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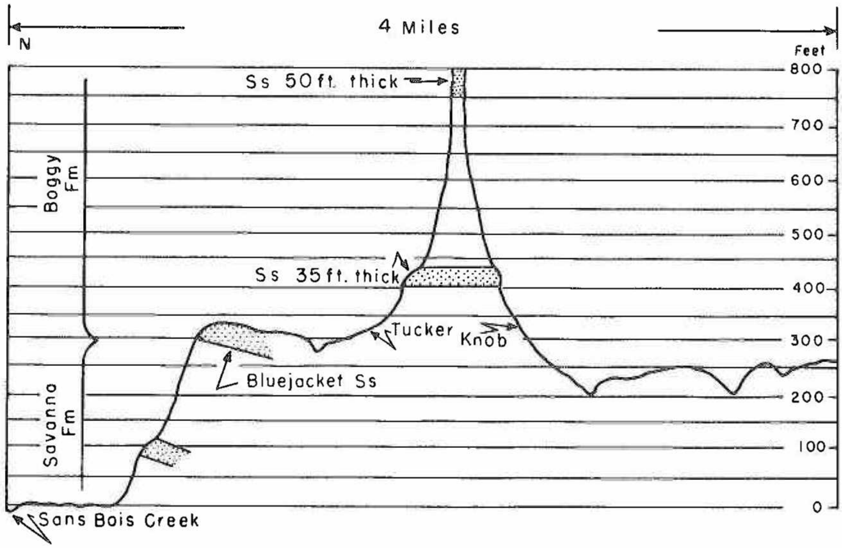
Cover Picture

Tucker Knob

The cover photograph is a vertical view taken for the United States Department of Agriculture, Agricultural Stabilization and Conservation Service, as part of the coverage of Haskell County, and includes the topographic feature known as Tucker Knob. Haskell County was mapped geologically in 1943 and 1944 by Malcolm C. Oakes, of the Oklahoma Geological Survey, and Maxwell M. Knechtel, of the United States Geological Survey. The map and report were published by the Oklahoma Geological Survey as Bulletin 67, 1948.



Tucker Knob is in sections 20 and 21, Township 7 North, Range 19 East, on the axis of the Panther Mountain syncline, and contains only rocks of the Boggy Formation. The summit is about one-half mile east of State Highway 2, about seven miles north of Lake Carlton in Robbers Cave State Park, in Latimer County. The lower part of the slope is visible from the road. On the photograph, the Knob is indicated by encircling bands of light and dark tones, caused by differences in vegetation on outcrops of sandstone and shale. The stereoscopic views of Tucker Knob, from this photograph used with adjacent overlapping photographs, are as striking as the approximate profile above, which was drawn through the summit along the line between sections 20 and 21 and extends northward to Sans Bois Creek. The elevation of the summit is about 1,300 feet above sea level. The easiest way up is from the south, along the east side of section 20. The ascent is steep, but the view from the top of the pinnacle, over the valley to the north and the mountains to the south, is worth the effort.

—M. C. O.

A Permian Fungus Spore Type from the Flowerpot Formation of Oklahoma*

L. R. Wilson

A species of fungal spore of the conidiospore type is abundant in the Flowerpot Shale of Oklahoma. This formation belongs to the Guadalupean Series and is considered to be Upper Permian in age. The outcrop from which the samples containing the fungus spores were collected is in SE¼ sec. 2, T. 4 N., R. 23 W., along the north bank of Salt Fork of the Red River in Greer County, Oklahoma. The stratigraphy and lithology of the section have been described in detail (Wilson, 1962) and it is sufficient here to note that the stratum in which the fungus spores occur is an olive-gray marine shale. In this shale also occurs an abundant spore and pollen flora of pteridophytes and gymnosperms. In addition to the plant fossils there occur a species of *Hystrichosphaeridium* (Wilson, 1960) and one species of scolecodont. No megafossils have been found in the Flowerpot Shale of the vicinity.

The microscope slide preparations containing the fungus spores are the same as those from which the Flowerpot Shale flora was described in the above papers. The shale samples were digested in 52 percent hydrofluoric acid and then treated with Schulze's solution and ammonium hydroxide. An ultrasonic generator was employed to free the fossils from adhering particles. The mounting media used for the microscope slide preparations were glycerine jelly or Clearcol.

DESCRIPTION OF FOSSILS

FUNGI SPORAE DISPERSAE

Class Fungi imperfectae

Order Moniliales

Genus *Reduviasporonites* gen. nov.

Genotype: **Reduviasporonites catenulatus** sp. nov.

Conidia-like spores occurring in uniseriate chains (phragmospores?) of several or more individuals; subspherical, slightly flattened at the contacts with adjacent spores, all approximately same diameter, walls 1 to 2 microns thick, uniform, smooth or slightly rough, yellow or brown, translucent.

The fossils of *Reduviasporonites* resemble somewhat the conidiospores of some species in the living genera *Aspergillus, Penicillium, Memnoniella, Lacellina, Hormodendrum, Monilia, Oospora,* and *Torula* (see illustrations in Clements and Shear, 1931; Funder, 1953; and Barnett, 1955), but are markedly different in size and in details of the spore walls. The fossils differ from *Penicillites curtipes* Berkeley, 1848 (Eocene), as illustrated in Hirmer (1927, p. 116), in having spores of subspherical rather than elliptical shape and walls that are relatively

*One study conducted under National Science Foundation Grant No. G6589.

thinner than those in *Penicillites*. *Reduviasporonites* differs from *Cercosporites* sp. Salmon 1903 (Miocene) in having more uniformity of spore size and chains that are straighter and always uniseriate. The spores of *Reduviasporonites* are translucent, whereas those of *Cercosporites*, described by Salmon, are opaque. The relating of Salmon's fossils to the modern genus *Cercospora* Fresenius seems a poor choice for the conidiospores of *Cercospora* are filiform, acicular, obclavate, or clavate in shape (Chupp, 1953), whereas those of *Cercosporites* are globular. Another fossil fungus with which *Reduviasporonites* should be compared is the Eocene *Torulites moniliformis* Menge (Caspary, 1906-07). This form, is illustrated as having spores that are progressively smaller toward the apex (Hirmer, p. 124). The shape of the spores and mycelium of *Torulites* compares more closely with the modern genus *Hormiscum* Kunze ex Wallr. than with *Torula* Presoon ex Fr.

Reduviasporonites spores remain persistently in chains of a number of individuals. They are more often found in chains of five to seven, but in one specimen a chain of ten was observed. Only a single specimen of an isolated individual was found, and it is probable that it had been torn from a chain during the ultrasonic processing.

The prefix of the generic name *Reduviasporonites* has been derived from the Latin *reduvia* (fragment), and the root and suffix *sporonites* indicates that the specimens are fossil fungus spores not organically attached to other fungal structures. *Sporonites* is used in preference to *sporites* to indicate that the spore is of fungal affinity.

Explanation of Plate I

Reduviasporonites catenulatus **gen. and sp. nov. Permian fungus spores from the Flowerpot Shale of Greer County, Oklahoma**

Figure 1. OPC 1-64-4 (holotype) Eight-spore chain showing characteristic fracture and compression folds of the Flowerpot Shale fungus spores.
Length of chain 118.2μ, width of spores 15.76 to 21.67μ, length of spores 15.76 to 23μ.

Figure 2. OPC 1-59-3 A seven-spore chain showing a slight difference in diameter. This is due to the twisted aspect of the chain.
Length of chain 74.86μ, width of spores 13 to 17.76μ, length of spores 13 to 17.73μ.

Figure 3. OPC 1-60-1 A seven-spore chain showing characteristic wrinkling and condition in which most of the Flowerpot Shale fungus spores occur. Length of chain 78.8μ, width of spores 15.7-17.7μ, length of spores 10.2-13.8μ.

Figure 4. OPC 1-64-4 (holotype) Oil-immersion photomicrograph of uppermost spores shown in figure 1. The spore wall is slightly roughened.

Figure 5. OPC 1-61-1 A five-spore-chain fragment showing a slightly modified shape of the uppermost spore. Length of chain 73μ, width of spores 17.73 to 19.7μ, length of cells 17.73 to 19.7μ.

Figure 6. OPC 1-62-1 A three-spore-chain fragment showing simple spore attachment. The darkened triangular areas in the two lower spores are torn portions of the respective spore walls.
Length of chain 39.4μ, width 15.76μ, length of spores 14 to 15.76 μ.

Plate I

Reduviasporonites catenulatus sp. nov.
Plate I, figures 1-6

Description as for the genus; consisting of a variable number of spores in moniliform chains, largest number observed 10; diameter of spores 13 to 23 microns; normally subspherical, flattened specimens have compression folds and cracks.

The specific name is derived from the Latin *catena* (chain) and is given in reference to the occurrence of the spores in chain-like units.

Holotype: Specimen OPC 1-64-4. An eight-spore chain; length of chain 118.2 microns, length of spores 15.76 to 23 microns, width of spores 15.76 to 21.67 microns. Plate I, figures 1 and 4.

Several hundred specimens have been observed during an examination of 150 microscope-slide preparations of the Flowerpot Shale. This abundance may indicate that the fungus was of a marine type and thrived in the shallow waters of the sea; however, no account of a modern marine fungus comparable to *Reduviasporonites catenulatus* has been found during a search of the literature. There are numerous soil-inhabiting fungi to which the fossils bear some resemblance. The generic names of these are noted above. These fungi produce an abundance of spores that are widely disseminated by wind and some are known to occur in marine deposits. Because the Flowerpot Shale fungus spores occur associated with pteridophyte spores and gymnosperm pollen, from upland and lowland plant communities, it might be inferred that *Reduviasporonites* was a terrestrial fungus species, but, until more evidence is found, this is only an assumption.

