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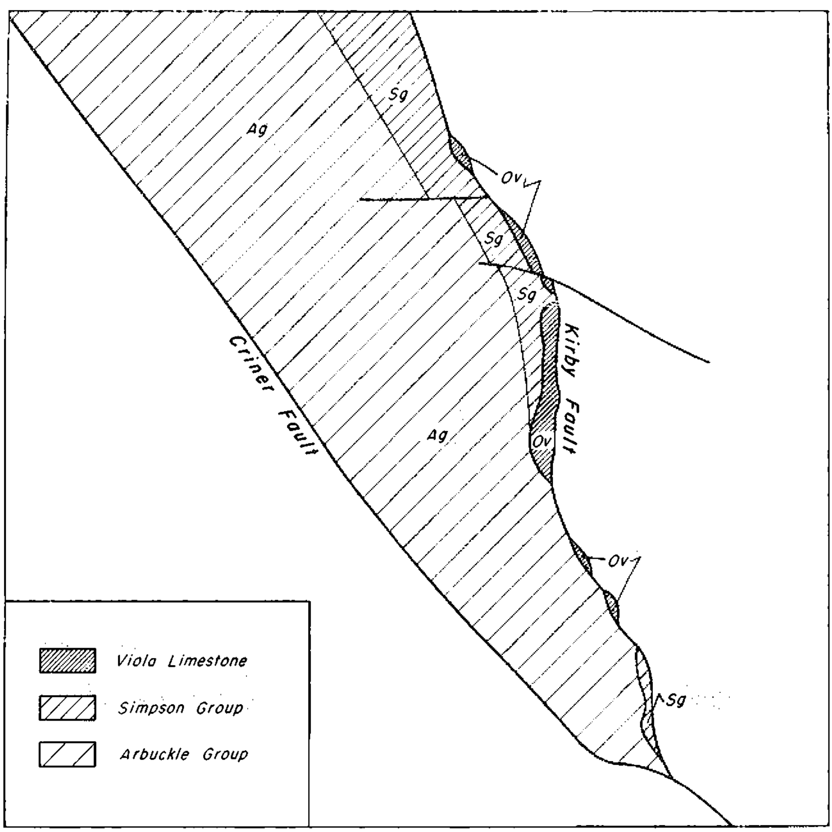
Cover Picture

Criner Hills

The cover photograph is a vertical view of a portion of the Criner Hills area (secs. 21, 22, 27, and 28, T. 5 S., R. 1 E.) in southern Oklahoma, taken for the U. S. Department of Agriculture by Robinson Aerial Surveys, Inc. of Newark, New Jersey, on May 22, 1949.

The photograph includes the horst, formed in rocks of Ordovician age, assigned to the Arbuckle and Simpson Groups. The horst is located along the crest of the Criner anticlinorium and is outlined at the west by the Criner fault and at the east by the Kirby fault.

Movement along the sharply defined Criner fault, which is shown trending diagonally across the picture from the upper left, has brought rocks of Pennsylvanian Hoxbar age in contact with the Ordovician Arbuckle Limestone of the horst. The Kirby fault trends irregularly in a north-south direction. It is a thrust fault dipping westward and here elongate blocks of the Ordovician Viola Limestone have been brought to the surface within the fault zone. The junction of the two faults can be seen just above the road junction in the lower right of the photograph.



The road north from this junction, just east of the Kirby fault, traverses the Hunton Limestone before angling a short distance eastward over the Sylvan Shale and then following the contact between the Sylvan Shale and the Viola Limestone northward to the middle of the photograph. From this point the road abruptly turns eastward, crosses the strike of the Viola Limestone, and continues onto the onlapping sediments of the Deese Formation of Pennsylvanian age. The road west from the fault junction crosses the Brock anticline, expressed in Upper Pennsylvanian sediments, from which oil has long been produced in the Brock oil field.

—E.A.F. and A.J.M.

New Theses Added to O. U. Geology Library

The following Master of Science theses were added to The University of Oklahoma Geology Library during March 1962:

Petrology of the Goodland Limestone (Lower Cretaceous), southeastern Oklahoma, by Peter E. Blau.

Tertiary stratigraphy and guide Foraminifera of the middle and upper Texas Gulf Coast, by James G. Dempsey.

Investigation of Newcastle sandstones (Cretaceous) for a water flood project, Black Thunder Field, Weston County, Wyoming, by John Burton Duffield, Jr.

Subsurface study of the Molas Formation in the Paradox basin, Colorado Plateau, by James A. Gibbs.

Areal geology of the Fairview area, Major County, Oklahoma, by William Hamilton, Jr.

Subsurface geology of west-central Lincoln County, Oklahoma, by George E. Kurash, Jr.

Reflection seismic correlation and interpretation marginal to the Central Basin platform, West Texas-New Mexico, by John Louis Robertson.

Palynology of the Tebo coal (Pennsylvanian) of Oklahoma, by James H. Ruffin.

Correlation of structural history with reservoir fluid distribution in the Lindsborg pool, Kansas, by Robert James Thatcher.

One doctoral dissertation, *Palynology and paleoecology of the Iron Post coal (Pennsylvanian) of Oklahoma,* by Lee B. Gibson, was also added to the library.

Master's thesis, *Subsurface study of Morrowan rocks in central and southern Beaver County, Oklahoma,* by Lynn W. Barrett, II, listed among the new theses available at the Geology Library in the December 1961 issue of the *Notes,* has been placed on the restricted list and will not be available until December 1962.

—L. F.

