its end.

In the following or neanic stage the siphonal lobe becomes three-pointed, and the shell corresponds to *Paraprolecanites* Karpinsky,† and its family affinities are beyond doubt (Pl. xxiv, Fig. 9*b*).

With the adult or ephebic stage the first lateral lobe becomes divided into two or three parts (Pl. xxiv, Fig. 9*c–f*). With this stage the genus *Pronorites* stops. But Gemmellaro‡ has described from the Permian of Sicily a further development of this form in the genus *Parapronorites*, in which the double lateral lobe and some of the simple ones become serrated.

Another line of development of *Pronorites* has been described by Gemmellaro (*op. cit.*) as *Sicantes*, in which all the lateral lobes become double like the first one. The next higher stages are given by *Medlicottia* Waagen, in which the siphonal saddles become indented and ammonitic. Karpinsky§ shows that *Medlicottia* in its development goes through the *Ibergiceras*, *Prolecanites*, *Paraprolecanites*, *Pronorites*, *Sicanites* and *Promedlicottia* stages.

* *Grundzüge der Palæontologie*, 1895, p. 400.

† *Ammoneen der Artinsk-Stufe*, p. 7.

‡ *Fauna Calc. Fusulina d. Valle d. fium Sosio*, 1887, p. 60.

§ *Ammoneen der Artinsk-Stufe*, p. 41.

Thus the finding of *Pronorites* in Arkansas is of great importance, since it is the ancestor of a form *Medlicottia*, which though unknown in Arkansas, has been found at no great distance away in the Texas Permian.* *Pronorites*, on the other hand, has not yet been found in Texas.

These occurrences help to prove the continuity of life from the Carboniferous into the Permian, and to show that the same conditions existed here as in the Artinsk region of the Ural mountains, where the Carboniferous beds contain the goniatites out of which most of the Permian ammonites were developed.

Pronorites cyclolobus Phillips, variety *arkansiensis* J. P. Smith, Pl. xxiv, Figs. 1–4. *Goniatites cyclolobus* Phillips, *Geol. Yorkshire*, Vol. ii, p. 237, Pl. xx, Figs. 40–42. *Goniatites cyclolobus* Phillips, Verneul, *Geol. Russia and the Ural Mountains*, Vol. ii, p. 370, Pl. xxvi, Fig. 4. *Goniatites cyclolobus* Phillips, Roemer, *Palæontographica*, ix, p. 167, Pl. xxvii, Fig. 1. *Goniatites cyclolobus* Phillips, DeKoninck, *Faune calc. Carb. Belg.*, Vol. ii, p. 121, Pl. 1, Figs. 5, 6. *Pronorites cyclolobus* Phillips, (variety *uralensis*) Karpinsky, *Mém. Acad. Impér. Sci. St. Petersbourg*, vii series, Tome 37, No. 2, p. 8, Pl. i, Fig. 4.

Phillips' original description of *Goniatites cyclolobus* is as follows: "Discoid, sides flat, back broad, inner whorls half concealed, septa with four round lateral lobes, a small double dorsal lobe, and small acute dorsal sinuses, the first lateral sinus double, the others simple, all round."

This description is too meagre to be of more than generic value, and also the term "dorsal" is used where now "abdominal" is in common use.

The shell is smooth, discoidal, very involute. The sides are nearly parallel and the breadth increases very slowly; the abdominal shoulders are nearly square, and the abdomen flat. The whorls are deeply embracing and increase rapidly in height. The umbilical shoulders are square, the umbilicus narrow and deep, and increases slowly in diameter.

Dimensions.—The specimen, which was septate throughout, gave the following dimensions:

	MM
Diameter	34.0
Height of last whorl from umbilical shoulders	17.5
Breadth	10.0
Width of umbilicus	7.0

This gives the proportions: 1 : 0.5 : 0.29 : 0.20 : which agree almost exactly with Karpinsky's figures, 1 : 0.5 : 0.30 : 0.20. On the Arkansas specimen the involution is shown by the height of the last whorl from the top of the next inner one, 12.5 mm. as compared with the total

*C. A. White, *Bull. 77 U. S. Geol. Survey*, p. 21.

height of the whorl which is 17.5 mm. No measurements of this relation were shown on the Russian specimen.

This description applies only to the adult shell, the relative measurements of the nepionic and neanic shells being very different. The Arkansas specimen showed only the last whorl, but the young stages have been worked out by Karpinsky,* from whose work the following description is translated: "Around the cylindrical embryonic chamber (Pl. xxiii, Fig. 8) are coiled very evolute whorls, whose involution increases gradually, but at first only in slight measure (Pl. xxiv, Fig. 8). So, for example, the fourth whorl embraces at the beginning only about one-fourth of the preceding; thus the height of the evolute portion of this fourth whorl is six or seven times as great as that of its own involute portion.

With later stages of growth the involution increases so that the whorls become finally completely embracing, and probably conceal a portion of the umbilicus. Because of this mode of growth the umbilicus appears at first broad, and increasing rapidly, then only gradually, and finally not at all, while the whorl continues to grow in height with great rapidity. Thus, at a diameter of the whorl of four or five millimeters, the umbilicus is about one-half of the total diameter, and at thirty mm. only about one-fifth. The first and second whorls have a broad elliptical cross-section (Pl. xxiv, Fig. 8), while that of the succeeding whorls becomes higher, with the long elliptical axis vertical (Pl. xxiv, Fig. 6), and then finally the flanks are bounded by almost parallel lines and the siphonal side is only slightly arched."

Ontogeny. According to Karpinsky,† the first or typembryonic stage is latisellate, that is the suture consists of a broad abdominal saddle; this saddle is next divided by a broad siphonal lobe (Pl. xxiii, Fig. 7).

The next stage corresponds to the genus *Ibergiceras* Karpinsky, of which *Gon. tetragonus* Roemer, of the Upper Devonian, is the type; in this the whorls are broad, low and only slightly embracing, the umbilicus wide and shallow. The sutures consist of a long rather narrow siphonal lobe, and two broadly rounded lateral lobes. This is the nepionic or larval stage (Pl. xxiv, Fig. 9*a*). In the continuation of this stage the whorls become higher, and the lobes more complicated, corresponding to the genus *Prolecanites*, of which *Gon. henslowi* Phillips and *Gon. serpentinus* Phillips are types.

In the next stage the shape of shell does change materially, but the siphonal lobe becomes three-pointed (Pl. xxiv, Fig. 9*b*); this is the neanic or youthful stage, and corresponds to the genus *Paraprolecanites* Karpinsky, of which the type is *Gon. mixolobus* Sandberger (not Phillips) (*Verstein, Rhein. Schichten-System in Nassau*, p. 67, Pl. iii, Fig. 13?; Pl. ix, Fig. 6).

The further development consists in the division of the first lateral

* *Ammoneen der Artinsk-Stufe*, p. 8.

† *Op. cit.*, p. 4 *et seq.*

lobe by a secondary saddle; the shell is then in the ephebic or adult stage, and in *Pronorites* gets no higher in its development.

The sutures are then constant in shape, and consist of a three-pointed siphonal lobe, a first lateral lobe deeply divided by a secondary saddle and five secondary lateral lobes outside the umbilical border, and one on the umbilical shoulder. All the lobes are pointed, and the saddles rounded. The inner lobes, covered by the involution, are unknown.