The abundant occurrence of fungus spores in palynological assemblages is not a rare phenomenon and, when the literature on living fungus-spore dissemination is reviewed, one must conclude that fungus spores are an important component. Research has shown that from at least Permian time to the present isolated spores of fungi (Fungi Sporae dispersae) have occurred in ever-increasing numbers and varieties. In earlier rocks the commonly observed fungus fossils are inter- and intracellular types associated with roots, stems, and leaves of vascular plants and have been mainly observed in thin sections of petrifactions, or as scars on leaf compressions. For a survey of fossil fungi see Hirmer (1927).

Almost concurrently with the appearance of the angiosperms in the fossil record, isolated spores of fungi appear in great abundance. Many of these Sporae dispersae are assignable to the Basidiomycetes, one of the more complex groups of fungi and one whose life cycles are intimately associated with the gymnosperms and angiosperms upon which many are parasites. It would seem probable, therefore, that the Basidiomycetes as an important element appeared some time after the gymnosperm-angiosperm plant association had evolved. The abundant occurrence of isolated fungus spores in the rocks suggests that those fungi which produce atmospherically borne spores may have evolved at approximately Pennsylvanian-Permian time and developed to major importance during the Late Cretaceous and Early Tertiary.

In palynological studies there are at least four factors which affect the fungus-spore record. These are: (1) production of spores, (2) distribution, (3) preservation, and (4) recovery for study. A few studies of modern fungi may be cited which will illustrate the phenomenal production of fungus spores, and it is reasonable to assume that in the geological past similar quantities of spores also were produced. Arthur (1929) stated that more than 2 billion spores may be formed from a single gall of the cedar-apple fungus. Meyer (1936) calculated that in twenty days a sporophore of *Fomes fomentarius* sheds 7,636,986,301,369 spores. Heald (1937) stated that in eastern Washington *Tilletia tritici* may be so abundant as to deposit 5 million smut spores on each square foot of soil. The spore production of a specimen of *Calvatia gigantea* was estimated by Moss (1940) as 20 million million. These and numerous other estimates derived from mycological studies demonstrate the potential importance of fungus spores to the palynologist. The occurrence of fungus spores in many types of sediments indicates that the parent plants lived in many environments and/or the spores were widely distributed by wind, water, and animals. It can be assumed from the wide range in the habitats of modern fungi that in the past fungi were also native to almost all environments where other organisms thrived. In aquatic fungi the spores that are produced need travel little distance to the place of burial and possible preservation. Observations of the dispersal of modern fungus spores indicate that they are also among the widest spread objects that can be found in palynological associations. Stakman and others (1923) entrapped viable rust spores at 16,500 feet over Waco, Texas, and at 5,000 feet over Manitoba. Rittenberg (1939) collected the soil-inhabiting organisms *Alternaria, Catenularia, Cephalosporium, Cladosporium, Penicillium, Spicaria, Sporotrichum, Stemphylium,* and *Trichoderma* on exposed agar plates in the Pacific Ocean near Monterey, California, and 400 miles seaward. Spores of several of these genera have been recovered by the writer from the Tertiary marine sediments of the Texas Gulf Coast. Studies of Pady (1955) over the Atlantic Ocean showed that fungus spores are common constituents of the atmosphere and are especially common in the tropical air masses. There was little diminution in the number of spores observed with increased distance from land. In two aerial crossings of the Atlantic from Montreal, Canada, to London, England, 24 genera of fungi were collected, the most common being *Cladosporium.*

The walls of fungus spores are from less than one micron to as much as several microns thick, and may be smooth, spiny, reticulate, or otherwise ornamented. The preservation of fungus spores, like that of other spores, can be expected to depend upon spore structure, sedimentation, and sediment diagenesis. As stated above and shown by the specimens recovered from the Flowerpot Shale and other rocks, fungus spores are abundantly preserved as fossils and generally are easily recovered from sedimentary rocks.

In conclusion it may be stated that one of the relatively unexplored areas of palynology is the study of the Fungi Sporae dispersae and their relations to plant evolution, paleoecology, and stratigraphy.

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1959 Bibliography of North American Geology

The useful series of volumes of cross-indexed bibliographies of geologic literature of North America has just been augmented by the 1959 volume, a thick book of 605 pages. It is disappointing that a ten-year volume was not issued and that no plan for a consolidated bibliogarphy has been announced. Geologists would appreciate a 1950-1960 volume and would be greatly aided by a 1919-1960 volume.

Oklahoma items listed number 125. Of these, 39 were published by Oklahoma Geological Survey; 17 in the Ouachita symposium of Ardmore and Dallas Geological Societies; 16 in the A. A. P. G. special volume, *Petroleum Geology of southern Oklahoma, volume 2;* eight in the *Shale Shaker* of Oklahoma City Geological Society, seven in *Proceedings of Sixth Geological Symposium* of the School of Geology, The University of Oklahoma; six in *Tulsa Geological Society Digest;* four in the *Bulletin of the American Association of Petroleum Geologists;* three in *Proceedings of Oklahoma Academy of Science;* and one or two each in 21 other journals.

The book is *Bibliography of North American Geology, 1959, U. S. Geological Survey, Bulletin 1145.* It can be purchased from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for $2.00.

—C. C. B.

Geology of the Southeast Dover Field, Kingfisher County, Oklahoma

John T. Bado*

Southeast Dover Field is five miles northeast of Kingfisher, Oklahoma. The oil field extends under parts of secs. 1, 12, 13, 23, 24, and 26, T. 17 N., R. 7 W., Kingfisher County. Part of the area was formerly named the Northeast Dunlap Field, but the two producing areas were combined by the Oklahoma Nomenclature Committee, July 31, 1961, and designated the Southeast Dover Field.

Northeast Dunlap Field was discovered by the Calvert Drilling, Inc., and King-Stevenson Oil Co. No. 1 Perdue, sec. 23, T. 17 N., R. 7 W., in April 1959 (fig. 1). The No. 1 Perdue was drilled to a total depth of 8,035 feet into the Hunton dolomite of Devonian-Silurian age. Top of the Hunton was called at 7,970 feet. With 5.5-inch casing set at 8,030 feet, perforations in the Hunton dolomite from 7,973 to 7,975 feet produced a gas flow of 1,020,000 cubic feet per day plus 36 barrels of condensate and 99 barrels of salt water. The hole was then plugged back to 7,900 feet and perforations were made in the Oswego, a limestone near the base of the Marmaton Group, Pennsylvanian in age. After treatment with acid, on initial-potential test the well flowed at the rate of 320 barrels of oil per day plus 5 barrels of water through a 24/64-inch tubing choke. Gravity of the oil ranges from 41° to 43° API.

In October 1959, the originally named Southeast Dover Field was found by the same operators in the No. 1 Corr in sec. 13 (fig. 1). The test was drilled into the Hunton, plugged back and completed in the Oswego for an initial flowing potential of 300 barrels of oil per day. This test is designated the discovery well of the combined Southeast Dover Field by the Oklahoma Nomenclature Committee. In the field area four holes have been drilled into the Hunton, and a fifth well tested the stratigraphically deeper sandstones of the Simpson Group, Ordovician in age (table I).

The producing formation in the Southeast Dover Field is the Oswego, a limestone considered equivalent to the Fort Scott Limestone of surface nomenclature, Middle Pennsylvanian in age (fig. 2). The limestone is buff to light brown, fine crystalline to granular, sandy, and oöcastic. It is interbedded with light-brown, fine- to medium-crystalline and granular, oöcastic dolomite. Depth to the top of the producing unit ranges from 6,620 to 6,875 feet.

Production appears to be stratigraphically controlled by two factors: (1) porosity and permeability variations from well to well, and (2) gradation of the productive limestone unit to shaly limestone. Available data on reservoir characteristics indicate that the main development of good porosity and permeability and of purer carbonate rock trends southwest to northeast. Structural position of the well apparently has little bearing on good reservoir conditions. Initial flowing potentials range from 4 to 658 barrels of oil per day.

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*Geologist, Gulf Oil Corporation, Oklahoma City, Oklahoma

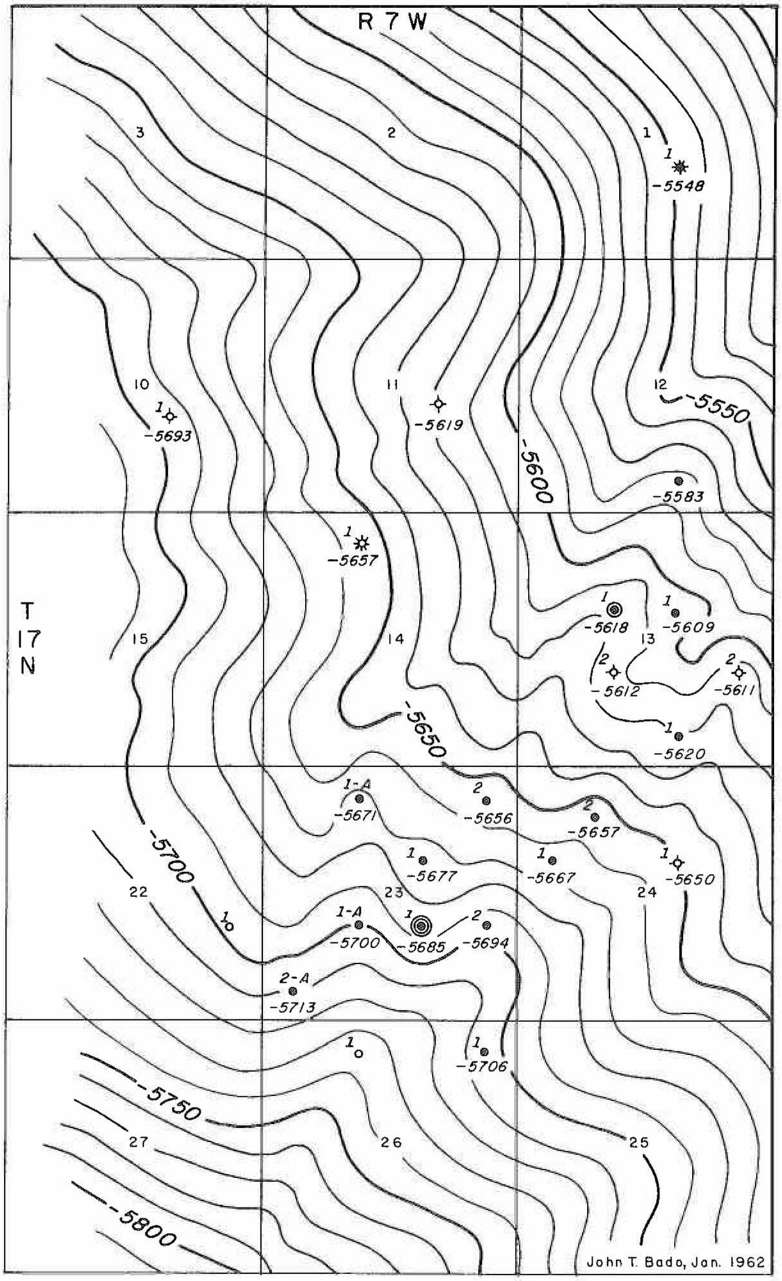


Figure 1. Structure map of Southeast Dover Field, Kingfisher County, contoured at top of Oswego "pay zone." Contour interval is 20 feet. Northeast Dunlap discovery well shown by one circle; Southeast Dover by two circles.