Maps of Oklahoma

A map of Oklahoma, showing the present surface and subsurface distribution of rocks older than Pennsylvanian, is now in press and will be issued by the Oklahoma Geological Survey during the summer. The map, GM-5, at a scale of 1:750,000, is being printed by A. Hoen Company, Baltimore, Maryland, in four colors on a black base showing county boundaries, townships, and ranges. Louise Jordan of the Survey staff compiled the map with the assistance of William H. Bellis and T. L. Rowland. The map was prepared in collaboration with the oil companies and geologists of Oklahoma.

A second map, showing the distribution of rocks older than the Woodford Shale, is planned for the future.

—L. J.

Statistics of Oklahoma's Petroleum Industry, 1961

Louise Jordan

The source of much of the statistics concerning the petroleum and natural-gas industry of Oklahoma, except where otherwise noted, is the annual review-forecast issue of the *Oil and Gas Journal*, vol. 60, no. 5, January 29, 1962. The data on exploratory wells (table III) differ considerably from those of the annual report of the Committee on Statistics of Exploratory Drilling of the American Association of Petroleum Geologists because the committee member for Oklahoma, F. L. Mackey of Humble Oil and Refining Company in Oklahoma City, compiles the data in accordance with the Committee's definitions.

For the year 1961, the Committee's report shows 866 total completions with footage of 3,978,322, 162 oil producers with 848,532 feet, 71 gas producers with 361,440 feet, 17 condensate producers with 152,719 feet, and 616 dry holes with 2,615,631 feet. Average depth of all holes in 1961 was 4,594 feet and in 1960 it was 4,508 feet. Over-all success ratio of 28.9 percent was attained in 1961 as compared with 27.5 percent in 1960. Exploratory drilling data for Oklahoma for the period, 1945-1960, as compiled by the Committee is now available in the Association's publication, *Statistics of Exploratory Drilling in the United States, 1945-1960,* by Frederic H. Lahee, who was chairman of the Committee for the period 1945-1955. Here the exploratory wells are grouped and tabulated by states and by classes for those wells which discovered new pools and therefore were responsible for the addition of new reserves of hydrocarbons for the United States.

A summary of the petroleum industry's activities in 1961, by R. B. McDougal of the U. S. Bureau of Mines, was published in the March 1962 issue of *Oklahoma Geology Notes,* p. 81.

TABLE I.—ESTIMATED PROVED RESERVES IN OKLAHOMA, 1959-1961*

	END OF 1959	END OF 1960	END OF 1961	CHANGE 1960-1961
Crude Oil (1,000 bbls)	1,864,749	1,790,500	1,787,429	— 3,071
Natural-gas liquids (1,000 bbls)	367,569	338,313	329,180	— 9,133
Total liquid hydrocarbons	2,232,318	2,128,813	2,116,609	—12,204
Natural gas (MMCF)	16,651,292	17,311,402	17,350,924	+39,522

*Reports of the American Petroleum Institute Committee on Petroleum Reserves and Committee on Natural Gas Reserves of the American Gas Association; reprinted in part in **Oil and Gas Journal,** vol. 60, no. 13 (Mar. 26, 1962), p. 84-86.

TABLE II.—HYDROCARBON PRODUCTION IN OKLAHOMA, 1960-1961

	1960	1961
Crude oil and lease condensate		
Total annual production (1,000 bbls)[1]	192,913	191,220
Value ($1,000)[1]	563,306	558,362
Cumulative production, 1891-1960 (1,000 bbls)[1]	8,226,396[2]	8,417,616
Daily production (bbls)[4]	524,448	523,274
Total number of producing wells	77,720[1]	80,679[3]
Daily average per well (bbls)	6.9[1]	6.5[3]
Wells flowing naturally at end of year[4]	3,147	3,775
Oil wells on artificial lift[4]	80,459	81,048
Natural gas		
Total annual marketed production (MMCF)[1]	824,266	874,000
Value ($1,000)[1]	98,088	104,900
Total number of gas and gas-condensate wells[4]	5,875	6,274
Natural-gas liquids		
Total annual marketed production (1,000 gals)[1]	1,294,253	1,331,100
Value ($1,000)[1]	65,483	67,800

[1]Item for 1960 is from U. S. Bureau of Mines final report. Item for 1961 is from U. S. Bureau of Mines preliminary report.
[2]Based on U. S. Bureau of Mines final figure for 1959 of 198,090,000 barrels, final figure of value for 1959 was $578,423,000.
[3]**Oil and Gas Journal,** January 29, 1962.
[4]**World Oil,** February 15, 1961 and 1962.

TABLE III.—DRILLING ACTIVITY IN OKLAHOMA, 1961

	1961						1960	1962
	CRUDE	CONDENSATE	GAS	DRY	SERVICE	TOTAL	TOTAL	FORECAST
All wells								
Number of completions	2,820	79	514	1,657	775	5,845[1]	4,802[2]	5,778
Footage	9,723,983	668,145	2,822,710	5,704,829	1,412,741	20,332,408	17,431,529	20,188,000
Average footage	3,094	8,457	5,492	3,443	1,823	3,479	3,630	
Exploration wells								
Number of completions	86	10	52	381		529	700	581
Percent of completions	16.2	1.9	9.8	72.1		100.0		
Footage	503,731	103,871	343,522	1,865,289		2,816,413	3,592,838	
Average footage	5,857	10,387	6,606	4,896		5,324	5,132	
Development wells								
Number of completions	2,734	69	462	1,276	775	5,316	4,102	5,197
Footage	9,220,252	564,274	2,479,188	3,839,540	1,412,741	17,515,995	13,838,691	

Source: **Oil and Gas Journal**, review-forecast issue, vol. 60, no. 5, January 29, 1962.
[1]Cable, 1,331; rotary 4,514.
[2]Cable, 1,780; rotary 3,022.

