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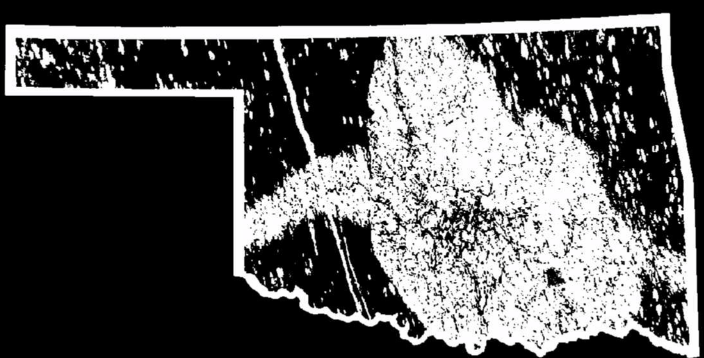
OKLAHOMA GEOLOGY NOTES



VOLUME 26 NUMBER 2 FEBRUARY 1966

Cover Picture

Low-Grade Metamorphism

Low-grade metamorphism in the "core area" of the Ouachita Mountains, southeastern Oklahoma, is indicated in the field by the presence of isoclinal folds and slaty cleavage in the fine-grained sedimentary strata. Mineralogical analysis of these strata provides the necessary information to assign the rocks to a chlorite grade of regional metamorphism as defined by H. G. F. Winkler. The primary clay mineral present is illite (2M polytype), which shows a strongly preferred orientation. Chlorite (1M polytype) is present in irregular patches and in fractures developed essentially normal to the rock foliation.

Published data of high temperature-pressure experiments on rock compositions similar to those present in the Ouachita "core area" suggest that these strata have been subjected to temperatures in the range of 375°C to 425°C and total pressures up to 2 kilobars.

The cover picture is a photomicrograph (x37) of a thin section of shale from the Mazarn Formation. Note the preferred orientation of the illite. Chlorite is concentrated along a fracture. A detailed study of the clay mineralogy of strata from the "core area" of the Ouachita Mountains was done in 1964 by Her Yue Wong at The University of Oklahoma and subsequently published in the Proceedings of the Geological Society of China.

—*Charles J. Mankin*

—*William H. Bellis*

The Mineral Industry of Oklahoma in 1965*
(Preliminary)

Robert B. McDougal†

Estimated value of Oklahoma mineral production in 1965 was $889 million, a slight increase above that of the previous record year of 1964, according to the Bartlesville, Oklahoma, office of the Bureau of Mines, U. S. Department of the Interior. The indicated total value reflected the over-all increase in the Oklahoma mineral industry in recent years. Increased value was noted in production of 11 mineral commodities; lower value was seen in production of 5; and output value of 2 mineral commodities was virtually unchanged. Significant gains were registered in value of lime, gypsum, lead, sand and gravel, natural gas, LP gases, volcanic ash, and zinc, in order of percentage increase. Substantial losses in value were registered in clays, petroleum, and natural gasoline.

MINERAL FUELS

Coal.—Output of coal was 8 percent below the previous year's production. Plans for development of a new multimillion-dollar coal-mining operation in Haskell County—the largest proposed for the State—were revealed in July by Kerr-McGee, Inc. Several factors, the company said, which favored the venture were faith in the coal reserves, particularly in view of the Arkansas River navigation project, and a 15 percent depletion allowance authorized during the last session of the State Legislature.

Natural gas.—Marketed output of natural gas increased almost 5 percent in volume and 6 percent in value over that of 1964.

Natural-gas liquids.—Condensable liquids stripped from natural gas by approximately 77 natural-gasoline plants and 4 cycling plants reached a new record of 1,464 million gallons. Pan American Petroleum Corp. placed on-stream a 20-million-cubic-foot-per-day refrigerated absorption plant in the northeast corner of Blaine and Kingfisher Counties. A depropanizer unit was completed at its North Richland Center plant by Anadarko Production Co. An expansion program was completed by Continental Oil Co. at its Medford plant. Pan American Petroleum Corp. doubled daily capacity to 100 million cubic feet per day at its Mooreland plant in Woodward County.

Storage capacity for LP gases at the end of the year totaled 1,259,000 barrels at eight underground sites. When completed in 1966, six additional sites in a salt bed in Grant County will add another 1,550,000 barrels to the State total.

Petroleum.—An estimated output of 201 million barrels of crude petroleum was reported in 1965, a 1 percent drop from that of the previous year. The daily petroleum allowable production was retained at 30 percent of the basic depth-acreage formula through February

* This report, U. S. Bureau of Mines Mineral Industry Surveys Area Report IV-191, was prepared December 9, 1965.

† Geologist, U. S. Bureau of Mines, Area IV Mineral Resource Office.

by the Corporation Commission; the rate was reduced to 26 percent in March and retained through October, then raised to 30 percent for November and December.

The *Oil and Gas Journal* reported a total 3,845 development wells and 365 test wells drilled in the first 10 months of 1965, compared with 3,728 wells and 408 wells, respectively, in 1964. This represents an increase of 3 percent in development-well drilling and an 11 percent decrease in exploratory-well drilling.

On January 1, 1965, 13 refineries had a total capacity of 416,430 barrels of crude oil per day, up slightly from the previous year. Equipment changes made by APCO Oil Corp. at its Cyril refinery reduced the crude-charge capacity from 12,000 to 10,250 barrels per calendar day. In February, Continental Oil Co. increased the catalytic-reforming capacity from 11,000 to 16,000 barrels per day at Ponca City. Sun-

TABLE I.—MINERAL PRODUCTION IN OKLAHOMA[1]

MINERAL	1964 QUANTITY	1964 VALUE (THOUSANDS)	1965 (PRELIMINARY) QUANTITY	1965 (PRELIMINARY) VALUE (THOUSANDS)
Clays[2] (thousand short tons)	835	$ 854	786	$ 803
Coal (bituminous) (thousand short tons)	1,028	5,474	950	[3]
Gypsum (thousand short tons)	694	1,899	692	2,189
Helium (thousand cubic feet)	230,673	8,074	245,772	8,602
Lead (recoverable content of ores, etc.) (short tons)	2,781	729	2,600	822
Natural gas (million cubic feet)	1,323,390	166,747	1,385,400	175,950
Natural-gas liquids:				
Natural gasoline and cycle products (thousand gallons)	554,053	34,011	560,400	33,620
LP gases (thousand gallons)	880,804	28,055	903,800	29,800
Petroleum (crude) (thousand 42-gallon barrels)	202,524	587,320	200,750	582,175
Salt (thousand short tons)	6	41	7	41
Sand and gravel (thousand short tons)	6,680	7,003	7,300	7,600
Stone (thousand short tons)	13,987	15,087	14,145	15,307
Zinc (recoverable content of ores, etc.) (short tons)	12,159	3,307	11,870	3,442
Value of items that cannot be disclosed: Bentonite, cement, lime, tripoli, volcanic ash, and value indicated by footnote 3	----	22,670	----	28,710
Total	----	$881,271	----	$889,061

[1]Production as measured by mine shipments, sales, or marketable production (including consumption by producer).
[2]Excludes bentonite; included with "Value of items that cannot be disclosed."
[3]Included with "Value of items that cannot be disclosed."

ray DX Oil Co. doubled asphalt capacity to 3,000 barrels per day in March at its Tulsa refinery.