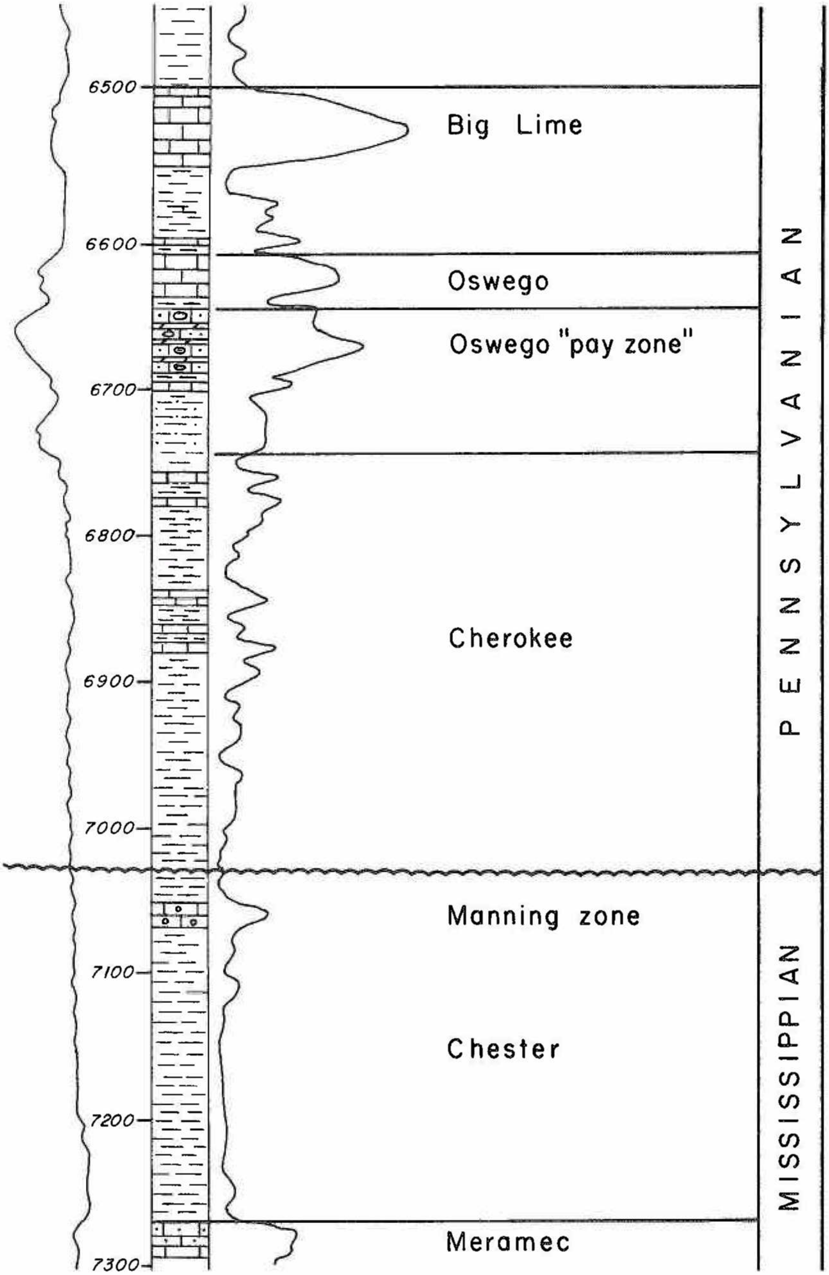


Figure 2. Typical electric and lithologic log of Southeast Dover illustrated by Calvert, King-Stevenson No. 1 Corr, SE¼ NW¼ sec. 13, T. 17 N., R. 7 W., Kingfisher County, Oklahoma.

TABLE I.—DEVELOPMENT HISTORY OF SOUTHEAST DOVER FIELD, KINGFISHER COUNTY, OKLAHOMA

Operator- Well name- Completion date-	Location- Elevation (feet)-	Top Oswego pay zone (feet)-	Perforations	Initial potential	Total depth- Deepest formation penetrated- Remarks-
Calvert & King-Stevenson No. 1 Perdue May 27, 1959	NW SE 23-17N-7W 1,089 KB	6,774	6,787-6,789 6,795-6,801 6,806 6,813-6,815	F 320 BOPD & 5 BWPD	8,035 Hunton Discovery well Northeast Dunlap Field
Tidewater No. 1 Vail July 8,1959	SW NE 23-17N-7W 1,069 KB	6,746	6,756-6,772	F 198 BOPD	6,859 Des Moines
Calvert & King-Stevenson No. 1 Corr October 10, 1959	SE NW 13-17N-7W 1,025 KB	6,643	6,648-6,668	F 300 BOPD	7,850 Hunton Discovery well Southeast Dover Field
Calvert & King-Stevenson No. 1-A Hobbs January 13, 1960	NE NW 23-17N-7W 1,065 KB	6,736	6,744-6,758	F 4 BOPD & ½ BWPD	7,200 Chester
Calvert No. 1 Perdue "A" March 3, 1960	NE SW 23-17N-7W 1,075 KB	6,775	6,780-6,788	F 162.5 BOPD	6,908 Des Moines
Calvert No. 1 Higgins March 9, 1960	SW NW 24-17N-7W 1,041 KB	6,708	6,720-6,740	F 350 BOPD	6,756 Oswego
Tidewater No. 1 Perdue July 13, 1960	NE NE 26-17N-7W 1,090 KB	6,796	6,764-6,830	P 16 BOPD, 5½ BWPD, & 44,000 CFGPD	6,885 Oswego
Tidewater No. 2 Vail July 27, 1960	NE NE 23-17N-7W 1,054 KB	6,710	6,715-6,736	F 115 BOPD	6,831 Des Moines

Calvert No. 1 Wrobbel August 3, 1960	SW SE 13-17N-7W 1,023 KB	6,643	6,648-6,668	F 197 BOPD	7,850 Des Moines
Calvert No. 1 Seefeldt November 15, 1960	SW NE 24-17N-7W 1,033 KB	6,683	None	None	7,856 Hunton Plugged & Abandoned
Calvert No. 2 Perdue December 20, 1960	NE SE 23-17N-7W 1,092 KB	6,786	6,798-6,806 6,809-6,813 6,816-6,876	F 216 BOPD	6,875 Des Moines
Calvert No. 2 Higgins February 2, 1961	C NW 24-17N-7W 1,037 KB	6,694	6,693-6,713	F 658 BOPD	6,793 Oswego
Calvert No. 2 Wrobbel February 2, 1961	NE SE 13-17N-7W 1,024 KB	6,635	None	None	6,753 Des Moines Temp. Abandoned
Eason No. 1 McNulty March 10, 1961	SW NE 13-17N-7W 1,023 DF	6,632	6,642-6,662	F 70 BOPD	6,783 Des Moines
Conoco No. 2 Corr April 28, 1961	NE SW 13-17N-7W 1,025 KB	6,637	6,637-6,657	Failed to Produce	6,772 Des Moines Plugged & Abandoned
Tidewater No. 1 Perdue June 16, 1961	NE NE 26-17N-7W 1,090 KB	See previous notes on original completion above.			6,885 Des Moines Oil well workover: Now producing from Cottage Grove zone, P 8 BOPD
Eason No. 1 Vincent June 20, 1961	SW SE 12-17N-7W 1,029 KB	6,612	6,624-6,644	F 83 BO plus 2 BSWPD	6,782 Des Moines
Conoco No. 2 Perdue "A" December 1, 1961	SW SW 23-17N-7W 1,103 KB	6,816	6,827-6,864	F 213 BO plus 132, 300 CFGPD	6,940 Des Moines

TABLE I. (cont.)

Operator- Well name- Completion date-	Location- Elevation (feet)-	Top Oswego pay zone (feet)	Perforations	Initial potential	Total depth- Deepest formation penetrated- Remarks
Yinger No. 1 Martin February 1, 1962	NW SE 1-17N-7W 1,084 DF	6,632	6,640-6,660	F 25 BOPD	8,567 Simpson PBTD - $4\frac{1}{2}$" csg. @ 7,153 Also produces 500 MCFGPD from Manning perforations 7,028-7,032 feet.
L. H. Armer No. 1 Gazin November 7, 1956	NE NW 14-17N-7W 1,029 DF	6,686		F 3,735 MCFPD plus 2.8 bbls condensate in 4 hrs	8,138 Hunton $5\frac{1}{2}$" casing @ 7,203 Produces only from Manning perforations 7,115-7,125
Conoco No. 1 L. E. Perdue	NE SE 22-17N-7W				Drilling
Conoco No. 1 F. C. Truel	NE NW 26-17N-7W				Drilling

Two gas-producing wells (each of which is about a mile from the present field area) in secs. 1 and 14 are shown on figure 1. The well in sec. 1 produces oil from the Oswego and gas from the Manning zone of the Chester Group, Mississippian in age. The well in sec. 14 produces gas and condensate from the Manning zone only (table I).