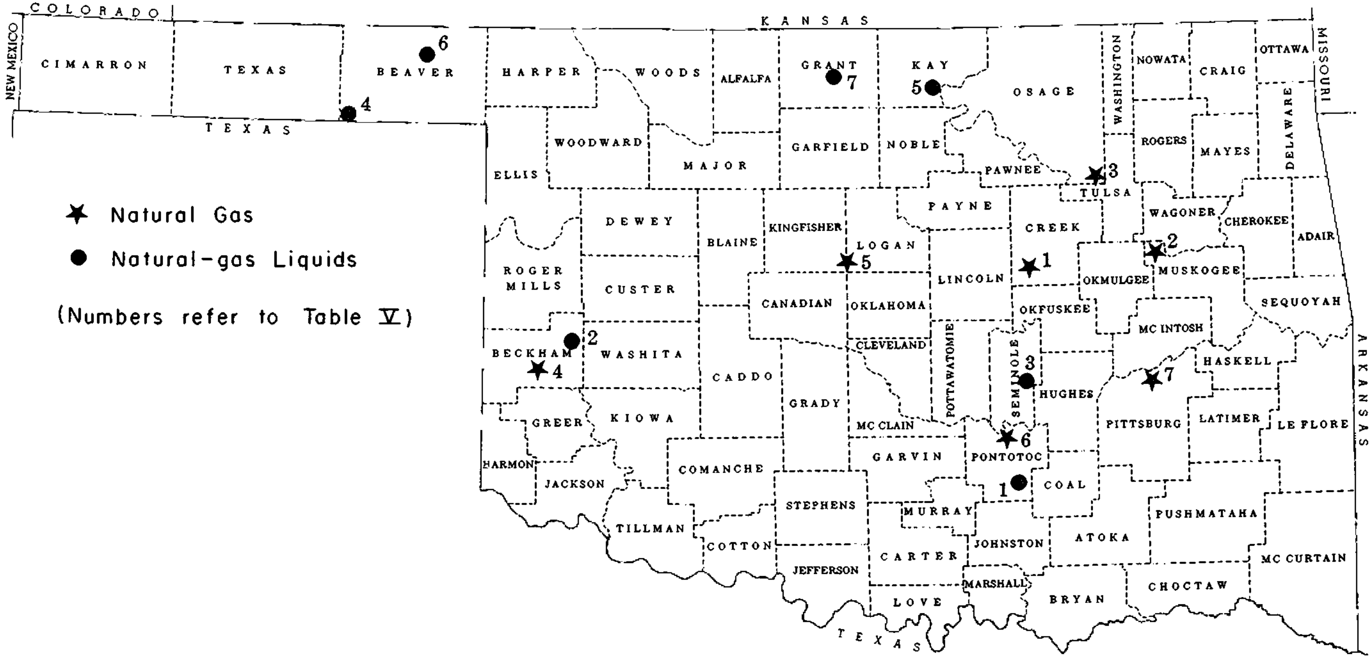


Figure 1. Locations of underground storage facilities for natural gas and natural-gas liquids in Oklahoma.

TABLE IV.—UNDERGROUND STORAGE, NATURAL GAS AND NATURAL-GAS LIQUIDS

(Locations are shown on figure 1)

A. Natural Gas

Company Storage, County Reservoir, Age	Average Depth (ft)	Capacity (MCF)		Maximum Pressure (psig)	Reference*	
		Cushion Gas	Total Reservoir		Vol.	Page
Oklahoma Natural Gas Co.						
1. Depew, Creek Dutcher, Pennsylvanian	3,250	37,400	63,500	1,480	19	185
2. Haskell, Muskogee Booch, Pennsylvanian	800	8,400	12,500	325	19	185
3. Osage, Osage Burgess, Pennsylvanian	1,600	1,900	3,200	565	19	185
4. Sayre, Beckham Panhandle dolomite, Permian	2,650	23,410	89,300	940	19	186
5. West Edmond, Kingfisher and Logan Bartlesville, Pennsylvanian	6,550		59,000†	2,000		
Arkansas Louisiana Gas Co.						
6. North Ada, Pontotoc Cromwell, Pennsylvanian	1,300	5,564	6,557	425	19	186
7. Ulan, Pittsburg Booch, Pennsylvanian	2,000	6,005	13,500	470	19	189
National Zinc Co.	(no report)					
8. Bartlesville, Osage						
		Total	247,557			

B. Natural-gas Liquids (LPG)

Company, County Type of Storage Formation, Age	Year Completed	Depth of Storage (ft)	Capacity (bbls)	Reference* Vol.	Page
1. Humble Oil & Refg. Co., Pontotoc Abandoned oil well Hunton limestone (Silurian)	1940	3,390	175,000	21	95
2. Shell Oil Co., Beckham Salt layer Blaine Formation (Permian)	1953	1,360-1,411	15,000	19	32
3. Sinclair Oil & Gas Co., Seminole Mined shale Nellie Bly Formation (Pennsylvanian)	1955	308-335	110,000	19	102
4. Texaco, Inc., Beaver Salt layer Flowerpot Shale (Permian)	1960	866-1,030	33,000	21	34
5. Continental Oil Co., Kay Mined limestone Wreford Limestone (Permian)	1961	350-372	300,000	21	250
6. Warren Petrol.-Gulf Oil Corp., Beaver Salt layer Lower Cimarron salt (Permian)	1962	1,600-1,730	50,000	22	23
7. Continental Oil Co., Grant Salt layer Wellington Formation (Permian)	1962	886-928	150,000	21	272
		Total	833,000		

*References are to **Oklahoma Geology Notes.**
†Estimated.