HELIUM

Marketable production and value of helium extracted from natural gas at the Federal Bureau of Mines Keyes plant was 7 percent above that of 1964.

NONMETALS

Estimated value of nonmetals—cement, clays, gypsum, lime, salt, sand and gravel, stone, tripoli, and volcanic ash—produced in 1965 totaled $49.6 million, more than 4 percent greater than in 1964.

Total construction outlay in the first 10 months of 1965 was nearly 9 percent ahead of 1964 to date. Residential building was over 19 percent greater than in the comparable period of 1964. Nonresidential construction was 19 percent below the same 10-month period in 1964. In this category, commercial building was more than 60 percent below 1964, manufacturing building was down, and public utilities construction was almost 30 percent above last year to date. State highway construction in the first 10 months of 1965 was nearly 10 percent below the comparable period in 1964, and other public-works construction was down about 5 percent in the same period.

Important progress was made on U. S. Army Corps of Engineers river-basin development programs by the Tulsa District Office at Webbers Falls lock and dam and at Short Mountain lock and dam (renamed the Robert S. Kerr lock and dam), both on the Arkansas River and the Broken Bow dam on the Mountain Fork River in McCurtain County. On May 22, the Keystone dam was completed and officially dedicated by the Corps of Engineers. The Arbuckle dam on Rock Creek, southwest of Sulphur, was under construction by the Bureau of Reclamation, and the agency's Norman dam on the Little River was completed and dedicated early in the year.

Shipments of all types of finished portland cement into Oklahoma were 16 percent greater than in 1964.

METALS

Copper.—The Eagle-Picher Co. began strip-mine operations at a copper deposit near Olustee, southwest of Altus in Jackson County. The company erected a small mill to process the ore—a combination of carbonates and sulfides of copper.

Lead and zinc.—Mine production in terms of recoverable lead and zinc, all from Ottawa County, decreased 7 percent and 2 percent, respectively, whereas the values of the lead and zinc concentrates increased 13 percent and 4 percent, respectively.

Smelters.—Three horizontal-retort zinc plants operated in 1965. They were American Metal Climax, Inc., at Blackwell, The Eagle-Picher Co. at Henryetta, and National Zinc Co. at Bartlesville.

On March 7, the United Acid and Smelter Workers Union local struck the National Zinc Co. smelter at Bartlesville in disagreement with the company involving working conditions and wages arising from recent automation changes in zinc production. Under a $1 million expansion and repair program begun in July 1964, a new unit was installed in one of the furnaces in December of that year, and an agreement on wages and conditions concerning the new unit was not reached in the 28 days allowed under the contract. The strike ended April 7 when the employees voted to accept the company's proposal and return to work at the smelter.

Tri-State district.—Nearly 59 percent of the lead concentrates and more than 62 percent of the zinc concentrates were produced in the Oklahoma portion of the Tri-State district. Kansas produced more than 41 percent of the district's lead concentrates and nearly 38 percent of the zinc concentrates. There has been no production in the southwest Missouri portion of the district since 1957.

New Theses Added to O. U. Geology Library

The following Master of Science theses were added to The University of Oklahoma Geology Library during December 1965:

Palynology of the Bevier coal (Pennsylvanian) of Oklahoma, by Edward Dawson Dolly.

Foraminifera from the Punta Gavilan Formation (Miocene), northern Falcon State, Venezuela, by Maria Lourdes Gamero.

A doctoral dissertation, *Palynology and stratigraphy of the Lower Cretaceous rocks of northern Wyoming,* by Phillip N. Davis, which was completed but restricted in 1963, has been released and is now available.

The following Master of Science thesis was added to The University of Oklahoma Geology Library in January 1966:

Steady state crystallization from solutions of metal salts under hydrogen atmospheres at elevated temperatures and pressures, by Robert L. Brown.

A doctoral dissertation, *Clay mineralogy and clay-mineral facies of the Lower Cretaceous Trinity Group, southern Oklahoma,* by Frederich H. Manley, Jr., was also added.

—L. F.

Reproduction of Lost Arms on a Crinoid from Le Grand, Iowa

H. L. Strimple* and B. H. Beane†

The ability of various members of the Echinodermata to autotomize arms, or portions of arms, is well known. Any child along the seacoast knows that a brittle star will disconnect from an arm if it is held, and the animal can then escape. Hyman (1955, p. 108) noted that living crinoids can readily throw off arms when molested, or even when deprived of sufficient oxygen, and are able to grow them back in a relatively short time. In fact they are able to regenerate all parts of the body provided not too much is lost. If all the arms are lost at the cup summit, the animal will die.

Over a period of 60 years Beane has collected and studied thousands of crinoids from the limestone beds of the Hampton Formation (Kinderhookian) near Le Grand, Iowa, but has observed only one specimen with regenerated arms. The specimen (fig. 1) is on a slab with several other forms, most of which are the same species, *Rhodocrinites watersianus* (Wachsmuth and Springer), a relatively common species at Le Grand. That more such specimens have not been found is remarkable and indicates that the crinoids lived in a favorable environment without serious molestation.

Other instances of the regeneration of the arms of fossil crinoids have been recorded at various times (for example, Strimple, 1961, p. 13-14, text-fig. 18), but the most interesting feature in the present instance is the structural difference between the original arms and the regenerated arms. One could expect the reproduced arms to be identical with the original arms; however, Whitfield (1904, pl. 12) illustrated a specimen of *Barycrinus hoveyi* Hall, from the Borden Formation at Crawfordsville, Indiana, which had two full arms developed in place of one lost armlet and one full arm. The reason the regeneration took this form was that, although the full arm and adjacent armlet were lost, the axillary brachial remained. The regenerated arm is normal, with some armlets branching from it, but the former armlet has been replaced by a full arm, also having some armlets branching from it.

In the specimen of *Rhodocrinites watersianus,* the entire left halves of the free arms in two rays were lost and replaced by regenerated arms at the summit of the dorsal cup. Three brachials (secundibrachs) are free above the fixed secundibrach, the third being an axillary. (Fixed secundibrachs are incorporated into the calyx walls of the animal). The adjacent arms have five free secundibrachs. The number of brachials is determined at a far earlier stage than is indicated by the regenerated arms, the number of secundibrachs having been completed as soon as the axillary appeared. Reduction in the number of proximal brachials within a generic line is generally considered a mark of evolutionary advancement. Because an advanced stage is indicated

* State University of Iowa, Iowa City.
† Le Grand, Iowa. Mr. Beane died January 15, 1966, after this paper went to press.

by the regenerated arms, they might be said to represent "portentum," a term proposed by Strimple (1963, p. 10-11) for abnormalities of evolutionary significance.