As of January 1962, the field contained 15 producing wells, three dry holes, and two holes (sec. 22 and 26) in the process of being drilled (table I). First production was established on May 27, 1959. Nine wells produced 83,479 barrels of oil from May 1959 to June 1961. The discovery well, No. 1 Perdue, produced a total of 20,492 barrels of oil for the period, May 1959 to December 1960. The development history of the field is given in table I.

Brachyschisma, A MIDDLE DEVONIAN BLASTOID FROM NEW YORK

ROBERT O. FAY

The genus *Brachyschisma* Reimann, 1945, with type species *Codaster corrugata* Reimann, 1935, is represented by three species from the Onondaga Limestone (Middle Devonian), Vogelsanger (Fogelsanger?) quarry, Williamsville, Erie County, New York. *Codaster curtus* Reimann, 1935, from the Tichenor Limestone, Eighteen Mile Creek, Erie County, New York, may belong to the above genus, but the only known specimen could not be examined and no positive assignment could be made. All types are on deposit in the Buffalo Society of Natural Sciences Museum.

Brachyschisma may be distinguished by its thick plates, nine exposed hydrospire fields (the "D" ambulacral field missing next to anus) with eight to nine hydrospire folds in each field except on anal side ("C" side only) where five folds occur, three anal deltoid plates (a superdeltoid, subdeltoid, and hypodeltoid), wide sinus areas adjacent to ambulacra, wide-keeled lancet plates, and broadly turbinate form.

The three known species may be distinguished: *B. corrugatum* has a pelvic angle on radials of about 90 degrees and on basalia of 60 degrees, with slightly indented interradial sutures in top view; *B. subumbrosum* has a 90-degree pelvic angle on radials and a 45-degree angle on basalia, with rather strongly indented interradial sutures; *B. subcrassum* has a 65-degree pelvic angle on radials and basalia, with slightly indented interradial sutures, and is higher than wide, whereas the other two species are about as wide as high.

Brachyschisma corrugatum (Reimann), 1935

Plate I, figures 1-5; text-figure 1

Codaster corrugata Reimann, 1935, in part, p. 25, pl. 4, fig. 2.
Brachyschisma corrugatum (Reimann), in Reimann, 1945, p. 23, pl. 5, figs. 1, 4, 7-9.

Description is of the type specimen. Theca calcitic, with thick plates, approximately 12 mm long by 14 mm wide, with damaged base and matrix-filled summit. Parachute-shaped in side view, lobed pentalobate in top view, with vault 6 mm long, preserved part of pelvis 6 mm long, pelvic angle on radial bodies approximately 90 degrees, and on basalia 60 degrees. Basalia damaged, broadly conical, approximately 3 mm long by 7 mm wide, with three normally disposed basals.

Radials five, broadly subquadrangular, each 9 mm long by 6 mm wide, with outward-flaring ambulacra and sinus 5.5 mm long by 6 mm wide. There are eight to nine hydrospire folds on each side of an ambulacrum, with two to three hidden under the lancet. On the anal side, the hydrospire folds are reduced in number on the "C" ambulacral side to five folds, and are absent on the "D" ambulacral side; thus there are nine exposed hydrospire fields. Radials overlap deltoids.

Deltoids four, mostly hidden beneath matrix, but in other specimens are sublancet-shaped, each approximately 5 mm long by 3.5 mm wide, with hydrospire folds continuous with adjacent radial plates. On the anal side are three deltoid plates: a U-shaped superdeltoid adjacent to the oral opening; an elongate U-shaped subdeltoid plate on the aboral face of the superdeltoid surrounding the adoral side of the anal opening; and a subpentagonal hypodeltoid on the aboral side of the anus, overlapping the subdeltoid limbs and abutting against the adjacent radial limbs. The radials overlap the subdeltoid plate and the other four deltoid plates. The right subdeltoid limb has five hydrospire folds, and the left subdeltoid limb lacks hydrospire folds.

Explanation of Plate I

Brachyschisma corrugatum **(Reimann). Buffalo Society of Natural Sciences Museum. Middle Devonian, Onondaga Limestone, Vogelsanger quarry, Williamsville, New York.**

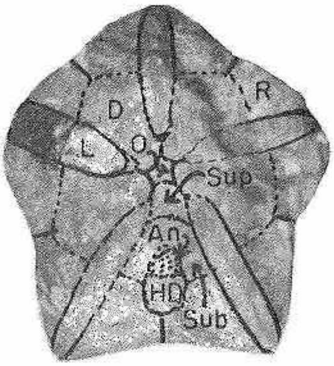
Figures 1, 2, 5. **Oral, aboral, and "D" ambulacral views, cotype E 9,070, x3.3.**

Figure 3. **Longitudinal (almost axial) section showing small body cavity, keeled lancet, and hydrospire folds, metatype E 22,496, x8.3.**

Figure 4. **Tangential (longitudinal) section through anal interradius, showing five hydrospire folds on right side of anal area and absence of folds on left side, with small body cavity, metatype E 22,494, x8.3.**

An—anal opening	**O—oral opening**
B—basal plate	**R—radial plate**
D—deltoid plate	**Sp—Side plate**
HD—hypodeltoid plate	**Sub—subdeltoid plate**
Hs—hydrospire slits	**Sup—superdeltoid plate**
L—lancet plate	**Z—azygous basal plate**

Plate I



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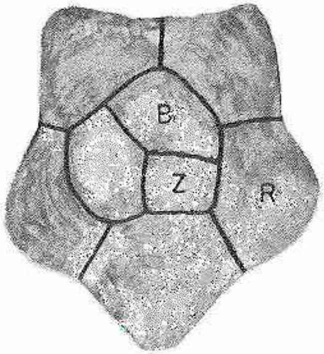

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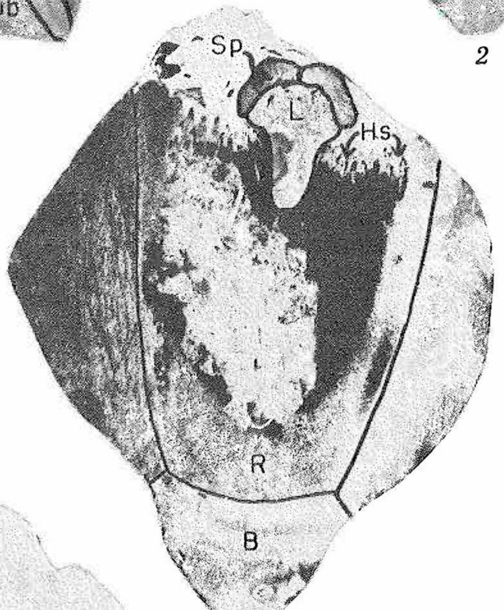

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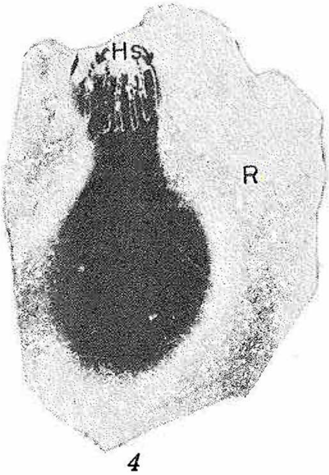

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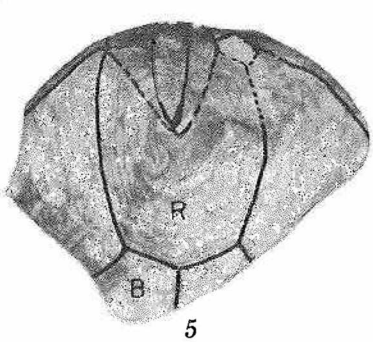

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Ambulacra five, linear, each 9 mm long by 1.75 mm wide, with lancet covered by side plates, with approximately 20 side plates in 10 mm length of an ambulacrum. The lancet stipes are about 1 mm away from the oral opening, and the side plates are elevated above the plane of the sinus areas. The lancet has an inner elongate rounded keel and is broadly mushroom-shaped in cross-sectional view. The primary side plates are thick and semihemispherical in side view or cross section, extending down the sides of the strongly rounded convex surface of the lancet plate. The secondary or outer side plates are large, subrectangular in top view, seemingly alternating in position with the primary side plates and partly overlapping the abmedial-adoral corner of each primary side plate, being mainly on the abmedial sides of the ambulacra. The surfaces of the thecal plates are ornamented with coarse growth lines subparallel to plate margins.

Types and occurrence.—Cotype, E 9,070; metatypes, E 22,494 (one longitudinal section), E 22,495 (one cross section), E 22, 496 (one axial section), Buffalo Society of Natural Sciences Museum, Buffalo, New York. All are from the Onondaga Limestone (Middle Devonian), Vogelsanger quarry, Williamsville, New York. Many other specimens are on deposit in the above-named museum.

Brachyschisma subcrassum Reimann, 1945
Plate II, figures 5-7

Brachyschisma subcrassum Reimann, 1945, p. 24, pl. 5, fig. 3.

The holotype is 14.5 mm long by 12.5 mm wide, with vault 7 mm long, pelvis 7.5 mm long, and pelvic angle of 65 degrees on basalia and radial bodies. In top view the interradial sutures are slightly indented. Otherwise the description is similar to that of the foregoing specimen of *B. corrugatum,* differing in proportional measurements of plates.

Type and occurrence.—Holotype, E 16,045, Buffalo Society of Natural Sciences Museum, Buffalo, New York; from Middle Devonian, Onondaga Limestone, Vogelsanger quarry, Williamsville, New York.