The sutures, as figured on Pl. xxiv, Fig. 4, show some differences from those figured by Phillips, Pl. xxiii, Fig. 9, and by Karpinsky,* Pl. xxiv, Fig. 9*f*. On the Arkansas specimen the three-pointed siphonal lobe is longer than on the type of Phillips, or the variety *P. cyclolobus*, variety *uralensis* Karpinsky, the secondary sinus on the first lateral lobe is deeper, and the second lateral lobe is proportionally longer. In this the Arkansas specimen does not depart further from the type than the variety *uralensis*. But if this difference should be thought to be of sufficient importance to characterize a new variety, the name *P. cyclolobus* Phillips, variety *arkansiensis* is proposed.

Surface Markings.—The shell is smooth and devoid of constrictions or other ornamentation, but on the body chamber of the adult, Karpinsky† observed weak ribs, that are stronger on the abdomen and grow weaker towards the umbilicus.

Affinities.—This species is certainly a variety of *Pronorites cyclolobus* Phillips (*Geol. Yorkshire*, Vol. ii, p. 237, Pl. xx, Figs. 40–42), but is more involute at the corresponding diameter, and has a narrower umbilicus and a greater number of lateral lobes. Specimens described by De Koninck‡ from Belgium, and by Roemer§ from the Hartz mountains in Germany, agree perfectly with the type of *Pronorites cyclolobus;* the English, Belgian and German beds, in which the species was found, are all older than the Lower Coal Measure horizon in Arkansas in which it was found, and considerably older than the Upper Carboniferous limestone, in which it was found in the Ural mountains From this Karpinsky‖ thinks the variety *uralensis* represents a mutation from the type of the species.

The form from the Pyrenees described by Barrois¶ as *Pronorites cyclolobus* Phillips has been shown by Karpinsky** to be a new species, *P. barroisi* Karpinsky. This form is more evolute than even the type of *P. cyclolobus*, and its lobes and saddles are broader and also less numerous.

Occurrence.—*Pronorites cyclolobus* Phillips, variety *arkansiensis* J. P. Smith, was found with *Gastrioceras branneri*, sp., nov. J. P. Smith, in

* *Ammoneen der Artinsk-Stufe*, Pl. I, Fig. 4 l.
† *Op. cit.*, p. 9, Pl. I, Fig. 4 *c* and *d*.
‡ *Faune du Calc. Carbon Belgique*, Vol. ii, p. 121, Pl. l, Figs. 5 and 6.
§ *Palæontographica*, Vol. ix, p. 167, Pl. xxvii, Fig. 1.
‖ *Ammoncen d. Artinsk-Stufe*, p. 10.
¶ *Recherches s. l. terr. anc. d'Asturies et de la Galice*, 1882, p. 295, Pl. xiv, Fig. 2.
** *Loc. cit.*

Arkansas, on Pilot mountain, Carroll county, three and a half miles southwest of Valley Springs, in 17 N., 19 W., section 18, northeast corner, in the Lower Coal Measures, so-called "Millstone Grit." The beds are called A 10 in Prof. H. S. Williams' section; below them lie fifty-five feet of micaceous sandstones and shales (A 9 of the section), and below that coarse, reddish-brown fossiliferous limestone, supposed to represent the Chester horizon of the Lower Carboniferous.

The type figured on Pl. xxiv, Figs. 1–4, is the property of the United States Geological Survey (National Museum), catalogue number Sta. 1275. The writer is indebted to Prof. H. S. Williams for the use of the type.

Other Localities.—Pronorites cyclolobus has been found in England in the upper part of the Mountain limestone; in Belgium in the limestone of Visé; in the Kohlenkalk of the Hartz, in Germany, and the variety *uralensis* has been found in Russia in the Upper Carboniferous limestone of the Ural mountains in C 2 of the section.

Pronorites, sp. indet., Pl. xx, Fig. 2.

In the Upper Coal Measures beds of Scott county, Arkansas, 1 N., 28 W., section 4, southeast quarter of southeast quarter, was found a single fragment that seems to belong to this genus. It is septate, and must have belonged to an individual about two and a half inches in diameter. The sides are smooth and little embracing and almost parallel; the coil is thin and discoidal, and the ventral or external portion seems to be only slightly arched. From the umbilicus towards the ventral portion are seen five lateral lobes that are long and pointed, the saddles being somewhat rounded. The siphonal lobe and part of the first lateral lobe are not seen, that part of the shell being worn so that they cannot be made out, but enough of the first lateral lobe is visible to show the secondary saddle that divides it. The septa are very close together, as seems to be the case on all species of this genus.

The nearest known relative is *Pronorites cyclolobus* Phillips, var. *uralensis* Karpinsky, *Die Ammoneen der Artinsk-Stufe*, p. 8, Pl. i, Fig. 4. The lobes figured on Pl. i, Fig. 4, of Karpinsky's monograph are very like those of the specimen from Scott county, and the general shape of the coil, the height and the amount of the involution are about the same on both.

Class *Crustacea*.

Order *Trilobitæ*.

Genus PHILLIPSIA, Portlock. *Phillipsia cliftonensis* Shumard, Pl. xxii, Fig. 5. *Phillipsia cliftonensis* Shumard, *Trans. St. L. Ac. Sci.*, Vol. i, p. 226. Compare *Phillipsia scitula* Meek and Worthen, F. B. Meek, *U. S. Geol. Surv. Nebraska*, p. 238, Pl. vi, Fig. 9.

A single well-preserved pygidium seems to belong to Shumard's

species. It is longer than wide, semi-elliptical. The axis is very prominent, has from thirteen to fourteen segments, and the furrows on each side are deep. The segments on the lateral lobes are sharply defined and are eight in number; Shumard mentions only seven on his specimen, but that slight difference is no obstacle to identity of species, since the number varies with age. These lateral segments do not reach the border, but terminate in a lateral furrow which surrounds the pygidium. The species is closely related to *P. scitula* Meek and Worthen, but that species has only eleven axis segments and seven on the sides. Meek was of the opinion that the specimen described as *P. scitula* in *U. S. Geol. Surv. Nebraska*, p. 238, might very possibly belong to *P. cliftonensis*, but Shumard had seen only a pygidium and had no means of characterizing the rest of the body.

Phillipsia major Shumard, figured by Meek in *U. S. Geol. Surv. Nebraska*, Pl iii, Fig. 2, grows much larger than our specimen, and has twenty-two to twenty-three segments on the axis and twelve to thirteen on the sides. These end abruptly at the lateral furrow, which is much wider than that on *P. cliftonensis*.

Occurrence and Locality.—A single well-preserved pygidium was found in the Upper Coal Measures of Poteau mountain, Indian Territory, associated with a fauna similar to that of the Upper Coal Measures or Permo-Carboniferous of Nebraska.

Phillipsia (*Griffithides*) *scitula* Meek and Worthen, *Proc. Ac. Sci. Phila.*, 1865, p. 270, and *Paleont. Ill.*, Vol. v, p. 612, Pl. xxxii, Fig. 3.

A pygidium from the Lower Coal Measures of White county, Arkansas, 9 N., 4 W., section 6, and another from similar strata in 9 N., 5 W., section 1, show the characteristics of this species, but are too imperfect to figure

Phillipsia, sp.

In the Lower Coal Measures of Johnson county, Arkansas, 11 N., 24 W., section 26, southeast quarter of southwest quarter, was found a pygidium of Phillipsia that could not be identified with certainty, although it probably belongs to one of the known species.

Phillipsia (*Griffithides*) *ornata* A. W. Vogdes, Pl. xxii, Fig. 6. *Griffithides ornata* A. W. Vogdes, *Proc. Cal. Acad. Sci.*, Ser. ii, Vol. iv, p. 589, "Notes on Palæozoic Crustacea, No. 4. On a New Trilobite from Arkansas Lower Coal Measures," by A. W. Vogdes.