TABLE V.—STRIPPER WELLS IN OKLAHOMA, 1959-1960

	END OF 1959	END OF 1960*
Number of stripper wells	68,836	65,688
Production (1,000 bbls)	91,329	95,054
Abandonments	1,331	2,384
Average daily production per well (bbls)	3.63	3.96
Producing acres	1,142,194	1,168,484
Reserves estimated at end of year (1,000 bbls)		
Primary	580,873	602,464
Secondary	661,371	594,494
Total	1,242,244	1,196,958

*Oil and Gas Journal, 1961, Stripper-well production climbs 7.6%: Oil and Gas Jour., vol. 59, no. 49 (Dec. 4), p. 99, from annual stripper-well survey made jointly by Interstate Oil Compact Commission, Independent Petroleum Association of America, and the National Stripper Well Association.

Echinaria IN THE FORAKER LIMESTONE OF OSAGE COUNTY

CARL C. BRANSON

The Foraker Limestone Formation is excellently exposed in the spillway of Phillips Lake, NW¼ NW¼ sec. 36, T. 25 N., R. 5 E., Osage County. The stratigraphic section was measured by David L. Vosburg in the course of preparing his master's thesis (1954, p. 96-97, 43-57). He reported that the rocks in the spillway are:

Foraker Limestone Formation	
Long Creek Shale Member	9.8 feet
Hughes Creek Limestone Member	24.2 feet
Americus Limestone Member	13.6 feet
Hamlin Shale Formation	
Oaks Shale Member	1.6 feet exposed

The specimens discussed here were collected by Vosburg from a shale near the base of the Hughes Creek Limestone Member.

Brachial values only were collected. Several of these are excellently preserved. The recurved bilobate cardinal process is supported on the base of the prominent median septum. The posterior adductor muscle scars are distinctly dendritic.

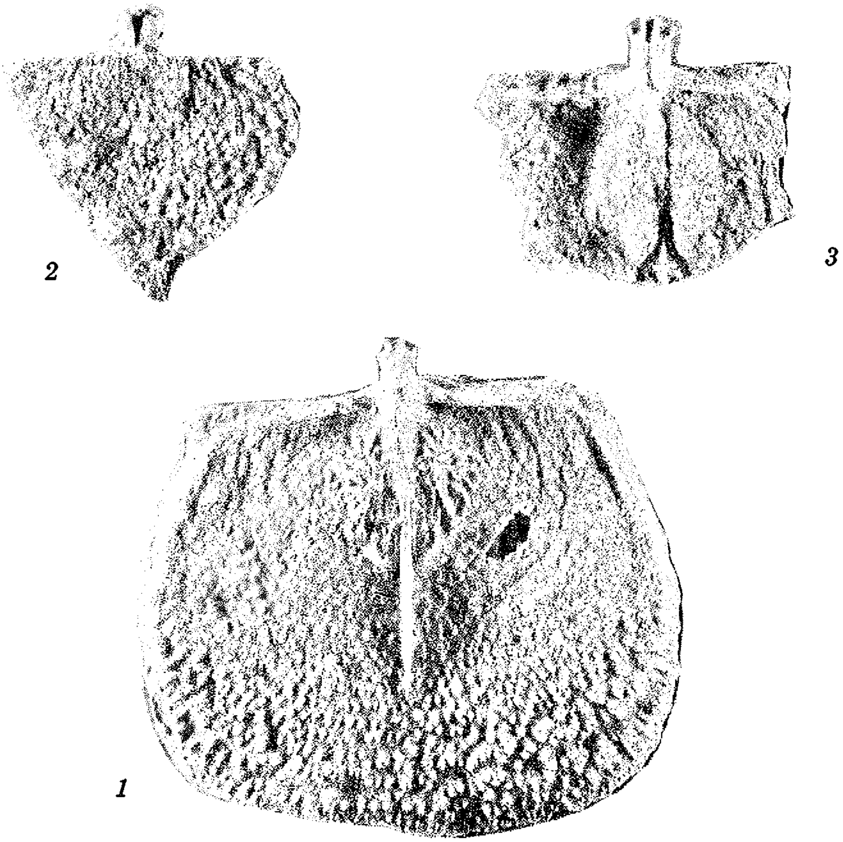


Figure 1. **Interior of a pedicle value of** Echinaria moorei, **OU 442, x2.**
Figure 2. **Exterior of a pedicle value of** Echinaria moorei, **OU 442, showing detail of cardinal process, x2.**
Figure 3. **Fragment of the interior of a pedicle value of a productid from the same horizon and locality showing bifid cardinal process, x2.**
(Photographs by William Bellis)

The genus *Echinaria* is represented by *E. semipunctata* (Shepard), 1838, the genotype; *E. moorei* (Dunbar and Condra), 1932; and the subspecies *E. semipunctata knighti* (Dunbar and Condra), 1932. The present specimens are referred to *E. moorei,* mainly upon the basis of size, but they may belong to an undescribed species.

References Cited

Dunbar, C. O., and **Condra, G. E.,** 1932, Brachiopoda of the Pennsylvanian System in Nebraska: Nebr. Geol. Survey, Bull. 5, 2d series, p. 209-211, pl. 24, figs. 1-5.

Vosburg, D. L., 1954, Geology of the Burbank-Shidler area, Osage County, Oklahoma: Okla., Univ., unpublished Master of Science thesis.