Explanation of Plate II

Brachyschisma spp., **Buffalo Society of Natural Sciences Museum. Middle Devonian, Onondaga Limestone, Vogelsanger quarry, Williamsville, N. Y.**

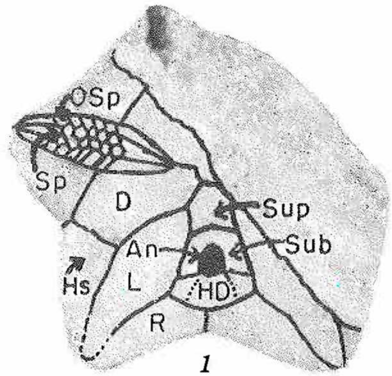
Figures 1, 3. B. subumbrosum **Reimann. Oral and "D" ambulacral views, cotype E 15,981, x3.3.**

Figures 2, 4. B. subumbrosum **Reimann. Oral and "D" ambulacral views, cotype E 12,133, x3.6.**

Figures 5-7. B. subcrassum **Reimann. Oral, "D" ambulacral, and aboral views, holotype E 16,045, x3.9.**

An—anal opening | **O—oral opening**
B—basal plate | **OSp—outer side plate**
D—deltoid plate | **R—radial plate**
HD—hypodeltoid plate | **Sp—primary side plate**
Hs—hydrospire slits | **Sub—subdeltoid plate**
L—lancet plate | **Sup—superdeltoid plate**
Z—azygous basal plate

Plate II



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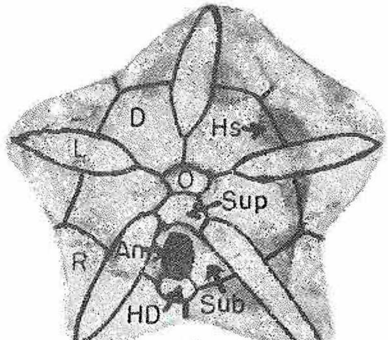

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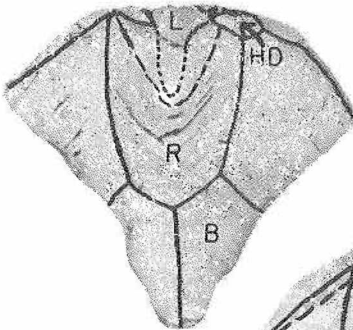

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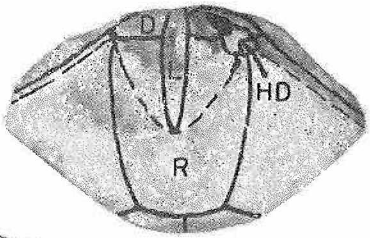

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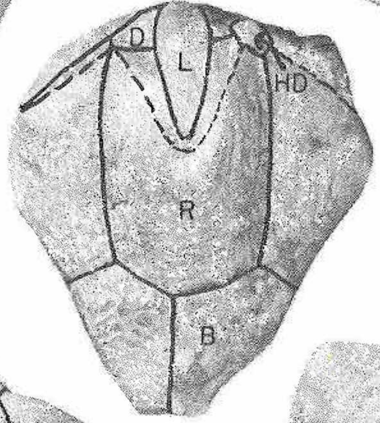

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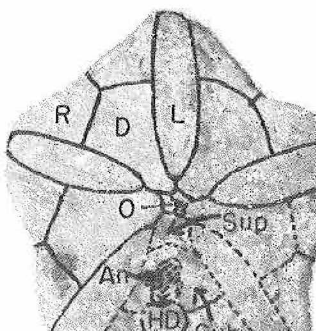

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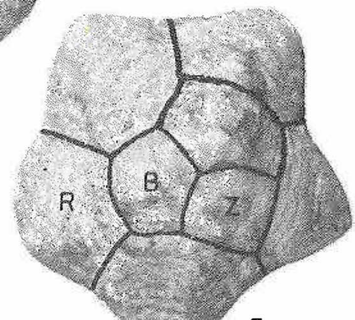

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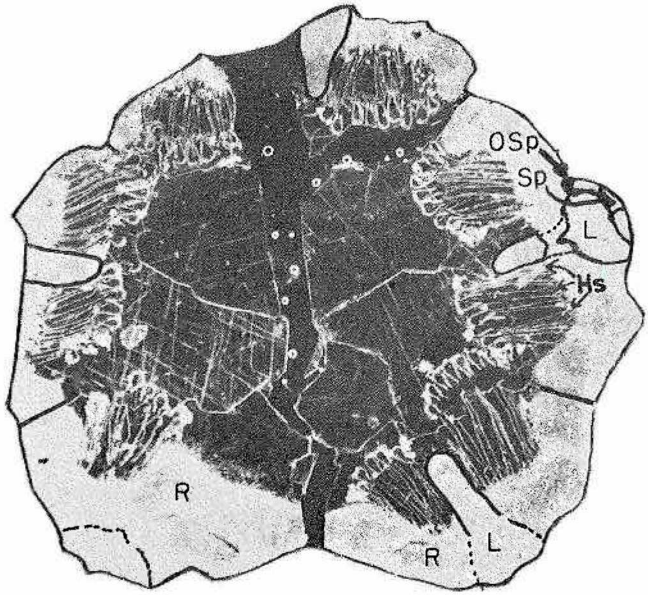

Text-figure 1. Brachyschisma corrugatum **(Reimann). Cross-section (anal side down), oral view, of metatype E 22,495, Buffalo Society Natural Sciences Museum, x8.3. Middle Devonian, Onondaga Limestone, Vogelsanger quarry, Williamsville, New York.**

Hs—hydrospire slits **OSp—outer side plate**
L—lancet plate **R—radial plate**
Sp—side plate

Brachyschisma subumbrosum Reimann, 1945
Plate II, figures 1-4

Codaster corrugata Reimann, 1935, in part, p. 25, pl. 4, fig. 1.
Brachyschisma subumbrosum (Reimann), 1945, p. 23, pl. 5, figs. 2, 5, 6.

One cotype is 13.5 mm long by 14.5 mm wide, with vault 3.5 mm long, pelvis 10 mm long, and pelvic angle on basalia 45 degrees and 90 degrees on radial bodies, with moderately strongly indented interradial sutures. The morphological features are otherwise similar to those of *B. corrugatum.*

Types and occurrence.—Cotypes, E 12,133, one specimen; E 15,981, specimen; Buffalo Society of Natural Sciences Museum, Buffalo, New York. All are from the Middle Devonian, Onondaga Limestone, Vogelsanger quarry, Williamsville, New York.

References Cited

Reimann, I. G., 1935, New species and some new occurrences of Middle Devonian blastoids: Buffalo Soc. Nat. Sciences, Bull., vol. 17, no. 1, p. 23-45, 4 pls.

———— 1945, New Devonian blastoids: Buffalo Soc. Nat. Sciences, Bull., vol. 19, no. 2, p. 22-42, pls. 5-9.

Crinoids of the Brownville Formation

Harrell L. Strimple

The crinoids described by Moore (1939) from the Brownville Formation, uppermost Virgilian, came from the vicinity of Strohm, Osage County, Oklahoma, and from the area for some seven miles to the west in the vicinity of Fairfax, Osage County, Oklahoma. Most of the material, including crowns, came from a cut on the A. T. & S. F. Railroad about five miles west of Strohm, near C south line SE¼ sec. 35, T. 25 N., R. 6 E. This is the University of Kansas location 4604. The exposure was found by Paul McGuire, who then lived at the loading station of Strohm. Mr. McGuire explained the conditions of preservation to me several years ago. The rocks taken from the cut were dumped on each side of the exposure, above the cut. The best material was preserved in association with a sandy limestone that is not now exposed. It was apparently either a localized lentil, or it came from a zone subsequently covered by the road-bed. For several years excellent calyces of *Delocrinus* could be found in the existing exposures, especially in thin clay shale on large blocks of limestone that fell from the walls of the cut from time to time. On an expedition to the outcrop in the spring of 1960, it was found that the large blocks of fallen limestone had been removed, presumably by the railroad. An intensive search yielded one dorsal cup of *Delocrinus ponderosus* Strimple and one of *Delocrinus brownvillensis* Strimple. This is the type locality of both species. The specimens are designated as metatypes and are numbered 3925 and 3926 respectively in the paleontological collections of The University of Oklahoma.

A large calyx of *Delocrinus brownvillensis* with a portion of one arm preserved in place, has been found in the Brownville Limestone in a road-cut on State Highway 18, SE cor. sec. 21, T. 18 N., R. 5 E., some two miles north of Cushing, Oklahoma, by C. C. Branson. The calyx has a maximum width of 30 mm; however, it is distorted by lateral compression. The height is 15 mm. Of considerable interest is the nature of the axillary primibrach, preserved in the left anterior ray, which has an appearance identical with that of a typical primibrach of *Erisocrinus*. It fills the entire width of the radial, which is 14.5 mm, and is 7 mm high. The area just below the apex is slightly swollen. The secundibrachs become interlocking with the second ossicle. This specimen is numbered 320 in the paleontological collections of The University of Oklahoma.

Delocrinus ponderosus is a rare form but *D. brownvillensis* is rather plentiful. I have seen at least a dozen specimens of the latter, most of which, including the holotype, are now in the Springer Collection, U. S. National Museum. Moore and Plummer (1940) referred three dorsal cups from the Brownville Limestone, near C NW¼ sec. 10, T. 24 N., R. 6 E., about seven miles west of Strohm, to *Delocrinus vulgatus* Moore and Plummer, 1940, as paratypes. Although the location is two miles west of the type locality of *D. brownvillensis*, the specimens are no doubt referable to my species. Description and cited measurements of *D. vulgatus* were based on specimens from the

Harpersville Formation, Cisco Group, Vifgilian, in Young and Stephens Counties, Texas. The Texas species is not conspecific with *D. brownvillensis* although they are somewhat similar forms.