The following description is copied from an advance sheet kindly furnished by Capt. Vogdes:

"The only specimen of this new species was discovered in Conway county, Arkansas, and consists of a head shield which is unfortunately not quite perfect, only exhibiting the right side and part of the glabella, with portions of the thorax and an entire pygidium; but it shows sufficient new characters to authorize us in considering it as a new species.

"The head shows that the latero-posterior angles are produced into short spines extending to about the third segment of the thorax, the glabella is pyriform, gibbous in front, and destitute of lateral furrows; basal lobes prominent. The posterior border of the glabella has two small, round nodes. The cervical lobe is broad and well marked, much broader than the axial lobes.

"The thorax exhibits imperfectly parts of the pleuræ and also the axis. Thorax with nine segments. The axis shows a series of nodes running through the centre of each ring. The pleuræ are smooth, each pleural groove extending slightly beyond the fulcral point; the extremities are probably rounded, but this is not indicated by the imperfect specimen now before us.

"The pygidium exhibits both in the axis and lateral lobes distinct segmentation. The axis does not extend to the posterior margin. The entire pygidium is surrounded by a marginal border, which widens out slightly anteriorly.

"The tail is parabolic in form, very convex and not as broad as the head, measuring on its anterior border 12 mm. The axis is broad, conical and prominent, occupying a little less than one-third the width of the tail on the anterior margin. It is marked with eleven rings; these become smaller and smaller and end in an obtuse point. Each ring is distinctly ornamented along the centre by a series of nodes, arranged into three double rows of two each. The sides of the axis are smooth.

"The lateral lobes are slightly flattened on top to the fulcral point. They are marked with seven pleuræ; the grooves between the pleuræ are deep and distinct, each being rounded on top and ornamented with a single node at the fulcral point; here they bend suddenly and join the marginal border.

"*Locality and Position.*—Lower Coal Measures, T. 5 N., R. 16 W., section 17, near centre of northwest quarter of the section, Conway county, Arkansas. From the collection of the Geological Survey of Arkansas.

"*Affinities and Differences.*—This species in some of its features resembles *Phillipsia rœmeri* Möller (*Ueber die Trilobiten Steinkohlenformation des Ural*, Pl. ii, Fig. 17), especially in the markings of the tail, which shows seven pleuræ ornamented by a single node at the fulcral joint, but it differs in form and especially in the marking of the axial lobe, so much so that it could not be placed under Möller's species. There is also a resemblance of this species with *Phillipsia* (*Griffithides*) *scitula* Meek and Worthen, from the Illinois Coal Measures. It has the same number of rings in the axis of the tail, and the same characteristic pleuræ and ornamentation, but the Arkansas species differs greatly in size and also in the number of pleuræ, seven instead of six. The axis is not as wide as in *Griffithides scitula* and not distinctly flattened on each side. The limb, although moderately wide and smooth, is not depressed or nearly flat, but convex. Secondly, the ornamentation of

the axis is entirely different, so much so that it would not warrant its reference to the Illinois species.

"It is doubtful in our present state of knowledge whether *Phillipsia* (*Griffithides*) *scitula* M. and W. should not be referred to the older name of *Phillipsia cliftonensis* Shumard, from the Upper Coal Measures, Clifton Park, Kansas, described from a pygidium. Dr. Shumard says that the axis has from thirteen to fourteen subgranulose rings and seven side segments. A thorough study of all these allied species may necessitate their reference to the older name; but for the present it would be advisable to give the Arkansas species a new name on account of the ornamentation of its tail."

Class *Arachnoidea.*

Order *Xiphosura.*

Genus undetermined. PRESTWICHIA?

In the Lower Coal Measures of White county, Arkansas, 9 N., 4 W., section 6, was found the mould of a part of the body of a crustacean that seems to belong to the family of the *Hemiaspidæ*, and yet differs from all known genera of this family in being armed with two rows of spines instead of only one.

Too little of the body is known for a generic description.

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	BRYOZOA.						
1	*Fenestella shumardi* Prout.	X		X	Poteau mountain, Indian Territory; Stone county, Arkansas, in Boone chert, 15 N., 12 W., Sec. 27.	Lower Coal Measures, Ohio; Upper Coal Measures, Nebraska.	1
2	*Rhombopora lepidendroides* Meek.			X	Poteau mountain, Indian Territory.	Upper Coal Measures, Nebraska, China.	2
3	*Septopora biserialis* Swallow.			X	Poteau mountain, Indian Territory.	Permo-Carboniferous, Kansas and Nebraska; Upper Coal Measures, Nebraska; Upper and Lower Coal Measures and Lower Carboniferous, Illinois; Upper Carboniferous, Arizona.	3
	ANTHOZOA.						
4	*Fistulipora nodulifera* Meek.			X	Sebastian county, 8 N. 32 W., Sec. 12: Poteau mountain, Indian Territory.	Upper Coal Measures, Nebraska, Iowa, Illinois.	4
5	*Lophophyllum proliferum* McChesney.			X	Poteau mountain, Indian Territory.	Coal Measures, Nebraska, Texas, Illinois, China, etc.	5
6	*Zaphrentis*, sp.			X	Crawford county, 10 N., 30 W., Sec. 10.		6
7	*Zaphrentis*, sp.		X		Conway county, 5 N., 16 W., Sec. 17.		7
	ECHINODERMATA.						
8	*Cyathocrinus*, sp.			X	Scott county, 1 N., 28 W., Sec. 4.		8
9	*Erisocrinus* (*Ceriocrinus*) *inflexus* Geinitz.			X	Poteau mountain, Indian Territory.	Coal Measures, Utah, Nebraska, etc.	9
10	*Hydreinocrinus mucrospinosus* McChesney.			X	Poteau mountain, Indian Territory.	Coal Measures, Mississippi valley.	10

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	ECHINODERMATA—Continued.						
11	*Poteriocrinus*, sp.			X	Poteau mountain, Indian Territory.		11
12	Crinoid stems, genus (?).		X		Pope county, 10 N., 20 W., Sec. 8.		12
13	Crinoid stems, genus (?).		X		White county, 8 N., 7 W., Secs. 33 and 26.		13
	BRACHIOPODA.						
14	*Athyris subtilita* Hall.	X	X	X	Sebastian county, 8 N., 32 W., Sec. 12; Poteau mountain, Indian Territory; Conway county, 6 N., 16 W., Sec. 29; in Boone chert, Stone county, 14 N., 10 W., Sec. 9.	Permo-Carboniferous of Kansas and Nebraska; world-wide in Coal Measures and Lower Carboniferous.	14
15	*Orthis* conf. *resupinoides* Cox.		X		White county, 8. N., 7 W., Sec. 33; Conway county, 8 N., 17 W., Sec. 33.	Coal Measures, Kentucky; Upper Carboniferous, New Mexico.	15
16	*Orthis pecosii* Marcou.	?	X	X	Poteau mountain, Indian Territory; Conway county, 6 N., 16 W., Sec. 29, southwest quarter of southwest quarter; Boone chert, Stone county, 14 N., 10 W., Sec. 9 (?).	Upper Coal Measures, Mississippi valley; New Mexico, China, India; Lower Carboniferous in California (?).	16
17	*Productus cora* d'Orbigny.	X		X	Poteau mountain, Indian Territory; Lower Carboniferous, Washington, Crawford, Independence and Stone counties.	Salt Range, India; China; South America; Upper Coal Measures and Permo-Carboniferous.	17
18	*Productus splendens* Norwood and Pratten.			X	Poteau mountain, Indian Territory.	Coal Measures and Permian, Mississippi valley region.	18
19	*Productus punctatus* Martin.	X	X		Conway county, 6 N., 16 W., Sec. 29.	Universal in Upper and Lower Carboniferous.	19