Strongyloblastus, a New Devonian Blastoid from New York

Robert O. Fay

Spherical or melon-shaped blastoids are almost unknown in pre-Mississippian rocks, except for *Nucleocrinus*, and therefore the new genus *Strongyloblastus* is important because it has intermediate characteristics between conical and spherical blastoids. The genus may be characterized as a suboval spiraculate blastoid, with ten spiracles and anus separate; anal opening between a small epideltoid and moderately long hypodeltoid; deltoids seen in side view, overlapped by radials; lancet widely exposed, with one pore between side plates along radial and deltoid margins; five hydrospire folds on each side of an ambulacrum; ambulacra broadly petaloid, moderately long; periphery at radial lips below mid-height; basalia conical, large; theca subrounded at level of deltoids to subrounded-pentagonal at periphery in top view. Middle Devonian, New York.

The only known genus with similar characteristics is the Permian blastoid *Deltoblastus*, with concave base, elongate ambulacra, coronal processes, two hydrospire folds, and deep sinus areas—features that are absent in *Strongyloblastus*. It would be conceivable that *Strongyloblastus* could have given rise to *Deltoblastus* except that intermediate forms are unknown.

Strongyloblastus petalus, new genus, new species
Plates I, II

Theca calcitic, with thick plates, damaged at base, 25 mm long by 21 mm wide, suboval in side view, subrounded to rounded-pentagonal in top view. Vault 17 mm long, pelvis 8 mm long, with pelvic angle approximately 110 degrees, and periphery below mid-height at radial lips. Basalia widely conical, 4 mm long by 12 mm wide, composed of three large thick basal plates, each normally disposed, with flattened proximal base 2 mm in diameter, and rounded crenellar stem. Radials five, elongate hexagonal, each 17 mm long by 10 mm wide, with moderately long, wide, shallow sinus 14 mm long by 4.5 mm wide. Radials overlap deltoids.

Deltoids four, arrow-shaped, each 10 mm long by 6 mm wide, with two semielliptical spiracles in adoral tip, separated by a deltoid septum about 0.5 mm wide. On the anal side, the oval anal opening is between

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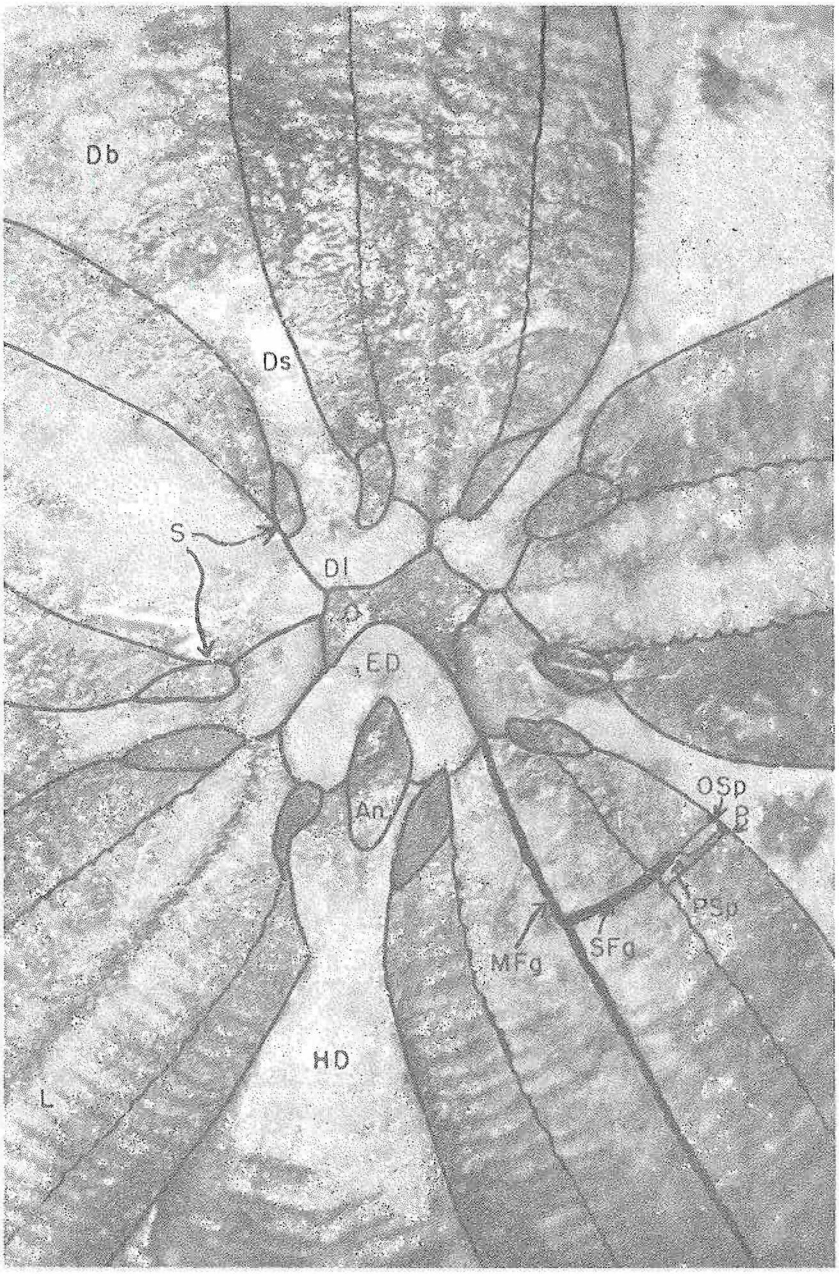
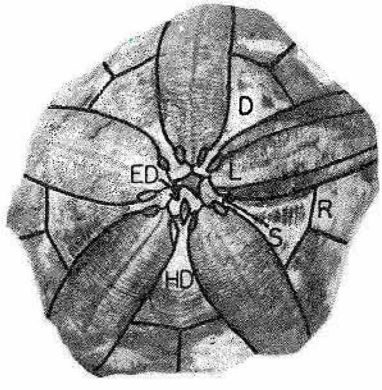
Explanation of Plate I

