

NEW TABULATE GENUS *SUTHERLANDIA* (COELENTERATA, ANTHOZOA) FROM PENNSYLVANIAN OF OKLAHOMA AND KANSAS

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ABSTRACT

Small tabulate corals assigned to *Sutherlandia* COCKE & BOWSER, n. gen., are described from Desmoinesian and Missourian (Pennsylvanian) rocks of Kansas and Oklahoma. The genus comprises squamulae-bearing tabulates with distal processes and mural pores. It presently includes six species previously assigned to *Pseudofavosites* GERTH, 1921, and three new species. Shapes of coralla depend on attachment surfaces; spherical forms circumscribe cylindrical objects; hemispherical and irregular forms usually encrust planar surfaces.

INTRODUCTION

Specimens of the small, squamulae-bearing, tabulate coral *Sutherlandia* COCKE & BOWSER, n. gen., have been collected from Pennsylvanian units of southeastern Kansas and northeastern Oklahoma. These corals occur in the Wewoka and Oologah Formations (Desmoinesian), and the Seminole, Coffeyville, Dewey and Stanton Formations (Missourian) (Fig. 1). The more common spherical to ellipsoidal forms encrust crinoid stems, rhomboporid bryozoans, and productid spines; hemispherical forms typically encrust phylloid algal fragments, fenestrate bryozoans, large brachiopods, and rugose corals. A few specimens of *S. alani* COCKE & BOWSER, n. sp., from the Oologah Formation are elongate, closely resembling isolated branches of *Acaciapora* MOORE & JEFFORDS (1941). Shapes of the coralla are believed to be dependent on available attachment material. Internally, squamulae, mural pores, and longitudinal ridges are present. Squamulae in sections cut without intersecting their free ends simulate tabulae.

	Kansas-Nebraska	S. Kansas and N. Oklahoma	Central Oklahoma		
Missourian Series	Iatan ls	Weston sh			
	Stanton ls*	Birch Creek ls			
	Plattsburg ls	Torpedo ss			
	Wyandotte ls	Wann fm			
	Iola ls	Iola ls	Avant ls	Ochelata sh	
	Drum ls	Dewey ls*		Belle City ls	
	Westerville ls	Cherryvale sh	Nellie Bly fm	Francis fm	
	Dennis ls	Hogshooter ls			
	Swope ls	Coffeyville sh*			
	Hertha ls	Checkerboard ls		DeNay	
Desmoinesian Series	Bourbon	Seminole fm*	Seminole ss		
	Lenapah ls	Lenapah ls	Holdenville		
	Altamont ls	Oo- logah ls*	Altamont ls	Wewoka fm*	
	Pawnee ls	Pawnee ls			
	Labette sh	Labette sh		Wetumka sh	
	Fort Scott	Higginsville	Fort Scott		Higginsville
		Blackjack ls			Blackjack ls
	Mulky coal	Mulky coal			
			Calvin ss		

FIG. 1. Stratigraphic chart with asterisks marking units from which *Sutherlandia* COCKE & BOWSER, n. gen., has been collected (modified from MOORE, 1944).

Localized occurrence lessens the stratigraphic and paleoecologic utility of all species described here. Stratigraphic intervals from which Oologah, Dewey and Stanton specimens were collected can be related to algal-mound complexes (=marine banks of HARBAUGH, 1959). Oologah forms are from the lower parts of calcareous shale units near the southern limit of the algal-mound complex; those from the Dewey are in interbedded

calcareous shale and algal limestone that underlie a massive buildup of algal material. Stanton specimens are from interbedded calcareous shale and calcarenitic limestone above algal-mound rock a few hundred feet from a contemporaneous calcarenite channel deposit (HECKEL, 1966). Other specimens discussed herein are from calcareous shales or interbedded thin calcareous shale and limestone.

SYSTEMATIC PALEONTOLOGY

COELENTERATA (ANTHOZOA)

Order TABULATA Milne-Edwards & Haime, 1850

Family FAVOSITIDAE Dana, 1846

Subfamily PSEUDOFIVOSITINAE Sokolov 1950

Genus SUTHERLANDIA Cocke & Bowsher, n. gen.

Type species.—*Sutherlandia irregularis* COCKE & BOWSHER, n. sp.

Previously described species now assigned to *Sutherlandia* include:

Pseudofavosites minus YAKOVLEV, 1939; Lower Permian, Artinskian, Urals, USSR.

Pseudofavosites extraspinosus SOKOLOV, 1955; Lower Permian, Artinskian, Urals.

Pseudofavosites guangxiensis LIN, 1963; Upper Carboniferous, Guangxi Province, China.

Pseudofavosites? liuchengensis LIN, 1963; Lower Carboniferous (Viscan), Guangxi Province, China.

Generic Diagnosis.—The genus *Sutherlandia* is characterized by spherical to hemispherical, or rarely by irregular coralla. Hemispherical forms commonly encrust tabular objects; in most instances, spherical colonies circumscribe cylindrical organic material. Internally, squamulae, mural pores, and distal processes are common. Faint longitudinal ridges mimic septa in some corallites.

Discussion.—In 1921 GERTH erected *Pseudofavosites* comprised of *P. styliifer* and *P. styliifer septosa* on material from Lower Permian beds of Timor. The following generic diagnosis is given by HILL & STUMM, 1956, p. F464.

Massive or encrusting; corallites as in *Favosites* but with angles of wall produced distally into processes, and apparently without tabulae.