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	BRACHIOPODA—Continued.						
20	*Productus semireticulatus* Martin.	X	X		White county, 8 N., 7 W., Secs. 33 and 26; Lower Carboniferous in Independence and Searcy counties.	Universal in Upper and Lower Carboniferous.	20
21	*Retzia radialis* Phillips.			X	Sebastian county, 8 N., 32 W., Sec. 12; and Poteau mountain, Indian Territory.	Coal Measures, Nebraska, Kansas, New Mexico, Nevada, etc.	21
22	*Rhynchonella uta* Marcou.			X	Sebastian county, 8 N., 32 W., Sec. 12; and Poteau mountain, Indian Territory.	Coal Measures, universal in the West.	22
23	*Rhynchonella*, sp.			X	Crawford county, 10 N., 32 W., Sec. 10.		23
24	*Rhynchonella*, sp.		X		White county, 8 N., 7 W., Sec. 33.		24
25	*Spirifer cameratus* Morton.		X		Sebastian county, 8 N., 32 W., Sec. 12; Poteau mountain, Indian Territory; Conway county, 6 N., 16 W., Sec. 29.	Coal Measures, universal in the West.	25
26	*Spirifer rockymontanus* Marcou.		X	X	White county, 8 N., 7 W., Sec. 33.	Coal Measures, Pennsylvania to Rocky mountains.	26
27	*Spiriferina cristata* Schlotheim.	?	X	X	Sebastian county, 8 N., 32 W.. Sec. 12; Poteau mountain, Indian Territory; Conway county, 6 N., 16 W., Sec. 29; Lower Carboniferous, Marble City, Newton county.	Universal in Western Coal Measures, chiefly Upper Coal Measures.	27
28	*Derbyia crassa* Meek and Hayden.	X	X	X	Conway county, 6 N., 16 W., Sec. 29; Poteau mountain, Indian Territory.	Universal in Western Coal Measures.	28
29	*Terebratula hastata* Sowerby.		X	X	Poteau mountain, Indian Territory; Conway county, 8 N., 17 W., Sec. 33: northeast quarter of northeast quarter.	Universal in Western Coal Measures.	29

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	LAMELLIBRANCHIATA.						
30	*Astartella newberryi* Meek.		X	X	Sebastian county, 8 N., 32 W., Sec. 12; Conway county, 8 N., 17 W., Sec 33; Poteau mountain, Indian Territory.	Coal Measures, Ohio.	30
31	*Astartella vera* Hall.			X	Poteau mountain, Indian Territory.	Coal Measures, Illinois, Pennsylvania, etc.	31
32	*Aviculopecten carboniferus* Stevens.		X		White county, 8 N., 7 W., Sec. 26; Conway county, 5 N., 16 W., Sec. 17.	Coal Measures, Indiana, etc.	32
33	*Aviculopecten coxanus* Meek & Worthen			X	Poteau mountain, Indian Territory.	Coal Measures, Nebraska and Illinois.	33
34	*Aviculopecten germanus* Miller & Faber			X	Poteau mountain, Indian Territory.	Coal Measures, Kentucky.	34
35	*Aviculopecten* conf. *occidentalis* Shumard.		X		Conway county, 5 N., 16 W., Sec. 17; 6 N., 16 W., Sec. 29.	Coal Measures from Pennsylvania to Arizona.	35
36	*Conocardium* conf. *aliforme* Sowerby.		X		Conway county, 5 N., 16 W., Sec. 17.	Carboniferous, probably Upper, of England, Belgium, Germany and Russia.	36
37	*Edmondia nebrascensis* Geinitz, sp.			X	Poteau mountain, Indian Territory.	Coal Measures, Nebraska.	37
38	*Edmondia unioniformis* Phillips.		X		Conway county, 8 N., 17 W., Sec. 33.	Coal Measures, Illinois, England.	38
39	*Lima retifera* Shumard.			X	Poteau mountain, Indian Territory.	Coal Measures, Kansas, Nebraska, Texas.	39
40	*Macrodon carbonarius* Cox.		X	X	Conway county, 5 N., 16 W., Sec. 17; Poteau mountain, Indian Territory.	Coal Measures, Mississippi valley, China.	40

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	LAMELLIBRANCHIATA—Contin'd.						
41	*Macrodon obsoletus* Meek.			X	Sebastian county, 8 N., 32 W., Sec. 12; Poteau mountain, Indian Territory.	Coal Measures, West Virginia and Ohio.	41
42	*Macrodon tenuistriatus* Meek and Worthen.	X		X	Poteau mountain, Indian Territory; Moorefield, Independence county.	Upper Coal Measures, Nebraska.	42
43	*Macrodon*, sp.			X	Crawford county, 10 N., 30 W., Sec. 10.		43
44	*Nuculana* aff. *bellistriata* Stevens.			X	Scott county, 1 N., 28 W., Sec. 4.	Coal Measures, Mississippi valley.	44
45	*Nucula parva* McChesney.		X	X	Conway county, 5 N., 16 W., Sec. 17; Sebastian county, 8 N., 32 W., Sec. 12; Crawford county, 10 N., 30 W., Sec. 10.	Coal Measures, Illinois, etc.	45
46	*Nucula ventricosa* Hall.		X		Conway county, 5 N., 16 W., Sec. 17.	Coal Measures, Iowa, Pennsylvania, Texas, etc.	46
47	*Pleurophorus oblongus* Meek.		X		Conway county, 5 N., 16 W., Sec. 17.	Upper Coal Measures, Nebraska.	47
48	*Pleurophorus*, sp.			X	Scott county, 1 N., 28 W., Sec. 4.	Permian, Texas.	48
49	*Schizodus* conf. *amplus* Meek and Worthen.		X		White county, 8 N., 7 W., Sec. 33.	Coal Measures, Illinois, etc.	49
50	*Schizodus wheeleri* Swallow.		X		Conway county, 8 N., 17 W., Sec. 33.	Coal Measures of the Mississippi valley region.	50
51	*Schizodus cuneatus* Meek.		X	X	Crawford county, 10 N., 30 W., Sec. 10; Conway county, 8 N., 17 W., Sec. 33.	Lower Coal Measures, Ohio; Upper Coal Measures, Nebraska (?).	51