Strongyloblastus petalus Fay, new genus, new species. Devonian, Tichenor Limestone, Eighteen Mile Creek, New York. Holotype, E 13,297, Buffalo Society of Natural Sciences. Oral view of summit, x15.0

An—anal opening
Db—deltoid body
Dl—deltoid lip
Ds—deltoid septum
ED—epideltoid plate
HD—hypodeltoid plate
L—lancet plate
MFg—main food groove
O—oral opening
OSp—outer side plate
P—pore
PSp—primary side plate
S—spiracle
SFg—side food groove

Plate I





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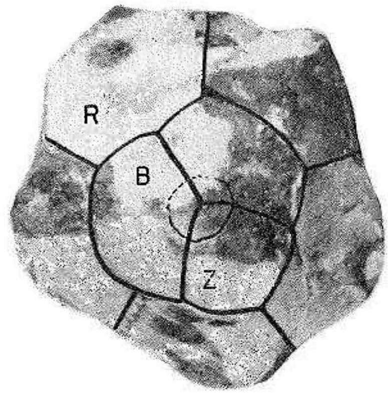

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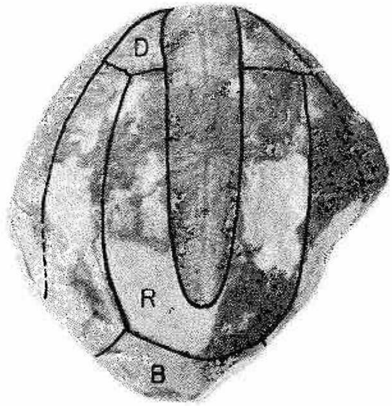

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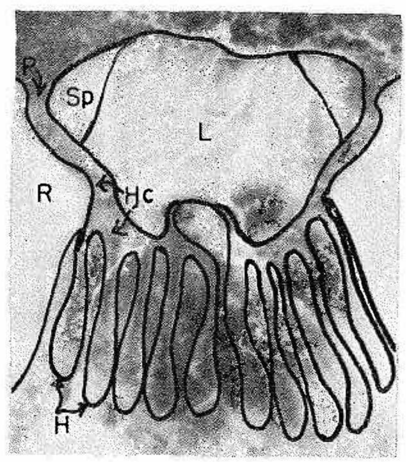

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Plate II

Strongyloblastus petalus **Fay, new genus, new species. Devonian, Tichenor Limestone, Eighteen Mile Creek, New York. Holotype, E 13,297, Buffalo Society of Natural Sciences.**

Figures 1-3. Oral, aboral, and "E" ambulacral views, x2.0

Figure 4. Cross section of "D" ambulacrum, looking aborally, x15.0

B—basal plate	**L—lancet plate**
D—deltoid plate	**P—pore**
ED—epideltoid plate	**R—radial plate**
H—hydrospire folds	**S—spiracle**
Hc—hydrospire canal	**Sp—side plate**
HD—hypodeltoid plate	**Z—azygous basal plate**

an epideltoid and hypodeltoid, separate from the two adjacent spiracles. Thus there are ten spiracles with anus separate around the oral opening. The epideltoid is U-shaped, about 1.5 mm long by 2 mm wide, with thin septa separating the anal opening from the adjacent spiracles. The hypodeltoid is arrow-shaped, 8.5 mm long by 6 mm wide, comparable to the deltoid body of the other four deltoids. Five hydrospire folds are on each side of an ambulacrum, in a small body cavity.

Ambulacra five, broadly petaloid, each 24 mm long by 5 mm wide, with widest portion at height of deltoids. Lancet exposed almost its width, with side plates about 1 mm wide resting on the bevelled abmedial edges. There is one pore per side plate along the deltoid and radial margins, and 26 side plates in 10 mm length of an ambulacrum. The primary and secondary side plates appear to be normally disposed, elongate, with a pronounced U-shaped brachiolar pit above the admedial part of the suture between the primary and associated secondary side plates. The surfaces of the calyx plates are ornamented with fine growth lines subparallel to plate margins, except on deltoids, which have coarse growth lines.

Type and occurrence.—Holotype, E 13,297, Buffalo Society of Natural Sciences Museum, Buffalo, New York. From Middle Devonian, Hamilton Group, Tichenor Limestone, Eighteen Mile Creek, New York.

Tarachiocrinus AND *Tholiacrinus*

HARRELL L. STRIMPLE

Mr. Jan Van Sant has directed my attention to the fact that two of the generic names recently proposed by me in Oklahoma Geological Survey Bulletin 93 (Strimple, 1961) are preoccupied. *Ataxiacrinus* was described by Lyon (1869) and the name was subsequently suppressed as a synonym of *Anomalocrinus*. *Corythocrinus* was described by Kirk (1946). New generic names are here proposed to replace the above-mentioned homonyms.

Family ETHELOCRINIDAE Strimple, 1961
Genus *Tarachiocrinus*, new name

Synonymy.—*Dicromyocrinus* Jaekel (part); *Ataxiacrinus* Strimple, 1961, (not *Ataxiacrinus* Lyon, 1869).

Genotype.—*Ataxiacrinus multiramus* Strimple, 1961.

Range.—Pennsylvanian (Morrowan to Desmoinesian); Midcontinent region, North America and State of Pará, Brazil.