The slab, originally prepared by Beane, has recently been subjected to the jet of an airbrasive unit. The crinoids, SUI 12345, are in the Department of Geology, State University of Iowa. A plaster cast will be deposited in the paleontological collections of The University of Oklahoma.

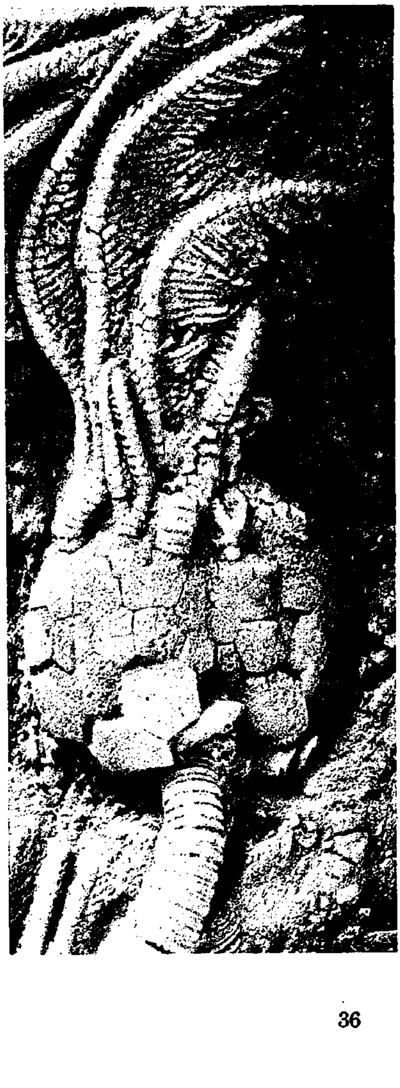


Figure 1. Rhodocrinites watersianus, hypotype SUI 12345, x3.5, with two regenerated arms.

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Strimple, H. L., 1961, Late Desmoinesian crinoid faunule from Oklahoma: Okla. Geol. Survey, Bull. 93, 189 p., 19 pls., 23 text-figs.
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Whitfield, R. P., 1904, Notice of a remarkable case of reproduction of lost parts shown on a fossil crinoid: Amer. Museum Nat. History, Bull., vol. 20, p. 471-472, pls. 12, 13.

Résumé of New Nomenclature Published in Oklahoma Geology Notes

January 1965 through December 1965

The following is a list of new taxa published in *Oklahoma Geology Notes* during 1965. It supplements lists published in January 1962, December 1963, and February 1965.

NAME	AUTHOR	VOLUME	PAGES
Bivalvia			
Conocardium lanterna, n. sp.	Branson	25	247-251
Cephalopoda			
Gaitherites, n. gen.*	Quinn	25	228-236
G. solidum, n. comb.*			
Conodonta			
Acodus auritus, n. sp.	Harris & Harris	25	34-47
Chosonodina? lunata, n. sp.			
Neomultioistodus, n. subgen.			
N. compressus, n. sp.			
Pteracontiodus, n. gen.			
P. aquilatus, n. sp.			
P. exilis, n. sp.			
Scolopodus striolatus, n. sp.			
Ulrichodina cristata, n. sp.			
Conularida			
Paraconularia magna, n. comb.	Branson	25	18-19
Crinoidea			
Rhodocrinites beanei, n. sp.*	Strimple & Boyt	25	222-226

* Not an Oklahoma form.

TYPE SPECIES OF *Cirratriradites* WILSON AND COE, 1940*

L. R. WILSON

The sporomorph genus *Cirratriradites* was established in 1940 by Wilson and Coe from specimens discovered in the Green County coal mine (Des Moines Series, Pennsylvanian) of Iowa. The type species chosen was *C. maculatus* Wilson and Coe. Subsequently Potonié and Kremp (1956, p. 125, 128), assuming that *C. saturni* (Ibrahim, 1932) Schopf, Wilson, and Bentall, 1944, was conspecific with *C. maculatus*, placed the latter in synonymy with *C. saturni*. This transfer was effected by comparison with an illustration of *C. maculatus*, without the type specimens having been seen by Potonié or Kremp. Guennel (1958, p. 47) recognized the error of this transfer and stated, "Ibrahim (1933, p. 30) mentioned a reticulate ornamentation; whereas Wilson and Coe (1940) failed to describe the body surface and gave no indication of a reticulum with their drawing (Fig. 7)."

In 1961 Professor Potonié kindly sent the writer a microscope slide containing specimens of *C. saturni*, and from these it is possible to resolve the problem and restore *C. maculatus* to the status of type species of the genus. Illustrations of *C. saturni* (pl. I, figs. 3-7) were made from Prof. Potonié's slide, and those of *C. maculatus* (pl. I, figs. 1, 2) are of the Iowa holotype and of another specimen from the type collection. The slides containing these specimens are in the palynology collection of the Oklahoma Geological Survey.

An examination of the German specimens reveals that three marked differences exist between the species. (1) *C. maculatus* has a more restricted range in diameter (77 to 90 microns) than has *C.*

* One project supported by National Science Foundation Grant GB-1850.

Explanation of Plate I

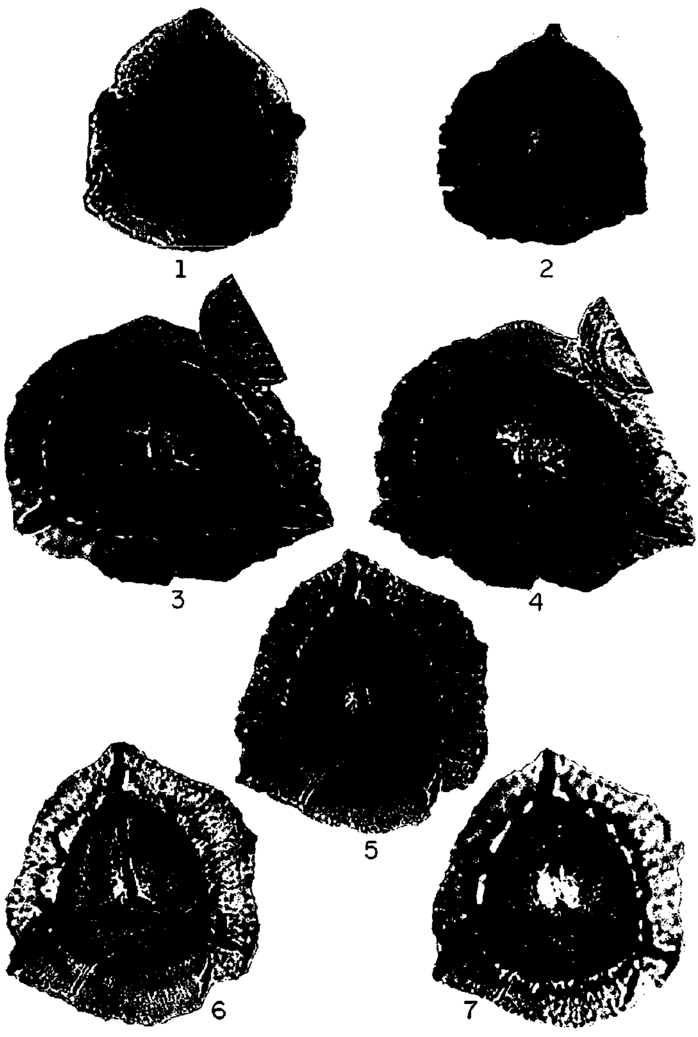
Figures 1, 2. Cirratriradites maculatus **Wilson and Coe, 1940. Green County coal mine, NW¼ SE¼ sec. 1, T. 82 N., R. 30 W., Franklin Township, Green County, Iowa.**