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	GASTEROPODA.						
52	*Bellerophon carbonarius* Cox.		X		Conway county, 5 N., 16 W., Sec. 17, and 8 N., 17 W., Sec. 33; Franklin county, 10 N., 26 W., Sec. 2.	Coal Measures, Mississippi valley.	52
53	*Bellerophon crassus* Meek & Worthen.		X		Conway county, 5 N., 16 W., Sec. 17.	Coal Measures, Pennsylvania and Western States; also Lower Carboniferous, Pennsylvania.	53
54	*Bellerophon marcouanus* Geinitz.			X	Sebastian county, 8 N., 32 W., Sec. 12.	Coal Measures, Mississippi valley.	54
55	*Bellerophon*, sp.		X		White county, 8 N., 7 W., Secs. 33 and 26.		55
56	*Euomphalus subquadratus* Meek and Worthen.		X		White county, 9 N., 5 W., Sec. 1, and 9 N., 4 W., Sec. 6.	Coal Measures, Illinois.	56
57	*Euomphalus*, sp.		X		Independence county, 11 N., 5 W., Sec. 9.		57
58	*Dentalium* conf. *meekianum* Geinitz.			X	Crawford county, 10 N., 30 W., Sec. 10.	Permo-Carboniferous, Nebraska.	58
59	*Macrocheilus* conf. *fusiformis* Hall.		X		Conway county, 5 N., 16 W., Sec. 17.	Coal Measures, Iowa.	59
60	*Macrocheilus* conf. *primigenius* Conrad		X		Conway county, 5 N., 16 W., Sec. 17.	Coal Measures, Iowa, Indiana, Ohio, Illinois.	60
61	*Naticopsis nana* Meek and Worthen.			X	Sebastian county, 8 N., 32 W., Sec. 12.	Coal Measures from Illinois to Nevada.	61
62	*Naticopsis*, sp.			X	Scott county, 1 N., 28 W., Sec. 4.	Texas Permian (?).	62
63	*Pleurotomaria modesta* Keyes.			X	Crawford county, 10 N., 30 W., Sec. 10.	Coal Measures, Kentucky and Pennsylvania.	63

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	GASTEROPODA—Continued.						
64	*Pleurotomaria* conf. *speciosa* Meek and Worthen.			X	Poteau mountain, Indian Territory.	Coal Measures, Illinois.	64
65	*Pleurotomaria tenuicincta* Meek and Worthen.			X	Poteau mountain, Indian Territory.	Upper Coal Measures, Illinois.	65
66	*Pleurotomaria harii* S. A. Miller.		X		Conway county, 8 N., 17 W., Sec. 33.	Upper Coal Measures, Missouri.	66
67	*Pleurotomaria*, sp.		X		Conway county, 5 N., 16 W., Sec. 17.		67
68	*Pleurotomaria*, sp.		X		Pope county, 10 N., 20 W., Sec. 8.		68
69	*Pleurotomaria*, sp.		X		Franklin county,12 N., 28 W., Sec. 27.		69
70	*Polyphemopsis inornata* Meek and Worthen.			X	Crawford county, 10 N., 30 W., Sec. 10.	Upper Coal Measures, Illinois.	70
	PTEROPODA.						
71	*Conularia* conf. *crustula* White.			X	Scott county, 1 N., 28 W., Sec. 4.	Coal Measures, New Mexico, Missouri.	71
	CEPHALOPODA.						
72	*Goniatites* (*Gastrioceras*), sp. indet.			X	Scott county, 1 N., 28 W., Sec. 4.		72
73	*Goniatites* (*Gastrioceras*) *excelsus* Meek.		X		Pope county, 10 N., 20 W., Sec. 8.	Coal Measures, Kansas.	73
74	*Goniatites* (*Gastrioceras*) *marianus* Verneul.			X	Scott county, 1 N., 28 W., Sec. 4.	Upper Carboniferous Limestone, Ural mountains.	74

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	CEPHALOPODA—Continued.						
75	*Goniatites* (*Gastrioceras*) *globulosus* Meek and Worthen.			X	Scott county, 1 N., 28 W., Sec. 4.	Upper Coal Measures, Illinois.	75
76	*Goniatites* (*Gastrioceras*) *branneri*, n. sp., J. P. Smith.		X		Carroll county, Pilot mountain, 17 N., 19 W., Sec. 18.		76
77	*Goniatites* (*Paralegoceras*) *iowensis* Meek and Worthen.		X		Conway county, 5 N., 16 W., Sec. 17.	Coal Measures, Iowa; Lower Carboniferous, Bend Formation, Texas; Upper Coal Measures, Kansas City, Mo.	77
78	*Goniatites* (*Pronorites*), sp.			X	Scott county, 1 N., 28 W., Sec. 4.	Ural mountains (?).	78
79	*Goniatites* (*Pronorites*) *cyclolobus* Phillips, var. *arkansiensis* J. P. Smith.		X		Carroll county, Pilot mountain, 17 N., 19 W., Sec. 18.	Carboniferous Limestone of England, Belgium, Russia.	79
80	*Nautilus* (*Endolobus*) *missouriensis* Swallow, (?).		X		Conway county, 5 N., 16 W., Sec. 17.	Coal Measures, Indiana, Missouri, Illinois (?).	80
81	*Nautilus* (*Ephippioceras*) *ferratus* Cox.		X		Conway county, 5 N., 16 W., Sec. 17; White county near Searcy.	Coal Measures, Kentucky.	81
82	*Nautilus*, sp.			X	Crawford county, 10 N., 30 W., Sec. 10.		82
83	*Orthoceras cribrosum* Geinitz.			X	Poteau mountain, Indian Territory.	Coal Measures, Nebraska.	83
84	*Orthoceras* cont. *rushense* McChesney.			X	Scott county, 1 N., 28 W., Sec. 4.	Coal Measures and Permian, Texas, etc.	84
85	*Orthoceras*, sp.		X		Conway county, 8 N., 17 W., Sec. 33.		85

	Fauna of the Coal Measures of Arkansas.	Lower Carboniferous.	Lower Coal Measures.	Upper Coal Measures.	Locality in Arkansas.	Other Localities.	
	CRUSTACEA.						
86	*Phillipsia cliftonensis* Shumard.			X	Poteau mountain, Indian Territory.	Upper Coal Measures and Permo-Carboniferous of Kansas.	86
87	*Phillipsia* (*Griffithides*) *scitula* Meek and Worthen.		X		White county, 9 N., 4 W., Sec. 6, and 9 N., 5 W., Sec. 1; Conway county, 5 N., 16 W., Sec. 17.	Coal Measures, Illinois and Nebraska.	87
88	*Phillipsia*, sp.		X		Johnson county, 11 N., 24 W., Sec. 26.		88
89	*Phillipsia* (*Griffithides*) *ornata* Vogdes.		X		Conway county, 5 N., 16 W., Sec, 17.		89
	Prestwichia (?).		X		White county, 9 N., 4 W., Sec. 6.		90

EXPLANATION OF PLATES.

[Where not otherwise stated the figures are all natural size.]

Plate XVI.

Fig. 1. *Gastrioceras marianum* Verneul..... 50

1 *a*. Side view.

1 *b*. Rear view.

Fig. 2. *G. marianum*, artificial cast, magnified twice.

2 *a*. Front view.

2 *b*. Side view.

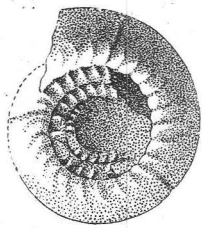
Fig. 3. *G. marianum*, largest specimen.

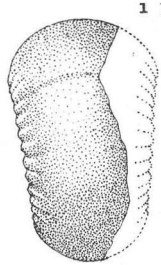
3 *a*. Side view.

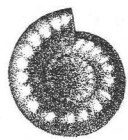
3 *b*. Cross section of whorl.

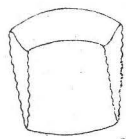
Fig. 4. *G. marianum*, artificial cast.

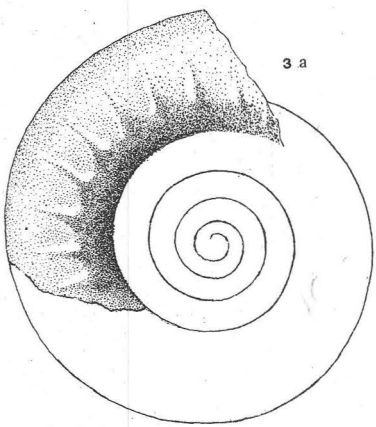
Fig. 5. *a, b, c*. *G. marianum*, showing the development of the sutures.