A list of described crinoids from the Brownville Formation is given below:

FLEXIBILIA

Cibolocrinus banioni Moore, 1939
**Trautscholdicrinus mcguirei* Moore, 1939

INADUNATA

**Plummericrinus mcguirei* (Moore), 1939. Genotype of *Plummericrinus* Moore and Laudon, 1943
Plaxocrinus modestus Moore, 1939
Plaxocrinus praevalens Moore, 1939
Plaxocrinus virginarius Moore, 1939
Perimestocrinus subtilis Moore, 1939
Utharocrinus quinquacutus Moore, 1939
Graphiocrinus delicatulus Moore, 1939
Aesiocrinus dilatus Moore, 1939
Oklahomacrinus supinus Moore, 1939. Genotype species
Delocrinus brownvillensis Strimple, 1939
Delocrinus ponderosus Strimple, 1939

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*Crowns of these species were found and described.

References Cited

Moore, R. C., 1939, New crinoids from Upper Pennsylvanian and Lower Permian rocks of Oklahoma, Kansas and Nebraska: Denison Univ. Bull., Jour. Sci. Lab., vol. 34, p. 171-294, pls. 5-9.

Moore, R. C. and **Laudon, L. R.**, 1943, Evolution and classification of Paleozoic crinoids: Geol. Soc. America, Special Paper 46, p. 56.

Moore, R. C. and **Plummer, F. B.**, 1940, Crinoids from the Upper Carboniferous and Permian strata in Texas: Texas, Univ., Publ. 3945, p. 288.

Strimple, H. L., 1939, Studies of Carboniferous crinoids: Palaeontographica Americana, vol. 3, p. 22-27, pl. 4, figs. 1-8.

AAPG Pennsylvanian Symposium

This reviewer was special editor of the newly issued special volume of the American Association of Petroleum Geologists. The project was begun in 1954 and 18 men were selected, each to write a chapter on one of the natural regions of Pennsylvanian rocks. In the succeeding eight years prior to the appearance of the book an extraordinary number of changes occurred: (1) Alaska became a state, but no chapter on its Pennsylvanian rocks is incorporated; (2) fourteen thousand feet of supposed Pennsylvanian rocks in the Ouachita Mountains has been proved to be Mississippian; (3) the Springeran Series has been found to be Mississippian and to deserve no more than formational status; (4) the supposedly Permian Dunkard and Wolfcampian have come to be considered as probably Pennsylvanian. Of the 18 original writers selected there were several changes. One man's house (and manuscript) was destroyed by a tornado. Three men promised well, but produced nothing. One man, C. W. Tomlinson, died before the book appeared.

The book as issued consists of 13 major articles written by 17 authors and co-authors, and with the help of many acknowledged assistants. Wanless' article was written for the symposium but was published in the Bulletin to serve as a model. Tomlinson and McBee wrote their chapter both for the special volume on petroleum geology of southern Oklahoma and for the Pennsylvanian symposium. The work inspired many collateral studies and can be expected to give initial impetus for many more.

The volume is *Pennsylvanian System in the United States,* 508 pages, illustrated. Bound copies are available from American Association of Petroleum Geologists, Box 979, Tulsa, Oklahoma, for $7.50 ($6.50 to members).

—C. C. B.

Volume of Geologic Literature

Carl C. Branson

Somewhere a statement was made that at present 46 percent of geologic literature is printed in the Russian language. The statistic seemed possible and a rapid check was undertaken. The last year for which relatively complete bibliographies are available is 1958.

The *Bibliography and Index of Geology Exclusive of North America, Volume 23,* contains 650 pages of titles and annotations covering geological publications for 1958 and papers not noted in volumes for previous years. The number of papers and total number of pages (excluding necrologies, abstracts, and resumes in languages other than the original one) were tabulated for each language. From this volume half of the pages were examined, the first 162 pages and the last 163 pages. The *Bibliography of Geology of North America, 1958* contains 323 pages of references. Of these, half of the pages (15-96 and 247-327) were examined. Abstracts, necrologies, and maps were ignored. The total number of titles in each count and the total number of pages in each count were doubled in order to obtain approximate totals.

The results (table I) show that Russian geologic publications recorded in the two bibliographies do not total 46 percent of the total, but 16 percent of titles and 32 percent of pages on non-North American subjects, 10 percent of titles and 21 percent of pages on all areas. It is recognized that the data are highly incomplete for several reasons: (1) coverage is much less comprehensive for Russian items, (2) only longer Russian items are noted, (3) many Russian journals and books are received in this country years after their issue, and many are never received, (4) the scope of what was considered geology is much narrower in the foreign bibliography.

TABLE I.—NUMBER OF TITLES AND PAGES OF 1958 GEOLOGIC LITERATURE

	NORTH AMERICA		OUTSIDE N. AMERICA		TOTAL	
	TITLES	PAGES	TITLES	PAGES	TITLES	PAGES
English	3,224	109,638	1,514	43,314	4,738	152,952
Russian	0	0	845	68,500	845	68,500
French	28	290	1,288	40,070	1,316	40,360
German	24	432	515	22,800	539	23,232
Polish	0	0	234	11,740	234	11,740
Spanish	79	3,792	87	5,080	166	8,872
Italian	0	0	160	4,910	160	4,910
Portuguese	0	0	84	3,484	84	3,484
Japanese	0	0	230	2,764	230	2,764
Hungarian	0	0	94	2,646	94	2,646
Other languages*	22	538	182	5,920	204	6,458
	3,377	114,690	5,233	211,228	8,610	325,918

*Bulgarian, 15 papers; Chinese, 18 papers; Swedish, 14 papers; Korean, 8 papers; Finnish, 8 papers: Icelandic, 7 papers; Danish, 10 papers; Dutch, 7 papers; Czech, 6 papers; Serbian, 5 papers; Romanian, 2 papers; Slovak, 1 paper; Afrikaans, 1 paper. The totals are included in the table at double value.

Papers and pages in English are overwhelmingly predominant according to the data used. English titles are 95 percent of North American geologic titles, 30 percent of non-North American, and 50 percent of the total. In number of pages, English publications constitute 47 percent of the total.

Factors which further distort the apparent pattern are: (1) Chinese literature received scant coverage; (2) items published in the U. S. S. R. not in Russian (such as Georgian, Kazakh, Ukrainian) are not covered; (3) pages of summaries in languages other than the original one of the article are counted as if in the original language.

The count, however, reveals the appalling total of 8,610 titles containing 325,918 pages. At an average of 400 pages to an inch, these would occupy 68 linear feet of shelving; and maps and plates have not been considered. It is quite apparent that no geologic library can be complete, for reasons of space alone, as well as the impossibility of procuring all items.

It was unexpected to find the volume of French literature in third place, ahead of German; and to find Polish in fifth place. It is consoling to us that more than half the titles and nearly half the pages are in English (although this statistic is patently not accurate), and to find that titles in Russian, Polish, Japanese, Hungarian, and some thirteen other languages that few of us can read, still constitute less than 20 percent of 1958 geologic literature listed in the standard bibliographies. The figures become more alarming to most of us when we realize that whereas only 22 of 3,377 papers on North American subjects are in these languages, a minimum of 1,607 of those on areas exclusive of North America, constituting nearly 30 percent of total pages, are in the unfamiliar languages. We know, also, that the actual proportion is greater and we strongly suspect that it is rising in each successive year.

Oklahoma's Deepest Production

Louise Jordan

In January 1962, Mobil Oil Company completed the No. 1 Wilbur Craddock at 16,669 feet, the fourth deepest producing well in the United States and Oklahoma's deepest (fig. 1). This deeper-pool discovery well in NE¼ NW¼ sec. 33, T. 5 N., R. 6 W., Grady County, is in the Chitwood Field where Mobil in 1945 discovered oil and gas at 12,000 feet in Springer sandstone as one of the State's deepest producers at that time.

The No. 1 Craddock, one of the better gas-condensate discoveries in the Midcontinent in several years, has been completed officially for 45 million cubic feet of gas and 10,215 barrels of 51° condensate daily from Bromide sandstones (Simpson Group, Ordovician in age) between 16,193 and 16,669 feet.

The well, drilled to confirm the Chitwood structure at depth, is also remarkable in that it has the highest recorded shut-in surface pressure in Oklahoma. Shut-in surface-tubing pressure stabilized at 9,134 psi with an estimated shut-in bottom-hole tubing pressure as high as 13,000 psi. At a cost of discovery of more than $1,000,000, Mobil exploration people believe that a reservoir of significant size has been located.

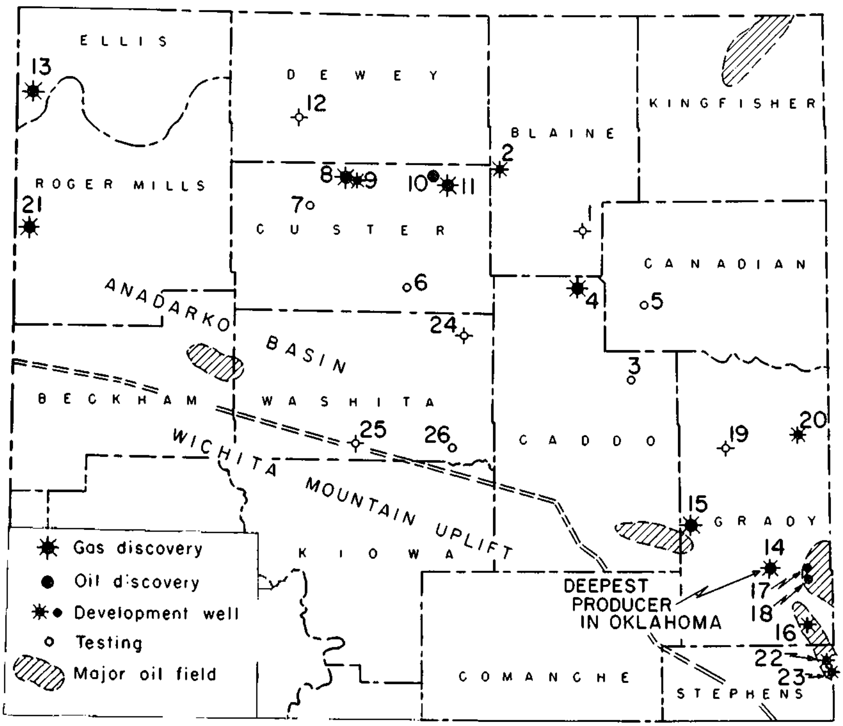

Figure 1. Map of west-central Oklahoma showing location of Oklahoma's deepest producing well and those of wells drilled below 11,000 feet in 1961 and early 1962. Data are listed in table I.