1. **Slide 136 P. Holotype. Diameter 82.5 microns; flange 12.5 microns wide.**
2. **Slide 136 P. Diameter 80 microns; flange 12 microns wide. Focus level on equatorial flange showing inner marginal development common in this species.**

Figures 3-7. Cirratriradites saturni **(Ibrahim, 1932) Schopf, Wilson, and Bentall, 1944. Flöz: Baldur Unteres Westfal C, Lippe-Mulde Ruhrgebiet, Germany.**

3. **Slide 455. Diameter 90 microns; flange 15 microns wide. Focus level on proximal surface.**
4. **Same as figure 3 with focus on distal surface.**
5. **Slide 455. Diameter 90 microns; flange 20 microns wide. Focus level on proximal surface.**
6. **Same as figure 5 with focus level on equatorial level.**
7. **Same as figure 5 with focus level on distal surface.**

Plate I



saturni (66 to 108 microns, from Ibrahim, 1932, in Potonié, Ibrahim, and Loose, 1932). The diameter of the type specimen of *C. saturni* reported in Potonié and Kremp (1956, p. 128) is 69 microns, but diameters of specimens received from Potonié range from 75 to 90 microns. (2) The body of *C. maculatus* appears essentially unornamented under magnifications lower than that of oil-immersion optics; however, when viewed by oil-immersion optics slight pitting is revealed. Under phase-contrast oil-immersion optics the pits appear as grana (pl. II, fig. 1). At magnifications lower than that of oil-immersion optics the ornamentation on the body surface of *C. saturni* may be described as somewhat reticulate, but under oil-immersion optics an irregular reticulate or vermiculate network of blunt to sharp spinules is apparent, especially on the distal surface (pl. II, figs. 2, 3). (3) The width of the equatorial flange of *C. maculatus* is nearly uniform (10 to 14 microns wide), whereas the flange of *C. saturni* (10 to 20 microns wide) is generally wider between the trilete rays. The flange border of *C. maculatus* is also much less serrate than that of *C. saturni*. The points on the edge and surface of the flange of *C. saturni* are generally minutely thickened. No difference is apparent in the distal foveal structures of the two species.

In Oklahoma a form of *Cirratriradites* occurs which somewhat resembles the specimens of *C. saturni* supplied by Potonié; however, none of these specimens has a reticulate pattern on the body surface as noted by Ibrahim in his original description nor the detailed wall structure reported here for *C. saturni*. Guennel (1958, p. 47) reported finding in the Brazil Formation (Pennsylvanian) of Indiana a few specimens with faintly reticulate body surfaces, but his description lacks sufficient detail to permit an adequate comparison with the German specimens of *C. saturni*. The specimen illustrated by him (1958, pl. 1, fig. 7) is approximately 80 microns in its greatest diameter. Dolly (1965) observed several specimens of *Cirratriradites* in the Bevier

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Explanation of Plate II

Figure 1. Cirratriradites maculatus **Wilson and Coe, 1940. Green County coal mine, NW¼ SE¼ sec. 1, T. 82 N., R. 30 W., Franklin Township, Green County, Iowa.**

1. Slide 136 P. Oil-immersion phase-contrast photomicrograph of distal surface showing minute irregular pitting on the body wall.

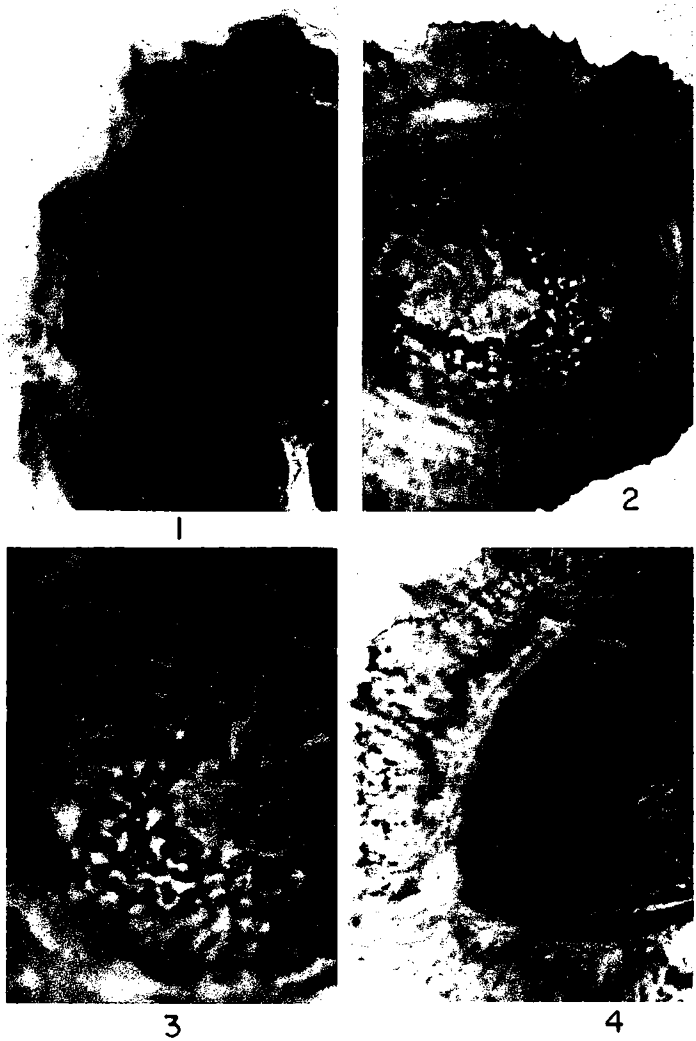
Figures 2-4. Cirratriradites saturni **(Ibrahim, 1932) Schopf, Wilson, and Bentall, 1944. Flöz: Baldur Unteres Westfal C, Lippe-Mulde Ruhrgebiet, Germany.**

2. Slide 145. Oil-immersion phase-contrast photomicrograph of distal surface showing minute vermiculate type of reticulation.