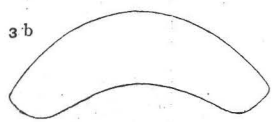

1 a

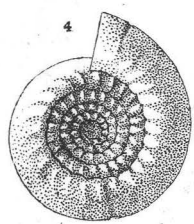

1 b

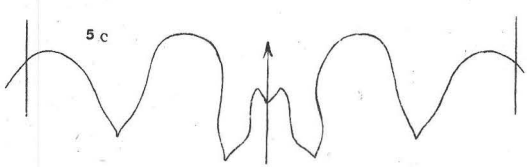

2 b

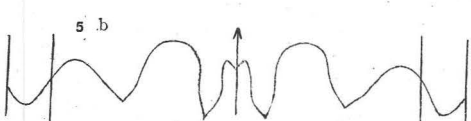

2 a


3 a


3 b


4


5 c


5 b

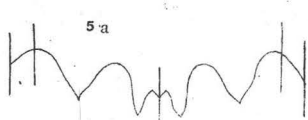

5 a

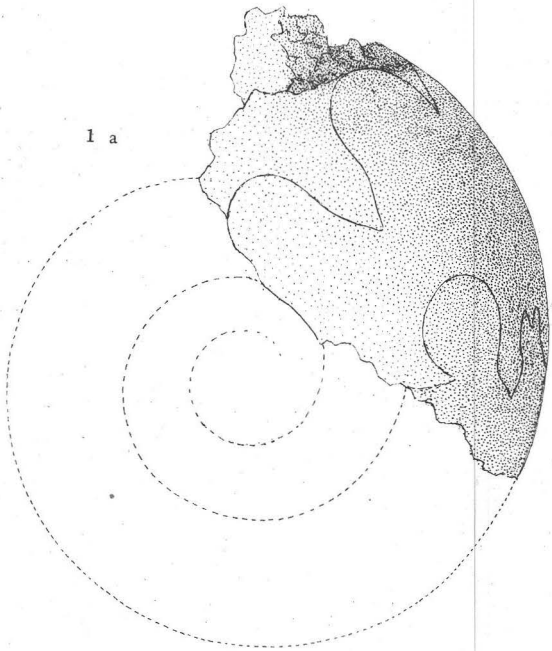
Plate XVII.

Fig. 1. *Gastrioceras excelsum* Meek..... 50

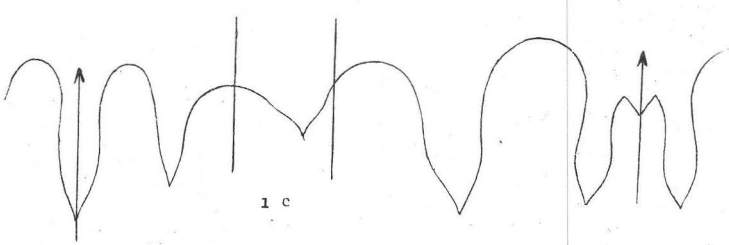
1 *a*. Side view.

1 *b*. Cross section of whorl.

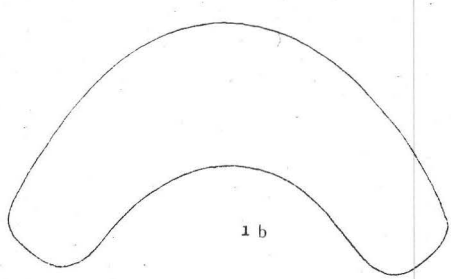
1 *c*. Sutures.



1 a



1 c



1 b

PLATE XVIII.

Fig. 1. *Gastrioceras globulosum* Meek and Worthen..... 48

1 *a*. Side view of small specimen.

1 *b*. Front view of small specimen.

Fig. 2. *G. globulosum*, artificial cast from a mould.

2 *a*. Side view.

2 *b*. Front view.

Fig. 3. *G. globulosum*, sutures, enlarged twice.

Fig. 4. *G. globulosum*, cast showing surface markings.

Fig. 5. *G. globulosum*, small globose specimen doubtfully referred to this species.

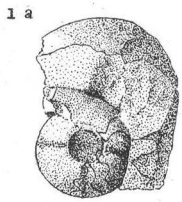
5 *a*. Front view.

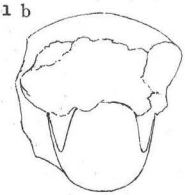
5 *b*. Side view.

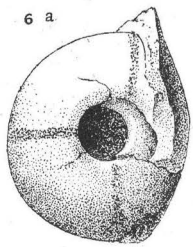
Fig. 6. *G. globulosum*, small specimen showing the low flattened whorl.

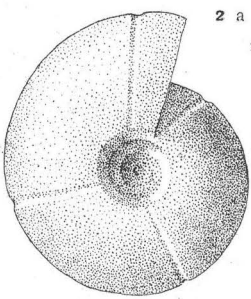
6 *a*. Side view.

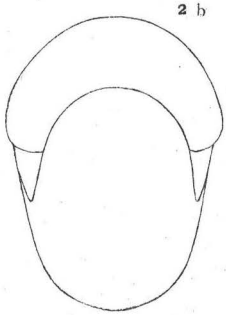
6 *b*. Front view.

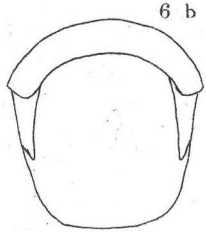

1 a

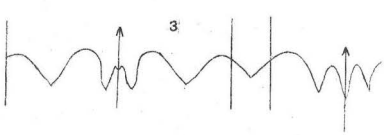

1 b

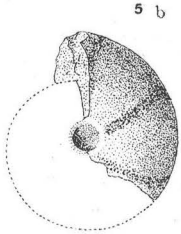

6 a


2 a


2 b


6 b


3


5 b


5 a


4

PLATE XIX.

Fig. 1. *Paralegoceras iowense* Meek and Worthen..... 53

1 *a*. Side view, partly restored.

1 *b*. Front view.

Fig. 2. *P. iowense*, inner whorl taken out of the large specimen shown in Fig. 1.

2 *a*. Side view.

2 *b*. Front view.

Fig. 3. *P. iowense*, sutures.

3 *a*. Sutures taken from the inner whorl of 25 millimeters diameter.

3 *b*. Sutures on the outer whorl.

Fig. 4. *Glyphioceras diadema* Goldfuss, showing development of the sutures (after Branco, *Palæontographica*, Vol. xxvii, Pl. ix, Fig. 1).

4 *a*. First suture.

4 *b*. Second suture.

4 *c*. Third suture.

4 *d*. At 1.25 millimetres diameter.

4 *e*. At 2.25 millimetres.

4 *f*. Adult.

Fig. 5. *Ternoceras retrorsum* v. Buch (after Branco).

5 *a*. First suture.

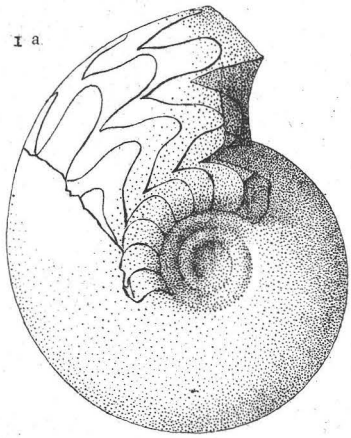
5 *b*. Second suture.

5 *c*. At 1.75 millimetres diameter.