Species assigned to *Tarachiocrinus*:

SPECIES	OCCURRENCE
Ataxiacrinus multiramus Strimple, 1961	Desmoinesian; Okla.
Mooreocrinus meadowensis Strimple, 1949	Missourian; Nebr.
Dicromyocrinus optimus Strimple, 1951	Morrowan; Okla.
Dicromyocrinus periodus Strimple, 1951	Missourian; Kansas
Dicromyocrinus tapajosi Strimple, 1960	Itaituba fm. (Penn.) Pará, Brazil

Remarks.—This action is only for the purpose of establishing a valid generic name to replace the name *Ataxiacrinus* which is preoccupied, as previously noted. Description of the genus is to be found in Strimple (1961, p. 89-90) under the name *Ataxiacrinus.*

Attention is directed to the expanded geographic range of the genus to South America with the species *Tarachiocrinus tapajosi* (Strimple, 1960).

Family Erisocrinidae S. A. Miller, 1889

Genus *Tholiacrinus,* new name

Synonymy.—*Endelocrinus* Moore and Plummer (part); *Corythocrinus* Strimple, 1961, (not *Corythocrinus* Kirk, 1946).

Genotype.—*Corythocrinus undulatus* Strimple, 1961.

Range.—Pennsylvanian (Desmoinesian and Missourian); Mid-continent region, North America.

Species assigned to *Tholiacrinus*:

SPECIES	OCCURRENCE
Corythocrinus undulatus Strimple, 1961	Desmoinesian; Okla.
Endelocrinus bifidus Moore and Plummer, 1940	Missourian; Texas
Endelocrinus rectus Moore and Plummer, 1940	Desmoinesian; Texas
Delocrinus parinodosarius Strimple, 1940	Desmoinesian; Okla.

Remarks.—This action is only for the purpose of establishing a valid generic name to replace the name *Corythocrinus* for reasons previously given. Description of the genus is found under *Corythocrinus* in Strimple (1961, p. 128-129).

References Cited

Kirk, Edwin, 1946, **Corythocrinus,** a new adunate crinoid genus from the Lower Mississippian [Mississippi Valley]: Jour. Paleontology, vol. 20, p. 269-274.

Lyon, S. S., 1869, Remarks on thirteen new species of Crinoidea from the Paleozoic rocks of Indiana, Kentucky, and Ohio, and a description of the columns of **Dolatocrinus,** and their attachment to the body of the animal: Amer. Philos. Soc., Trans., vol. 13, new series, p. 443-466.

Strimple, H. L., 1961, Late Desmoinesian crinoid faunule from Oklahoma: Okla. Geol. Survey, Bull. 93, 189 p.

Graphiocrinus stantonensis IN OKLAHOMA

HARRELL L. STRIMPLE

The primary purpose of this report is to record the occurrence in Oklahoma of *Graphiocrinus stantonensis* Strimple, previously reported from rocks in Kansas. Complete crowns provide additional data concerning the species, and a résumé of information on North American species of Pennsylvanian and Lower Permian ages is given.

The genus *Graphiocrinus* de Koninck and Le Hon, 1854, has as its genotype species *Graphiocrinus encrinoides* de Koninck and Le Hon, 1854, from the Lower Carboniferous (Visean) at Tournai, Belgium. Many forms of Mississippian (Lower Carboniferous), Pennsylvanian (Upper Carboniferous), and Permian ages have at one time or another been assigned to the genus. Species of Pennsylvanian age that are currently assigned to the genus are listed below:

Graphiocrinus kingi Moore and Plummer, 1940
Keechi Creek Shale, Mineral Wells Formation (Missourian)
Palo Pinto County, Texas

Graphiocrinus bridgeportensis Strimple, 1951
Brownwood Shale, Graford Formation (Missourian)
Wise County, Texas

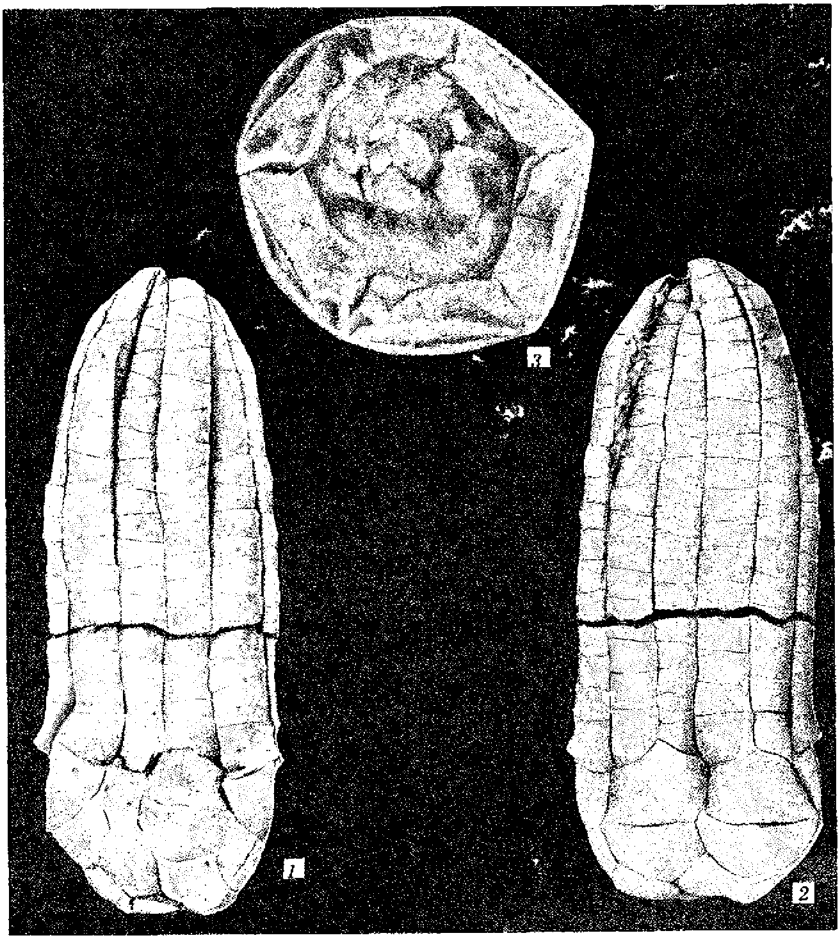
Graphiocrinus stantonensis Strimple, 1939
Stoner Limestone Member, Stanton Formation (Missourian)
Montgomery County, Kansas
Wann Formation, Ochelata Group (Missourian)*
Washington County, Oklahoma