3. Enlarged detail of foveal area shown in figure 2. Same photomicrography.

4. Slide 145. Same as figure 2 with focus on the equatorial flange to show serrated edge and thickened points. Same photomicrography.

Plate II



coal of Oklahoma that have a reticulate pattern on the body but not the detailed ornamentation structure of the German specimens. The Bevier coal specimens have diameters ranging from 99 to 104 microns.

Cirratriradites maculatus is readily distinguishable from *C. saturni*, but some confusion exists as to what constitutes the morphography of the latter species. The apparent wide range in size and structure of the German specimens suggests that more than one species exists in the complex. Potonié, in a letter (November 14, 1961), stated that "in the German collections transitional forms have been observed." Considerable variation in morphography is also observed in American collections of all species where preservation ranges from good to poor. In the present state of knowledge one cannot be certain that *C. saturni* occurs in the United States or that *C. maculatus* occurs in Europe. Several specimens reported by Wilson (1965) from Morrowan (Lower Pennsylvanian) rocks of the Ti Valley in Oklahoma are as near in morphography to the German specimens of *C. saturni* as have been observed by the writer. The resolution of the morphographic problem concerning *C. saturni* must be made with more study material at hand than is now available to the writer. Several other species described from the United States and elsewhere are likewise in need of critical examination.

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Wilson, L. R., and **Coe, E. A.**, 1940, Descriptions of some unassigned plant microfossils from the Des Moines Series of Iowa: Amer. Midland Naturalist, vol. 23, p. 182-186, 1 pl.

New Goniatite Ammonoid from the Late Mississippian of Arkansas

W. Bruce Saunders*

Uppermost Mississippian (Chesterian) strata in northern Arkansas have provided specimens of an ammonoid which, because of its morphology, ornamentation, and suture configuration, appears to represent a new genus of the goniatite family Girtyoceratidae.

The subfamily Girtyoceratinae Wedekind, 1918, contains two genera: *Eumorphoceras* Girty, 1909, and *Girtyoceras* Wedekind, 1918, (= *Adelphoceras* Girty, 1909). *Girtyoceras* and *Eumorphoceras* are known from Upper Mississippian strata in the United States, but they do not occur together. *Girtyoceras* is older than, and seemingly related to, *Eumorphoceras* (McCaleb, Quinn, and Furnish, 1964, p. 16). *Peytonoceras,* here described as a new genus, is from the "Peyton Creek beds" (uppermost Mississippian) south of Leslie, Van Buren County, Arkansas. Although *Eumorphoceras* is abundant in Upper Mississippian rocks in the vicinity of Leslie, only one species, and that rarely, occurs with *Peytonoceras.* Because of its stratigraphic position and faunal association, as well as its close morphologic affinity to *Eumorphoceras, Peytonoceras* is placed in the subfamily Girtyoceratinae.

Family GIRTYOCERATIDAE Wedekind, 1918

Subfamily GIRTYOCERATINAE Wedekind, 1918

Genus *Peytonoceras* Saunders, new genus

Type species: *Peytonoceras ornatum* Saunders, new species.

The genus *Peytonoceras* is characterized by a subdiscoidal, involute conch with a narrowly rounded venter and sharply sculptured lateral grooves or sulci. Conch sculpture, in addition to the narrow ventrolateral grooves, includes sinuous lateral ribs and extremely fine spiral lirae on the flanks. Heavier spiral lirae decorate the ventrolateral groove and are even more prominent over the ventral area. Growth lines form a deep, rounded ventral sinus, but become obscured on the flanks. The ventral lirae and the growth lines intersect to form a delicate reticulate pattern over the venter of the conch. The external suture has wide, rounded saddles; a symmetrical, V-shaped ventral lobe; and a wide, dorsally steepened first lateral lobe, which, at a diameter of approximately 10.5 mm, is only bluntly pointed (pl. I, figs. 5, 6).

In some respects *Peytonoceras* is morphologically similar to *Eumorphoceras.* These similarities include ventrolateral grooving and lateral ribbing, which are features shared by all species of *Eumorphoceras. Peytonoceras,* however, is involute beyond the third or fourth whorl, whereas *Eumorphoceras* remains evolute to the fifth whorl in most cases. The narrow, deep ventrolateral groove of *Peytonoceras* is a feature shared by few, if any, species of *Eumorphoceras,* which may have two ventrolateral grooves separated by a ventrolateral ridge.

* Graduate student, University of Arkansas, Fayetteville.

Where only one groove is present, as in *E. bisulcatum*, it is shallow and wide. The external suture serves to distinguish *Peytonoceras* from some species of *Eumorphoceras*. The first lateral saddle of *Peytonoceras* is wider than that of *Eumorphoceras*, and the first lateral lobe of *Peytonoceras* is shallow, widely rounded, and faintly pointed in contrast to the sharp, V-shaped lateral lobe of *Eumorphoceras* at corresponding diameters.

Peytonoceras may be distinguished from *Girtyoceras*, sensu stricto, by the prominent lateral ribbing and the absence of constrictions in *Peytonoceras*, whereas the ribs in *Girtyoceras* are absent to reduced, and the constrictions are strongly expressed.

Peytonoceras exhibits some features which indicate affinities with the Baschkiritinae, also a subfamily of Girtyoceratidae. The subfamily Baschkiritinae Ruzhencev, 1962, contains two genera: *Hudsonoceras* Moore, 1946, and *Baschkirites* Librovitch, 1957. (*Baschkirites* sp. occurs in Lower Pennsylvanian rocks of northern Arkansas in the Prairie Grove Member of the Hale Formation.) More specifically, *Peytonoceras* shares several characteristics with, and may be ancestral to, the type species of *Hudsonoceras*, *H. proteum* Moore (1946, p. 433-437, pl. 27, figs. 5-7). The external suture is strikingly similar in both, differing in that the lobes and saddles of *Peytonoceras* are wider and less rounded, and the median saddle is narrower. *Hudsonoceras proteum* is characterized by spiral lirae on the flanks of the conch and by stronger spiral lirae beginning in a ventrolateral position and continuing across the venter, a pattern similar to that of *Peytonoceras*. Also, a faint ventrolateral groove is discernible on some specimens of *H. proteum*. Nevertheless, the two genera are readily distinguishable by the sinuous lateral ribbing and strongly involute conch of *Peytonoceras*.

Peytonoceras occurs in the "Peyton Creek beds," an informal name for approximately 100 feet of silty, black shale which overlies the Upper Mississippian Pitkin Formation of northern Arkansas. An abundant goniatite assemblage is associated with *Peytonoceras*, which

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Explanation of Plate I

Peytonoceras ornatum **Saunders, new genus, new species, from the "Peyton Creek beds" (uppermost Mississippian) near Peyton Creek, Arkansas.**

Figures 1-3. Side, back, and front views of holotype (L-114-10), x4.1. Figure 3 is a reconstruction of the front view of the holotype.