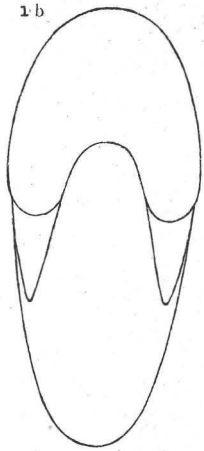
5 *d*. At 2.50 millimetres.

5 *e*. At 10 millimetres, adult.

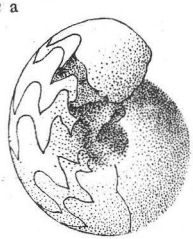
1 a



1 b

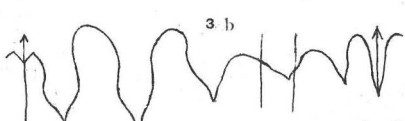


2 a



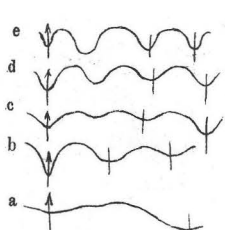
2 b

3 b

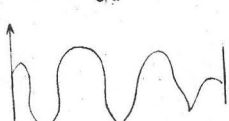


4

5



3 a



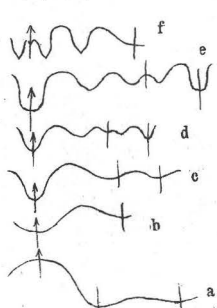


Plate XX.

Fig. 1. *Gastrioceras*, sp. indet. 52

1 *a*. Side view of a composite artificial cast, from three specimens.

1 *b*. Side view of a septate fragment.

1 *c*. Cross section of whorl.

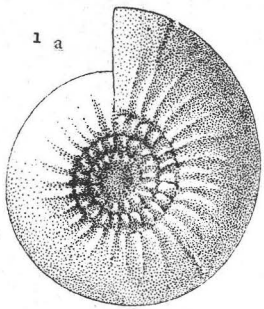
1 *d*. Sutures.

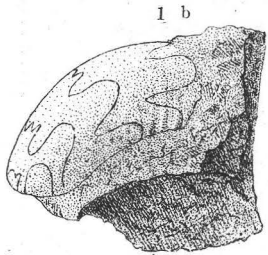
Fig. 2. *Pronorites*, sp..... 60

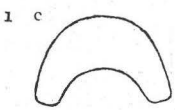
2 *a*. Side view of septate fragment.

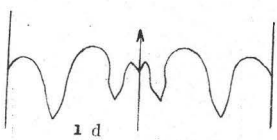
2 *b*. Cross section of whorl.

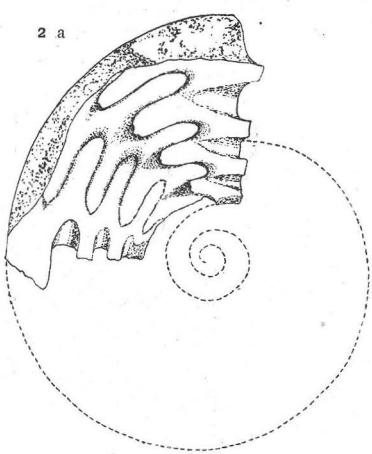
2 *c*. Sutures.


1 a


1 b


1 c


1 d


2 a


2 b

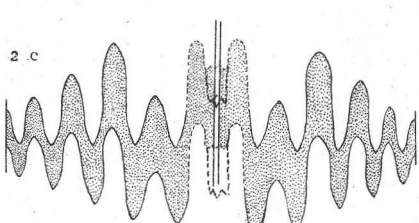

2 c

Plate XXI.

Fig. 1. *Endolobus missouriensis* Swallow..... 42

1. Side view of large specimen.

Fig. 2. *Endolobus missouriensis* Swallow.

2 *a*. Side view of small specimen.

2 *b*. Rear view of small specimen.

2 *c*. Front view of small specimen, twice enlarged

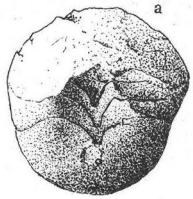
Fig. 3. *Endolobus missouriensis* Swallow.

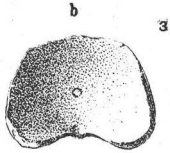
3 *a*. Dorsal view, showing internal lobe.

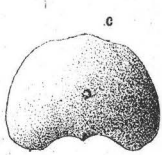
3 *b*. Concave side of chamber.

3 *c*. Convex side of chamber.

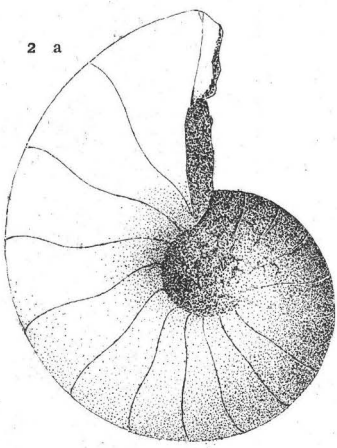
3 *d*. Chamber, from the side.

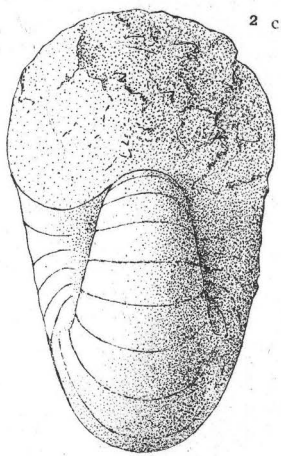

a

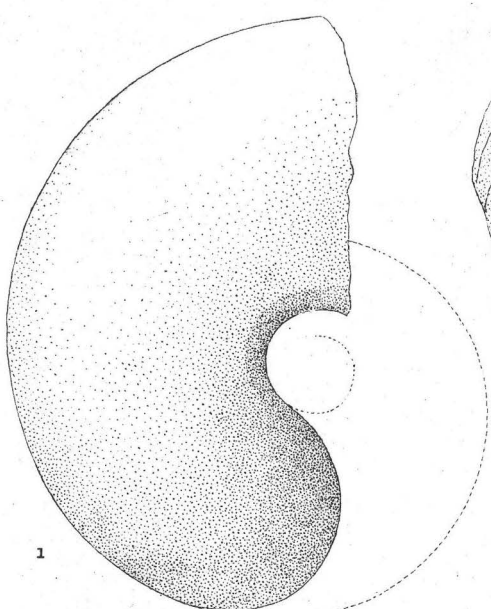

b
3


c


d


2 a


2 c


1

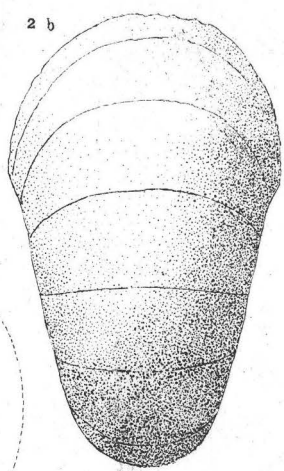

2 b

PLATE XXII.

Fig. 1. *Conocardium aliforme* Sowerby..... 37

1 *a*. Side view, natural size.

1 *b*. Side view of another specimen, twice enlarged.

Fig. 2. *Conocardium aliforme* Sowerby.

2 *a*. Another specimen, from above.

2 *b* From front.

2 *c*. From side.

Fig. 3. *Schizodus cuneatus* Meek..... 35

3 *a*. Side view.

3 *b*. Front view.