Table I.—List of 1961 and Early 1962 Tests Deeper than 11,000 Feet in the Anadarko Basin

BLAINE COUNTY

1. Sunray 1 McNeeley-Fahl, 27-14N-11W. TD 13,340 feet in Hunton. Dry.
2. Texaco 1 Maier-Bolen, 5-15N-13W. TD 12,003 feet in Chester. Gas-condensate in Morrow, East Fay Field.

CADDO COUNTY

3. Fain-Porter 1 Duncan, 26-10N-10W. TD 13,196 feet. WOC.
4. Mobil 1 Weathers, 8-12N-11W. TD 12,337 feet in Chester? Gas in lower Cherokee. **Bridgeport discovery.**

CANADIAN COUNTY

5. Sun Oil 1 Litton, 30-12N-9W. TD 11,500 feet. Testing, indicated oil **discovery** from three levels in Pennsylvanian.

CUSTER COUNTY

6. G. C. Parker 1 Wagner, 10-12N-16W. OWDD. Drilling below 16,400 feet.
7. Sunray 1 Hatcher Estate, 1-14N-18W. TD 16,434 feet in Hunton. Testing.
8. Hunt 1 Graft-Burmah unit, 18-15N-17W. TD 15,581 feet in Hunton. Gas in Meramec and Morrow. **Northwest Anthon discovery.**
9. Hunt 1 Coit unit, 17-15N-17W. TD 14,946 feet in Hunton. Gas in Meramec. Testing.
10. Mobil 1 Horton, 14-15N-15W. TD 14,869 feet in Sylvan. Oil and gas in Oswego and Meramec. **West Crane discovery.**
11. Mobil 1 Dobbins, 9-15N-15W. TD 14,405 feet in Hunton. Oil in Oswego. **Southwest Nobscott discovery.**

DEWEY COUNTY

12. Humble 1 Saylor, 25-17N-19W. TD 12,412 feet in Chester. Dry.

ELLIS COUNTY

13. El Paso 1 Eggleston, 11-17N-26W. TD 13,079 feet in Chester. Gas in Morrow. **South Bishop discovery.**

GRADY COUNTY

14. Mobil 1 Craddock, 33-5N-6W. TD 16,729 feet in Ordovician. Gas-condensate in Third Bromide. **Chitwood Field new zone discovery. State's deepest production.**
15. Gulf 1 Wood, 29-6N-8W. TD 17,000 feet in Springer. Gas in Springer. **Laverty Field discovery.**
16. British-American 1 McKinney-Woods, 17-3N-5W. TD 15,750 feet in Ordovician. Gas in Second and Third Bromide, Knox Field.
17. Musgrove and Roberts 1 Laws, 33-5N-5W. TD 14,334 feet in Ordovician. Oil in Springer, Bromide, Tulip Creek, Golden Trend Field (Bradley area).
18. Musgrove 1 Godfrey C, 4-4N-5W. TD 14,553 feet in Ordovician. Oil in Springer, First and Second Bromide, Golden Trend Field (Bradley area).
19. Blackwell Zinc 1 Coleman-Davis, 20-8N-7W. TD 14,134 feet in Meramec. Dry.
20. Cleary 3 Hilltop, 8-8N-5W. TD 11,934 feet in Ordovician. Gas in Bromide, Northwest Blanchard Field.

ROGER MILLS COUNTY

21. Gulf 1 Hartley, 34-14N-16W. OWDD. TD 17,588 feet in Morrow. Gas-condensate in Morrow. **West Reydon discovery. First production in county.**

STEPHENS COUNTY

22. Sinclair 1 Moody, 13-2N-5W. TD 16,282 feet in Ordovician. Gas-condensate in Second Bromide, Knox Field.
23. Gulf 1 Graham, 25-2N-5W. TD 15,900 feet in Ordovician. Gas-condensate in Third Bromide, Knox Field.

WASHITA COUNTY

24. Continental 1 North Corn unit, 19-11N-14W. TD 17,323 feet in Chester. Dry. Hole is to be deepened to Hunton and possibly to Bromide.
25. Humble 1 Schmidt, 20-8N-17W. TD 17,820 feet. Dry.
26. Gulf 1 Tabor, 24-8N-15W. TD 18,500 feet. Testing gas in Morrow, 16,660 to 16,704 feet.

Deep drilling in the Anadarko basin was an active program of the industry in 1961 and is a continuing one. At least 24 tests were completed and about 20 are in the process of drilling below 10,000 feet. Six of these tests have gone to 17,000 feet or deeper. Since 1947 when the Superior Oil Company No. 1 Weller in Caddo County was drilled to 17,823 feet (the world's deepest hole at that time), 65 additional holes, totaling 953,864 feet or an average footage of 14,675 feet, have been drilled in the Anadarko basin below 12,000 feet (McCaslin, 1962, p. 255). Fourteen of these were completed in 1961, and four in January 1962. Of the 18 tests, only four were dry, and seven were new-field discoveries. Of the 70 tests drilled in northwestern and western Oklahoma below 12,000 feet since 1939 (when the deepest hole in the Midcontinent was the Continental No. 1 Proctor, Washita County, with a total depth of 14,582 feet), 26 were new-field discoveries and an additional 20 wells were productive. The overall success ratio is 65.7 percent.

The deepest test in Oklahoma and second deepest in the world is Shell Oil Company's No. 5 Rumberger in Elk City Field which, drilled in 1959, went to a total depth of 24,002 feet, and is 1,338 feet shallower than the first-ranking test located in the Delaware basin of West Texas. Locations of 5 of the 22 major (ultimate cumulative production of 100 million barrels or more) oil fields of Oklahoma are shown in figure 1: Elk City in Beckham County, Dover-Hennessey in Kingfisher County, Cement in Caddo and Grady Counties, part of Knox in Grady and Stephens Counties, and part of Golden Trend in Grady County.

References

McCaslin, J. C., 1962, No other deep wildcat arena can match Sooner Anadarko success: Oil & Gas Jour., vol. 60, no. 5 (Jan. 29), p. 252f.

Oil and Gas Journal, 1961, Deep drilling marks Oklahoma's Anadarko: Oil and Gas Jour., vol. 59, no. 50 (Dec. 11), p. 135f.

————1962a, Deep Mobil test proves prolific: Oil and Gas Jour., vol. 60, no. 4 (Jan. 22), p. 43.

————1962b, Completions up from '60; hit 46,962: Oil and Gas Jour., vol. 60, no. 5 (Jan. 29), p. 110-120.

Beavers Bend Illite

A deposit of exceptionally pure illite has been discovered recently in the Blaylock Formation at Beavers Bend in the Ouachita Mountains of southeastern Oklahoma. A complete description of the occurrence and mineralogy of this clay was presented at the Tenth National Clay Conference, held in Austin, Texas, October 1961, and it will be published in the proceedings of the Conference. A comparative study of the Beavers Bend illite and other currently used reference illites is now being conducted. The results of this study will be published by the Oklahoma Geological Survey.

Owing to the overwhelming number of requests for samples of the clay, the Oklahoma Geological Survey has prepared and is currently sending out complimentary samples to clay-mineral research laboratories throughout the world. Requests for samples of this material should be sent to Dr. Carl C. Branson, Director, Oklahoma Geological Survey, Norman.

—C. J. M.

Age of Union Valley Cephalopod Fauna

James H. Quinn*

An assemblage of goniatite cephalopods from the upper part of the Union Valley Formation of south-central Oklahoma was described and compared by Miller and Owen (1944) with a somewhat similar assemblage (Miller and Moore, 1938) from Gaither Mountain, near Harrison, Arkansas. It was thought the Gaither Mountain strata and the goniatites recovered from it are of Hale age. Similarity of some of the Gaither Mountain fossils to some of the Union Valley materials led the authors to conclude that the two assemblages are correlative.

Large numbers of goniatites have subsequently been recovered in the "type" areas of the Cane Hill Member of the Hale Formation, and from the Brentwood, cap rock (Henbest, 1953, p. 1944) and Kessler of the Bloyd Formation. An additional assemblage of goniatites was collected at Bradshaw Mountain near Green Forest, Arkansas, and at Greers Ferry Dam near Heber Springs, Arkansas. The Bradshaw Mountain assemblage contains species found in the middle part of the Prairie Grove Member of the Hale Formation in Washington County, Arkansas; the Greers Ferry assemblage contains species found in the cap rock stratum (above the Baldwin coal) in Washington County, Arkansas.

Many of the goniatite genera of the Lower Pennsylvanian rocks range through the entire Morrow section. Most of these vary in relative abundance from bed to bed. Some forms are restricted to a single horizon insofar as their occurrence in Washington County is concerned, and appear otherwise to have had a short range. Still others are confined to lower, middle, or upper strata of the Morrow Group. By comparing the assemblages on the basis of kinds, in terms of genera and species, abundance on the basis of relative numbers, and proximity of similar forms (in older or younger rocks), it is possible to develop correlations of reasonable dependability which should have the stability to withstand the pressure of further accumulation of information.

The goniatite material from Washington County, Arkansas, eliminates the possibility that the Union Valley assemblage is of Hale age (fig. 1). The Gaither Mountain assemblage closely resembles that of the Brentwood Member of the Bloyd Formation, but with some exceptions. The Gaither Mountain assemblage contains *Bisatoceras secundum,* which is not found in the Brentwood and not reported from Union Valley, but *Bisatoceras greenei*? (Miller and Owen, 1939, p. 155-156) is present in the Greers Ferry fauna. *Gastrioceras adaense* of the Union Valley is found in the Brentwood and Greers Ferry assemblages but is not reported from Gaither Mountain. The Brentwood occurrence is based upon a single specimen which could represent a slightly less advanced form.

Gastrioceras grileyi, most abundant in the Union Valley, has not been found at the Gaither Mountain locality but is represented by a

*Department of Geology, University of Arkansas.