Figure 4. Side view of paratype (L-114-11), x4.

Figure 5. External suture of a topotype (L-114-13) at a conch diameter of approximately 10.5 mm, x12. Dashed portion of suture line is inferred.

Figure 6. External suture of holotype (L-114-10) at a conch diameter of approximately 6 mm, x13.

(Suture drawings made by use of camera lucida. Photograph of holotype (fig. 1) courtesy of J. A. McCaleb, Pan American Petroleum Corporation; other photographs and drawings by W. B. Saunders.)

includes *Eumorphoceras richardsoni, Delepinoceras bressoni, Anthracoceras* cf. *A. discus,* and *Cravenoceras* sp.

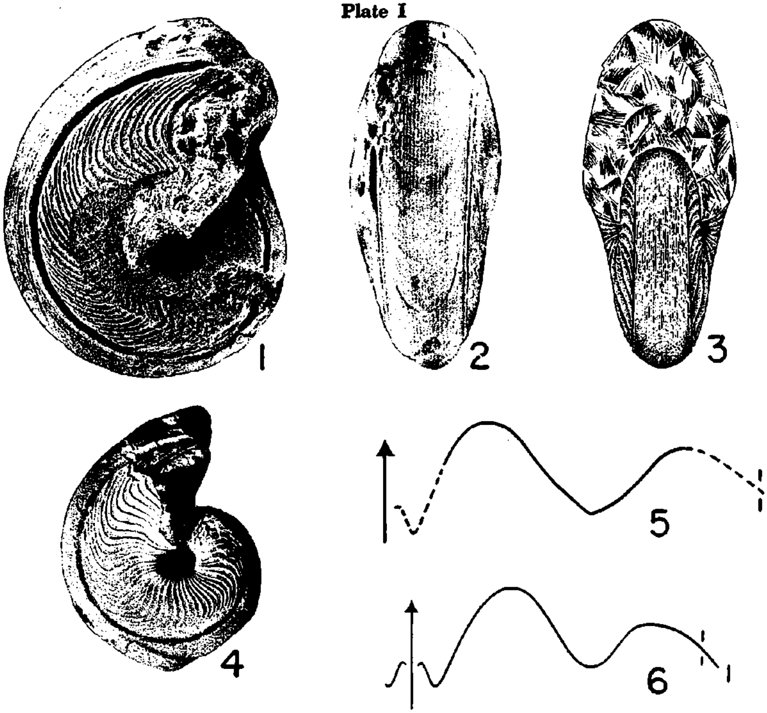
According to Furnish, Quinn, and McCaleb (1964 p. 175), this fauna appears to fall within the uppermost *Eumorphoceras* zone, lower Namurian, of Europe (Ruzhencev, 1962; Kullmann, 1962; Pareyn, 1962). The Peyton Creek beds are correlated with the Rhoda Creek Formation, Pontotoc County, Oklahoma, primarily upon the occurrence of *Delepinoceras bressoni.* Further collecting from the Rhoda Creek strata may provide additional information concerning the occurrence of *Peytonoceras.*

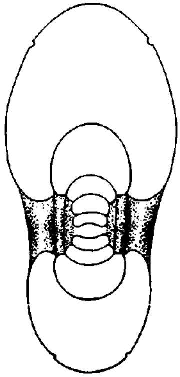
Peytonoceras ornatum Saunders, new species

Plate I, figures 1-4

Peytonoceras ornatum is based upon nine specimens, ranging from 7.0 mm to 14.5 mm in diameter. Only one of the specimens is a mold, and seven of the casts have some shell material. The holotype (L-114-10, pl. I, figs. 1-3), which is the largest complete specimen, is

Plate I





Text-figure 1. Diagrammatic cross section of an immature specimen of Peytonoceras ornatum Saunders, drawn from a topotype (L-114-12), x8.5. Because of the poor preservation of the specimen, the configuration of the innermost two whorls is inferred.

12.7 mm in diameter, 5.8 mm wide, 7.5 mm high at the apertural termination, and 0.75 mm across the umbilicus. The holotype is somewhat damaged by the loss of a portion of the shell adjacent to the umbilicus. Also, part of the adoral portion was lost in exposing the suture. The smallest complete specimen providing accurate measurements is 9 mm in diameter, 4.5 mm high, 4.0 mm wide, and has an umbilical diameter of 0.85 mm.

The prominent lateral ribs extend from inside the umbilical shoulder to the lateral groove. They form a slight sinus adjacent to the umbilical shoulder and, at diameters greater than 6 mm, form a gentle salient, then curve adorally again to form a deep, broadly rounded sinus, and finally sweep forward to intersect the ventrolateral groove at an angle of approximately 20 degrees. The growth lines form a deep, rounded ventral sinus and, in places, cross the ventrolateral groove coincident with one of the lateral ribs, thereby forming a deep ventrolateral salient. Although the lateral ribs appear to diminish in prominence as the conch diameter increases, they become slightly more numerous and more closely spaced. The ribs number 43 per whorl at a diameter of 9 mm, and more than 50 per whorl at a diameter of 12 mm. Constrictions of any sort are absent on the internal casts, but the lateral rib impressions are quite distinct. On some specimens impressions of the spiral lirae along the venter are retained on the internal casts.

Extremely fine, closely spaced spiral lirae are discernible between the lateral ribs. These lirae are obscurely present on the holotype, but are less distinct on a paratype (L-114-11, pl. I, fig. 4). Spiral lirae are also present within the ventrolateral groove, where they are more pronounced and more widely spaced than are those on the flanks. Along the venter, however, these spiral lirae are prominent and most widely spaced. Twenty-six continuous spiral lirae cross the venter between the ventrolateral sulci of the holotype. This number appears to be constant on the other specimens examined. Some secondary, discontinuous spiral lirae are also present. The conch on the ventral side of the ventrolateral sulcus is slightly raised, thereby forming a gentle lip adjacent to the groove.

The entire external suture is known from only one specimen, the holotype of *Peytonoceras ornatum*. At a conch diameter of approximately 6 mm, it consists of a wide, shallow median saddle; a rounded, symmetrical, V-shaped ventral lobe; a widely rounded first lateral saddle; a steep-sided, rounded lateral lobe; and a shallow, gently sloping second lateral saddle (pl. I, fig. 6). At a conch diameter of approximately 10.5 mm the first lateral saddle is wide, slightly asymmetrical, and only bluntly pointed (pl. I, fig. 5).

A transverse section made of one specimen (L-114-12) indicates that the conch of *P. ornatum* is flattened for two or three whorls, then becomes rounded on the third or fourth whorl, and involute beyond (text-fig. 1).