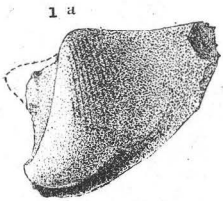
Fig. 4. *Schizodus wheeleri* Swallow 36

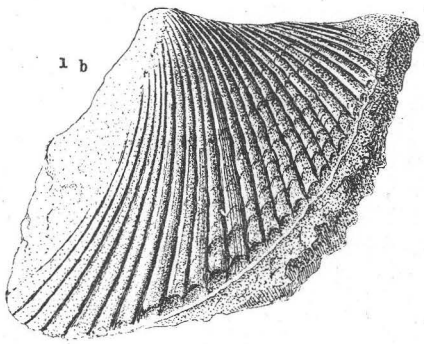
Fig. 5. *Phillipsia cliftonensis* Shumard..... 60

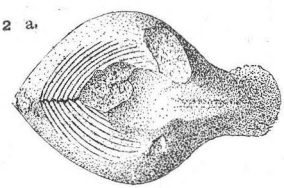
5 *a*. From above, twice enlarged.

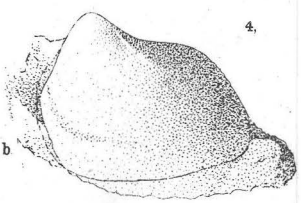
5 *b*. Side view, twice enlarged.

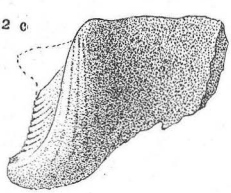
Fig. 6. *Phillipsia* (*Griffithides*) *ornata* Vogdes, twice enlarged..... 61

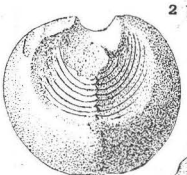

1 a

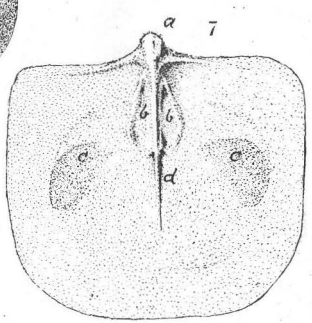

1 b

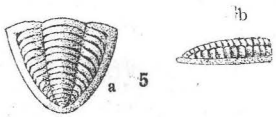

2 a

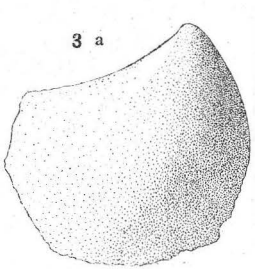

4
2 b


2 c




a
7
b
b
c
c
d


b
a
5


3 a


3 b

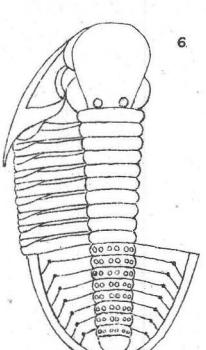

6

Plate XXIII.

Gastrioceras branneri, sp. nov., J. P. Smith 47

Fig. 1. Side view.

Fig. 2. Front view.

Fig. 3. Rear view.

Fig. 4. Cross section.

Fig. 5. Sutures of adult, twice enlarged.

Fig. 6. Sutures at diameter 23 millimetres, twice enlarged.

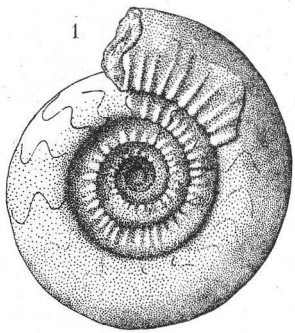
Pronorites præpermicus Karpinsky (to show the young stages. After Karpinsky, *Ammoneen d. Artinsk-Stufe*, Pl. i, Fig. 2 *e*, *f*, *g*).

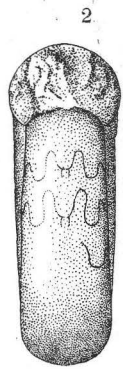
Fig. 7. First two sutures.

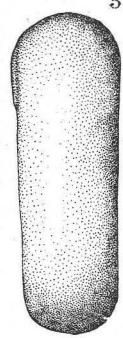
Fig. 8. Embryo-chamber.

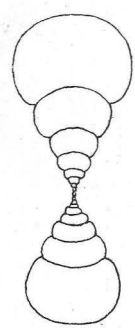
Pronorites cyclolobus Phillips (*Geol. Yorkshire*, Vol. ii, Pl. xx, Fig. 42).

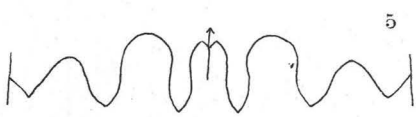
Fig. 9. Sutures, twice enlarged.


1


2

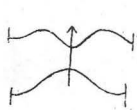

3


4


5


6


9


7

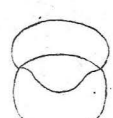

8

Plate XXIV.

Pronorites cyclolobus Phillips (variety *arkansiensis* J. P. Smith).... 57

Fig. 1. Side view, Arkansas specimen.

Fig. 2. Rear view, Arkansas specimen.

Fig. 3. Front view, Arkansas specimen.

Fig 4. Sutures, Arkansas specimen.

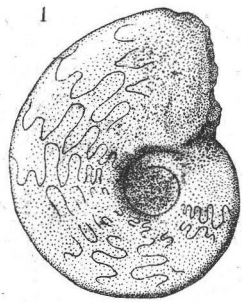
Fig 5. Side view of Ural Mountains specimen (after Karpinsky, *Ammoneen d. Artinsk-Stufe*, Pl. i, Fig. 4 *a*, *b*).

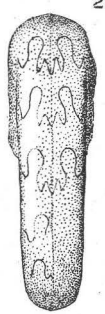
Fig. 6. (After Karpinsky, *Ammoneen d. Artinsk-Stufe*, Pl. i, Fig. 4 *n*.)

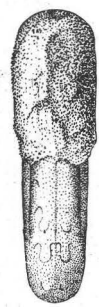
Fig. 7. (After Karpinsky, *Ammoneen d. Artinsk-Stufe*, Pl. i, Fig. 4 *m*.)

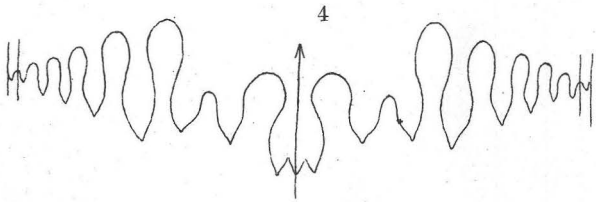
Fig 8. (After Karpinsky, *Ammoneen d. Artinsk-Stufe*, Pl. i, Fig. 4 *e*, *f*.)

Fig. 9. Showing development of the sutures, from the Ibergiceras to the Pronorites stage, after Karpinsky (Pl. i, Fig. 4 *g–l*).

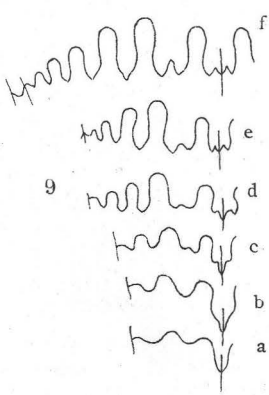

1


2


3


4


6

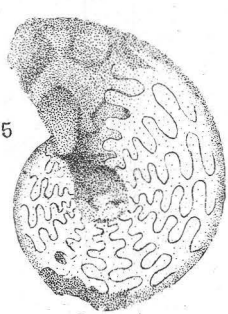

9


a

8


b


7


5