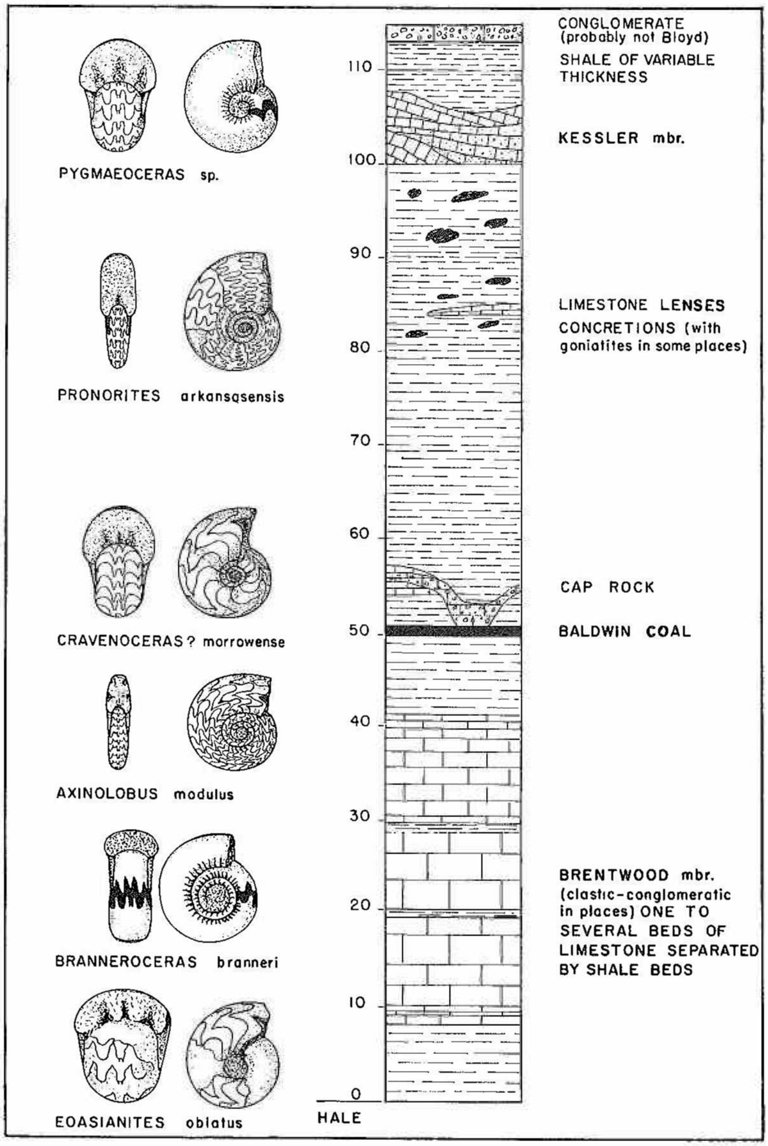

Figure 1. Generalized diagram of Bloyd strata in the vicinity of Brentwood, Arkansas, and Bloyd Mountain from which the Bloyd Formation was named. The cap rock lies directly upon the Baldwin coal at the foot of Bloyd Mountain on Mill Creek at "Male's Coal Bank" and is the source of several of the cap-rock goniatites including two specimens of Axinolobus. **The thickness represents averages and some of the lithic units may or may not occur at a given place.**

fragment in the Brentwood assemblage. It is abundant above the Baldwin coal in the cap rock and at Greers Ferry. A single fragment has also been found in shale between the cap rock and Kessler. A single goniatite, seemingly *Proshumardites,* is represented by a single Brentwood

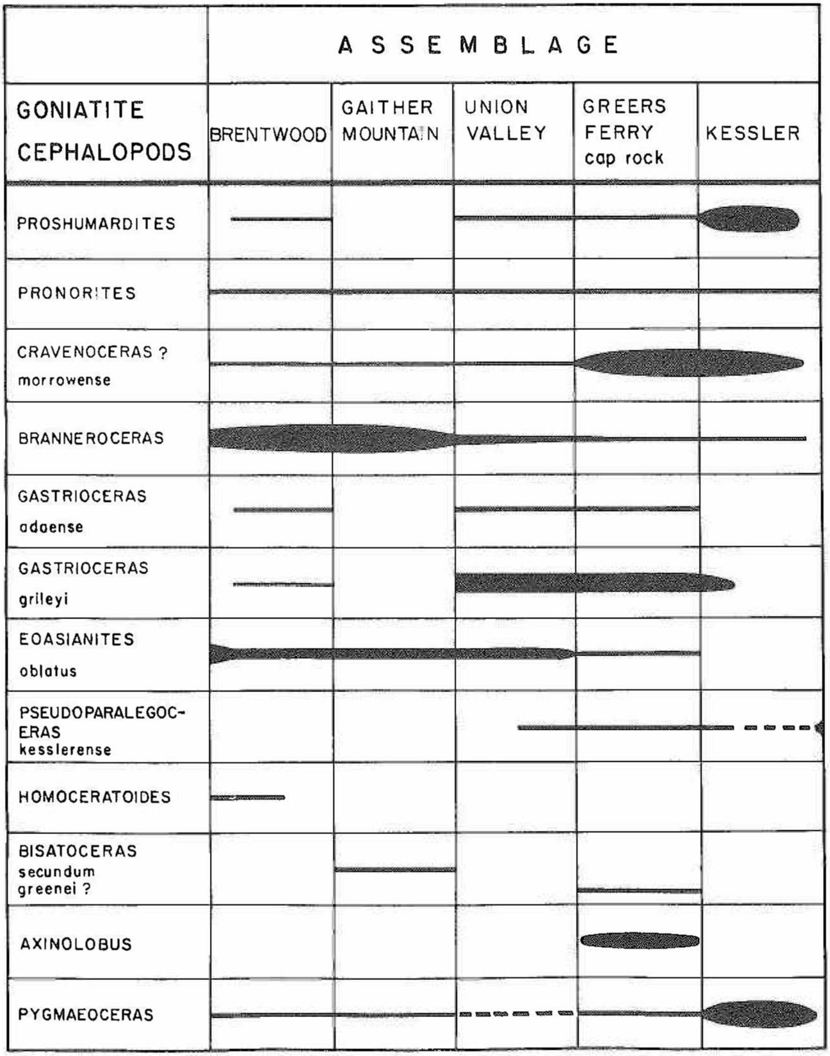

Figure 2. Distribution and relative abundance of goniatite assemblages of Bloyd age in Arkansas including the Union Valley assemblage of Oklahoma. Thickening of the lines is intended to indicate relative abundance but is not scaled to mathematical proportions. Contact of range lines with boundary lines indicates extensions of genera or species into older or younger formations.

specimen but is relatively abundant in the Greers Ferry, Union Valley, and in a recently discovered locality in Washington County, which appears to be of Kessler age. A new goniatite, *Axinolobus* Gordon (1960), described from Gore, Oklahoma, on a single specimen, occurs in abundance at Greers Ferry. Three occurrences have been found in Washington County, all in the cap rock and in association with "typical" Union Valley goniatites, although *Axinolobus* has not been reported from Union Valley. Three or four specimens of *Pseudoparalegoceras kesslerense* have been found in the Greers Ferry assemblage, but otherwise this form has not been found in the Bloyd Formation with the exception of Mather's (1915) reference of the type of the species to Kessler strata. Unklesbay (1962, p. 93-94) has reported a single specimen from the Union Valley.

Because some contradiction exists, sampling deficiencies are indicated. The Union Valley fossils most closely resemble the Greers Ferry assemblage, lacking *Bisatoceras, Axinolobus,* and *Pygmaeoceras* Gordon (1960) for complete agreement. *Cravenoceras*? *morrowense* and *Eoasianites oblatus* appear to occur in about equal numbers in the Union Valley, Brentwood, and Gaither Mountain units, but *E. oblatus* is represented at Greers Ferry by a single specimen, whereas *C.*? *morrowense* is the most abundant form.

Goniatites tentatively referred to *Homoceratoides* Bisat are abundant in the Hale Formation and two specimens are available from the Brentwood, suggesting greater antiquity for the Brentwood in comparison with Gaither Mountain or Union Valley. With the exception of *Pronorites, Pygmaeoceras, Eoasianites oblatus,* and possibly *Branneroceras,* the Hale goniatites are mostly undescribed and unique. Above the Kessler Limestone Member of the Bloyd Formation only *Pronorites* and *Pseudoparalegoceras* of the Bloyd forms are encountered in abundance. In Washington County, Arkansas, a conglomeratic, calcareous unit, above the Kessler Limestone and below the Greenland Sandstone (Henbest, 1953, pp. 1946-1947), contains a unique goniatite assemblage, differing from that of the Bloyd below and of the Winslow above. The most abundant goniatites in the Winslow Formation are *Pseudoparalegoceras kesslerense, Paralegoceras* (in the "*Diaboloceras*" stage of development), and *Winslowoceras* Miller and Downs (1948, p. 678-680). Miller and Downs questioned the advisability of referring the Winslow Formation to the Atoka, which is an older designation. If the synonymy is recognized, it becomes necessary to coin the term "Boston Mountain Atoka" to distinguish the section. It seems preferable to retain the old name rather than to employ a new one, which is precisely the outcome of recognition of the synonymy. The Bloyd Formation is distinguished from the Hale and Winslow Formations by changes in the goniatite assemblages of about equal magnitude. Within the Bloyd Formation, changes from unit to unit are of a considerably lesser order of magnitude.

It appears probable that the sequence from oldest to youngest is: Brentwood, Gaither Mountain, Union Valley, cap rock=Greers Ferry, Kessler (fig. 2). The only qualification is that the Union Valley may be Greers Ferry equivalent or slightly younger. Perhaps an exhaustive search of collections or of the locality may yet produce *Pygmaeoceras* or *Axinolobus* or both.

The illustrations were prepared by R. G. Miller, Department of Geology, University of Arkansas.

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