Remarks.—*Girtyoceras costatum* Ruprecht, 1937 (p. 271-272, pl. 10, figs. 5, 6), resembles *Peytonoceras ornatum*, but in contrast to the narrow ventrolateral groove and closely spaced, more sinuous ribs of *P. ornatum*, *Girtyoceras costatum* has a wide, shallow ventrolateral groove and widely spaced, stronger ribbing. No suture diagram of *Girtyoceras costatum* has been published, and, although it may belong in the genus *Peytonoceras*, such a designation is not now feasible upon the basis of published and illustrated material.

Several species of *Eumorphoceras* might be confused with *Peytonoceras ornatum*. Among these, *Eumorphoceras involutum* Horn, 1960 (p. 330-332, pl. 1, figs. 3-5) and *Eumorphoceras rota* Yates, 1961 (p. 57-58, pl. 6, figs. 6, 7) have subdiscoidal, involute conchs with sinuous lateral ribbing. (It appears that *E. involutum* Horn and *E. rota* Yates are identical. If such is the case, *E. rota* Yates is a synonym of *E. involutum* because Horn's work has priority.) No suture drawings exist for these specimens because the type material is crushed. However, *P. ornatum* has a single ventrolateral groove, whereas *E. involutum* and *E. rota* have two ventrolateral grooves separated by a ventrolateral ridge.

The generic name for *Peytonoceras ornatum* is derived from the informal name for the stratigraphic unit and area where it occurs, near Peyton Creek, Arkansas. The specific name refers to the ornate ribs and spiral lirae characteristic of the genus and species.

Occurrence.—All known specimens of *Peytonoceras ornatum* were collected from two exposures of the Peyton Creek beds, 5 miles south of Leslie, Van Buren County, Arkansas. The holotype was collected from the Frank Stewart phosphate mine on the south side of Peyton Creek. Other specimens were collected from a nearby roadcut, adjacent to the phosphate mine, along State Highway 65 (sec. 12, T. 13 N., R. 15 W.). The fossils were collected from the shale and from fossiliferous concretions in the shale.

Types.—The holotype of *Peytonoceras ornatum* (L-114-10) and other specimens illustrated in this paper are in the State University of Iowa repository at Iowa City.

Acknowledgments.—Professor James H. Quinn, University of Arkansas, has been a constant source of advice and constructive criti-

cism, without which the preparation of this paper would not have been possible. The provision of optical equipment and drawing apparatus by the Coordinator of Research, University of Arkansas, greatly facilitated detailed study and illustration of the specimens described herein.

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New Survey Publications Issued

BULLETIN 106. *Geology and mineral resources of Woods County, Oklahoma,* by Robert O. Fay. 189 pages, 40 figures, 4 plates (plates are cased in separate plastic folder). Issued December 29, 1965. Cloth bound, $6.00; paper, $5.00.

BULLETIN 109. *Rugose corals of the Henryhouse Formation (Silurian) in Oklahoma,* by Patrick K. Sutherland. 92 pages, 26 figures, 34 plates. Issued December 30, 1965. Cloth bound $4.50; paper, $3.50.

CIRCULAR 63. *Geology and petroleum of Love County, Oklahoma.* Part I. *Geology of Love County,* by E. A. Frederickson and R. H. Redman. Part II. *Petroleum geology of Love County,* by Jerome M. Westheimer. 91 pages, 29 figures, 2 plates. Issued December 27, 1965. Cloth bound, $4.50; paper, $3.50.

Treatise Volumes on Brachiopoda, Review for Oklahoma

Carl C. Branson

Part H (Brachiopoda) of the *Treatise on Invertebrate Paleontology* was issued in November 1965. It is a vast undertaking resulting in two volumes of 927 pages and 746 figures. To have been able to complete this work at all is an enormous accomplishment for which the 19 authors and Editor R. C. Moore are to be praised and thanked.

Oklahoma specimens figured are as follows [added material, corrections, and changes are in brackets]:

Plectoglossa oklahomensis [Cooper, 1956]
Type species of the genus [Pooleville Member of Bromide Formation], M. Ordovician [Carter County], p. 269, figs. 162 (6a-b). Figures from Cooper, 1956 [pl. 6, figs. 7, 15].

Artiotreta parva [Ireland, 1961]
Type species of the genus. [Clarita Member of Chimneyhill Formation (Amsden, 1963)], M. Silurian, p. 278-279, figs. 172(2a-e). New figures by Rowell.

Acrotretella siluriana [Ireland, 1961]
Type species of the genus. [Clarita Member of] Chimneyhill Formation [M. Silurian], p. 279, figs. 172(4a-d). Figures from Ireland, 1961 [pl. 137, figs. 13, 14, 16, 18].

Archaeorthis biconvexa Cooper [1956]
Womble Shale, M. Ordovician [Pushmataha County], p. 311, figs. 194(2a-c). Figures from Cooper, 1956 [pl. 31, B, figs. 7, 8, 9].

Orthostrophia strophomenoides parva Amsden [1958]
Haragan Marlstone, L. Devonian [Murray and Coal Counties], p. 313, figs. 196(2a-e). Figures said to be from Boucot and Amsden, 1958 [actually from Amsden, 1958, pl. 1, figs. 24, 28, 27, 30, 32].

Schizoramma hami Amsden [1951]
Henryhouse Marlstone, U. Silurian [Pontotoc County], p. 318, figs. 199(4a-c). Figures from Amsden, 1951 [pl. 16, figs. 1, 3, 6].

Glyptorthis costellata Cooper [1956]
[Pooleville Member] Bromide Formation, M. Ordovician [Carter County], p. 319, fig. 200(3d). Figure from Cooper, 1956 [pl. 44, D, fig. 37].

Valcourea deckeri Cooper [1956]
Tulip Creek Formation, M. Ordovician [Murray County], p. 321, fig. 201(2d). Figure from Cooper, 1956 [pl. 74, A, fig. 14].

Fasciculina fasciculata Cooper [1952]
Signal Mountain Formation, L. Ordovician [Murray County], p. 322, figs. 203(1a-d). Figures from Cooper, 1952 [pl. 2, figs. 1, 2, 3, 4].

Oligorthis arbucklensis [Ulrich and Cooper, 1936]
[Probably Kindblade Formation], L. Ordovician, p. 324, figs. 204(5a-c). Figures from Ulrich and Cooper [1938, pl. 30, figs. 19, 25, 24].

Polytoechia subcircularis (Cooper [1952])
West Spring Creek Formation, L. Ordovician [Murray County], p. 349, figs. 211(2a-c). Figures from Cooper, 1952 [pl. 4, figs. 13, 14, 16].

Pomatotrema murale [Ulrich and Cooper, 1932]
[West Spring Creek Limestone], L. Ordovician, p. 349, figs. 221(3a-c). Figures from Ulrich and Cooper, 1938 [pl. 35 C, figs. 23, 14, 24].