Graphiocrinus delicatulus Moore (1939)
Brownville Formation (Virgilian)
Osage County, Oklahoma

Graphiocrinus stantonensis, G. delicatulus, and *G. bridgeportensis* were established on the basis of dorsal cups without attached arms. The holotype of *G. kingi* is a partial crown. An undescribed species is from the Oologah Limestone Formation (Desmoinesian) of Tulsa County, Oklahoma, and is, therefore, the oldest known representative of the genus within the Pennsylvanian. Another new species, which I shall describe elsewhere, is from the Bennett Shale Member, Red Eagle Formation, Lower Permian of Cowley County, Kansas. It is, therefore, the youngest known North American species and has infrabasals that are readily visible in side view of the calyx.

More than fifty specimens of *G. stantonensis* have been observed from the Oklahoma location, including several partial and complete crowns. The horizon is a local, weak, sandy limestone within the Wann Formation and is the type locality of *Cibolocrinus conicus* Strimple, 1951. *C. conicus* is also associated with *G. stantonensis* at the Kansas type locality and, at both exposures, *Apographiocrinus typicalis* Moore and Plummer, 1940, is the most common crinoid found. However, all crinoid forms are not identical at both exposures; for example, *Eueriso-crinus waysidensis* Strimple, 1939, is restricted to the Kansas location,

*New recording.



Figures 1-2. Graphiocrinus stantonensis **Strimple, crown from posterior and anterior, ca. x2.5.**
Figure 3. G. stantonensis, **dorsal cup from above, ca. x4.2.**

and a new species of *Graphiocrinus,* having bulbous plates and a sharp basal concavity, is restricted to the Oklahoma exposure.

Special attention is directed to the anal plate of the posterior interradius. In every specimen observed from Kansas and Oklahoma, the anal X rests solidly and evenly on the upper face of the posterior basal. In all but four of the specimens, the upper edge of anal X provides for reception of a single tube plate. The nature of the facet is shown in figure 3, fine crenulations marking the outer edge of the broad muscular fossae. The four exceptions are all partial crowns in which anal X is truncated for the reception of two tube plates. Such a condition is characteristic of associated species of *Apographiocrinus* and has not been observed elsewhere among species of Pennsylvanian *Graphiocrinus.*

The articular facets of the radials, shown in figure 3, occupy the full width of the plates, and the plane of the facets is nearly horizontal except for the outward slope of the outer ligament area. The outer ligament area is rather short, depressed, and contains a small ligament pit. Weak, oblique furrows and elevations are present along the outer part of the lateral ridges and at the edges of the intermuscular notch of the inner ligament area.

Ten arms are present, bifurcation taking place with the first primibrach in all rays. They are fundamentally uniserial but tend slightly to become cuneiform in their upper portions. The primibrachs are low, wide axillary elements much like those of *Erisocrinus* Meek and Worthen, 1865. The secundibrachs are relatively thin, wide elements with almost flattened exteriors. The arms are closely apposed and do not taper appreciably until just before termination. Weak, thin pinnules are present. In comparison with the arms of the associated *Apographiocrinus typicalis* there is no appreciable difference other than with the frosted appearance of the entire crown of *Graphiocrinus stantonensis* and the constricted midsection of primibrachs found in *A. typicalis.*

In size, *Graphiocrinus stantonensis* is slightly larger than *Apographiocrinus typicalis;* however, it is by no means a large species. Measurements in millimeters of the figured crown are as follows:

Maximum width	12.3*
Over-all height	33.9*
Length of primibrach	3.7
Height of dorsal cup	4.3*

*slightly distorted by lateral compression.

The hypotypes are deposited in the paleontological collections of The University of Oklahoma, number OU 3912.

Conclusions.—It is unlikely that Pennsylvanian-Permian species currently assigned to the genus *Graphiocrinus* are bona fide representatives of the genus. They are relatively rare forms. Close relationship with *Apographiocrinus* is indicated but exact affinities are uncertain at this time.

Regressive evolution is shown by the relatively high calyx of the Virgilian species, *Graphiocrinus delicatulus,* and high calyx with infrabasals visible in side view of the unpublished new species from the Lower Permian. Progressive evolution is currently considered to be from a high, turbinate calyx with infrabasals visible in side view, to subhorizontal infrabasals, to a low bowl-shaped calyx with downflared infrabasals restricted to a basal concavity. Regressive evolution has been noted among the erisocrinids by the author (1960).

One characteristic that appears to be more or less consistent* among the species of *Graphiocrinus* under consideration is the frosted or finely granular appearance of the crowns which serves to distinguish them from associated species of *Apographiocrinus.* The latter forms have a hard,

*Moore reported the calyx of **Graphiocrinus delicatulus** to be smooth; I have not at this time been able to examine the holotype to determine if the frosted appearance is present.

shiny surface and, when ornamented, have pronounced granules, or pustules, and/or fine ridges and depressions.

Euerisocrinus waysidensis, the genotype and only known species, has a more erect calyx than *Graphiocrinus stantonensis,* with which it is associated. The forms are obviously related but the author considers them to be distinct. No specimen of *G. stantonensis* has been observed with the anal plate removed from contact with the posterior basal.

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