Tritoechia typica (Schuchert and Cooper, 1932)
[Kindblade Formation], L. Ordovician [Johnston County], p. 349, figs. 221(1a-e). Figures from Cooper, 1956 [pl. 77, figs. 7, 1, 8, 2].

Cliftonia bellula Ulrich and Cooper [1936]
[Chimneyhill limestone boulder in Johns Valley Shale], L. Silurian or M. Silurian, p. 358, fig. 228(1). Figure from Ulrich and Cooper, 1936 [pl. 48, fig. 15]. [An unfortunate choice of an example.]

Murinella partita [Cooper, 1956]
[Mountain Lake Member of Bromide Formation], M. Ordovician [Murray County], p. 386, figs. 247(4a-c), identified only as from Porterfield. Figures from Cooper, 1956 [pl. 227, D, figs. 17, 24; pl. 223, F, fig. 17].

Leptaenisca concava (Hall [1857])
Haragan Marlstone, L. Devonian, p. 391, figs. 250(4a-c). New figures by Cooper.

Strophodonta (*Brachyprion*) sp.
Haragan Marlstone, L. Devonian [Murray County], p. 395, figs. 255(1a-c). Figures from Williams, 1953 [pl. 7, figs. 5, 6, 7].

Lissotrophia (*Lissotrophia*) *cooperi* [Amsden, 1949]
Henryhouse Marlstone, U. Silurian [Pontotoc County], p. 402, figs. 259(1a-c). Figures from Williams, 1953 [pl. 8, figs. 10, 11, 12].

Quadratia hirsutiformis (Walcott, 1884)
[Moorefield Formation, M. Mississippian, Muskogee County], p. 467, figs. 333(2a-c). Figures from Muir-Wood and Cooper, 1960 [pl. 39, figs. 1, 2, 11].

Semicostella oklahomensis (Snider, 1915)
[Moorefield Formation, M. Mississippian, Muskogee and Cherokee Counties], p. 475, figs. 342(4a-d). Figures from Muir-Wood and Cooper, 1960 [pl. 62, figs. 7, 3, 6, 11].

Kozlowskia haydenensis (Girty [1908])
[Pumpkin Creek Limestone], M. Pennsylvanian [Johnston County], p. 479, fig. 345(4b). Figure said to be from Kozlowski, 1914 [actually from Muir-Wood and Cooper, 1960, pl. 63, fig. 12].

Desmoinesia muricatina (Dunbar and Condra, 1932)
[Stuart Shale], M. Pennsylvanian, p. 479, figs. 347(2a-f). Figures said to be from Hoare, 1960 [but are from Muir-Wood and Cooper, 1960, pl. 64, figs. 17, 18, 19, 16, 25, 23].

Inflatia inflata (McChesney [1860])
[Fayetteville Shale], U. Mississippian [Mayes County], p. 482, figs. 348(4a-f). Figures from Muir-Wood and Cooper, 1960 [pl. 55, figs. 1, 2, 6, 7, 4, 13].

Diaphragmus cestriensis (Worthen [1860])
[Fayetteville Shale, U. Mississippian, Muskogee County], p. 484, figs. 352(1d-e). Figures said to be from Girty, 1910 [but are from Muir-Wood and Cooper, 1960, p. 73, figs. 1, 12].

Echinoconchus alternatus (Norwood and Pratten [1855])
[Fayetteville Shale, U. Mississippian, Craig County], p. 485, fig. 353(1f). Figure said to be from Weller, 1914 [but is from Muir-Wood and Cooper, 1960, pl. 83, fig. 9].

Flexaria arkansana (Girty, 1910)
[Fayetteville Shale], U. Mississippian [Mayes County], p. 490, figs. 360(2a-g). Figures said to be from Girty, 1910 [but are from Muir-Wood and Cooper, 1960, pl. 78, figs. 4, 2, 3, 1, 15; pl. 123, figs. 19, 21].

Auloprotonia aulacophora [Muir-Wood and Cooper, 1960]
Moorefield Formation [M. Mississippian, Cherokee County], p. 495, figs. 364(3a-d) and p. 441, figs. 299(1a-c). Figures from Muir-Wood and Cooper, 1960 [pl. 97, figs. 1, 3, 6, 8; pl. 98, fig. 2; pl. 97, figs. 1, 2].

Ovatia elongata [Muir-Wood and Cooper, 1960]
[Fayetteville Shale], U. Mississippian [Muskogee and Mayes Counties], p. 503, figs. 374(2a-d). Figures said to be from Hall, 1858 [but are from Muir-Wood and Cooper, 1960, pl. 114, figs. 1, 2, 3, 11].

Ancistrorhyncha costata [Ulrich and Cooper, 1942]
[Pooleville Member of Bromide Formation], M. Ordovician, p. 553, figs. 419(5a-d), 420(1a-e). New figures by Schmidt.

Dorytreta bella [Cooper, 1956]
[McLish Formation], M. Ordovician [Pontotoc County], p. 554, figs. 419(2a-d). Figures from Cooper, 1956 [pl. 124, G, figs. 39, 43, 41, 40].

Atrypina hami Amsden [1958]
Haragan Marlstone, L. Devonian [Murray County], p. 636, figs. 520(1a-e). Figures from Amsden, 1958 [pl. 7, figs. 9, 10, 13, 15, 17].

Nanospira parvula [Amsden, 1949]
Henryhouse Marlstone, U. Silurian [Pontotoc County], p. 644, figs. 525(1a-f). Figures from Amsden, 1951 [text-fig. 1; pl. 19, figs. 3, 7, 6, 2, 5].

Coelospira virginia Amsden [1958]
Haragan Marlstone, L. Devonian [Murray County], p. 646, figs. 529(1a-e). Figures from Amsden, 1958 [pl. 7, figs. 29, 30, 32, 34, 36].

Rhynchospirina maxwelli Amsden [1958]
[Haragan Marlstone], L. Devonian, p. 652, figs. 532(1b-e). Figures from Amsden, 1958 [pl. 9, figs. 1, 2, 8, 12].

Meristella atoka Girty [1899]
Haragan Marlstone, L. Devonian [Coal County], p. 656, figs. 533(1a-d). Figures from Amsden, 1958 [pl. 10, figs. 3, 5, 9, 10].

Gacina moorefieldensis [Stehli, 1961]
Moorefield Formation [M. Mississippian], p. 752, figs. 613 (3a-b). New figures by Stehli.

Pseudodielasma perplexa [Brill, 1940]
[Doe Creek Member of Marlow Formation], Permian [Woods County], p. 755, figs. 615(2a-b). Figure 2a new by Stehli; figure 2b said to be from Brill, 1940 [but not from that source].

NOTE

In the announcement of the publication of **New Permian Vertebrates from the Chickasha Formation in Oklahoma** in the January 1966 issue of **Oklahoma Geology Notes,** the designation of the report was erroneously given as Bulletin 70; the correct designation is Circular 70.

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