GERTH's photographs show prominent septa-like

ridges in *P. styliifer septosa* and faint ridges in a single corallite of *P. styliifer styliifer*. Timor specimens in The University of Kansas Museum of Invertebrate Paleontology exhibit well-developed, numerous ridges in the calyx but lack squamulae and tabulae. *Pseudofavosites* is restricted here to septate to aseptate forms which possess neither squamulae nor tabulae. More recently, some workers (YAKOVLEV, 1939; SOKOLOV, 1955; LIN, 1963) have expanded the original concept of *Pseudofavosites* to include squamulate coralla which are here placed in *Sutherlandia* COCKE & BOWSHER, n. gen. The argument (YAKOVLEV, 1939) that the squamulate *P. minus* can be considered intermediate in the evolution of tabulae-bearing favositids to nonsquamulate *Pseudofavosites* may be well taken; however, subsequent data presented by SOKOLOV (1955), by the present paper, and particularly by LIN (1963) suggest that the problem is more complex. Squamulate forms range from Lower Carboniferous to Lower Triassic and construction of an evolutionary chain based on disappearance of squamulae is difficult. The earliest known representative of the genus, *P.? liuchengensis* LIN (1963), from Lower Carboniferous rocks of China, although apparently poorly preserved, most closely resembles the Permian *P. styliifer* in having fewer squamulae than other species of *Sutherlandia*. The Lower Permian species from the Soviet Union, *P. extraspinosus* SOKOLOV, resembles the American species *S. alani* closely and in confirmation of YAKOVLEV's contention, has fewer, more widely spaced squamulae. An increase in size is evident in younger specimens; most Carboniferous representatives are small, rarely attaining 15 mm. in diameter, whereas the Permian species, *P. extraspinosus* and *P. styliifer*, have diameters of 24 mm. and 47 mm., respectively.

Shape and size of squamulae are major factors in determining taxonomic assignment. It may be argued, on the basis of external shape, that generally hemispherical representatives of *Sutherlandia irregularis* from the Dewey Limestone and spherical ones from the Wewoka Formation should be assigned to different species, but we believe that lack of cylindrical objects in the Dewey sea led to attachment of these organisms on platy objects, whereas the spherical Wewoka forms grew in an environment with abundant crinoid stems.

SUTHERLANDIA IRREGULARIS Cocke & Bowsher,
n. sp.

Figure 2, 1-4

Diagnosis.—Small, spherical to hemispherical coralla, characterized by deep calices bounded by porous walls, comprise this species. Attachment areas are concentrically wrinkled. Distally, corallites are subcylindrical to polygonal and are either aseptate or marked by faint, broad, longitudinal ridges. Internally, squamulae of a given corallite may be gently convex upward, distally inclined to planar, or subhorizontal plates which tend to alternate with squamulae of the opposite wall. Large mural pores are concentrated in upper part of corallites. Distal processes are common.

Description.—Dimensions of hemispherical forms range from 2.5 by 4.0 mm. in smaller specimens to 4.0 by 8.5 mm. in larger forms and 4.0 to 6.8 mm. in spherical forms. Calices are polygonal to subcylindrical; intercorallite cavities except for smaller-size mimic corallites. Two rows of mural pores occur along each wall. Longitudinal ribbing is developed obscurely in a few corallites of a single corallum. Characteristically, hemispherical specimens are attached to fenestrate bryozoans but some are attached to brachiopods, large rugose corals, and rarely to phylloid algal fragments. The attachment area is concentrically wrinkled, thin, and generally reflects the shape of the material on which the colony grew. Spherical specimens most commonly circumscribe crinoid stems and rhomboporid bryozoan colonies. Corals growing on the edge of platy fossil material in some instances overlap the edges to form subspherical coralla.

Internally, corallite walls are straight and range in thickness from 0.05 to 0.08 mm. in proximal part to 0.17 to 0.35 mm. in distal area.

In longitudinal thin sections, mural pores are rare and usually have diameters of approximately 0.15 mm. Squamulae are abundant with a maximum of 10 in 1 mm. vertically, ranging from 0.02 to 0.05 mm. in width with an average of 0.03 mm. They are most abundant in the proximal one-third to one-half of the corallite. Most squamulae are irregularly convex distally and transverse two-thirds to three-fourths of corallite diameter; a small number are distally convex near the wall but recurve to become concave. In many instances, horizontal and inclined squamulae alternate with those of the opposing wall. Complete plates which simulate tabulae are here interpreted as squamulae in which the thin section did not intersect free ends.

Discussion.—This species is based on specimens from the Dewey, Coffeyville, and Stanton Formations. Although specimens from each unit have characteristics which are unique, they are not considered sufficiently important taxonomically to justify separation into distinct species. Dewey colonies are predominantly hemispherical, probably owing to lack of crinoid stems and other cylindrical material for attachment. Internally, they have squamulae which are irregular, gently convex distally, and sharply inclined. Squamulae and corallite walls of Stanton forms are more irregular; two of four specimens are spherical and the other two irregularly hemispherical. A single specimen collected from the Coffeyville Formation differs from other members of *Sutherlandia irregularis* in having more and larger mural pores, fewer squamulae, crooked walls, and irregular squamulae.

Internally, *Sutherlandia irregularis* is morphologically similar to *P. minus* YAKOVLEV in length and convexity of squamulae but is readily differentiated on the basis of its more abundant squamulae vertically, more highly irregular squamulae, and smaller size. It is most similar to *S. alani* but separated from it by the more irregular squamulae of the latter.

Material Studied.—Sixty-five longitudinal thin sections were examined, of which 59 are of Dewey specimens, five of Stanton specimens, and one of a Coffeyville specimen. Dewey forms were collected in the interbedded calcareous shales and algal limestones from the Dewey Portland Cement Company Quarry, 1 mile east of Dewey, Oklahoma, in SW SW sec. 5, T. 27 N., R. 13 E., Washington County, and from an abandoned

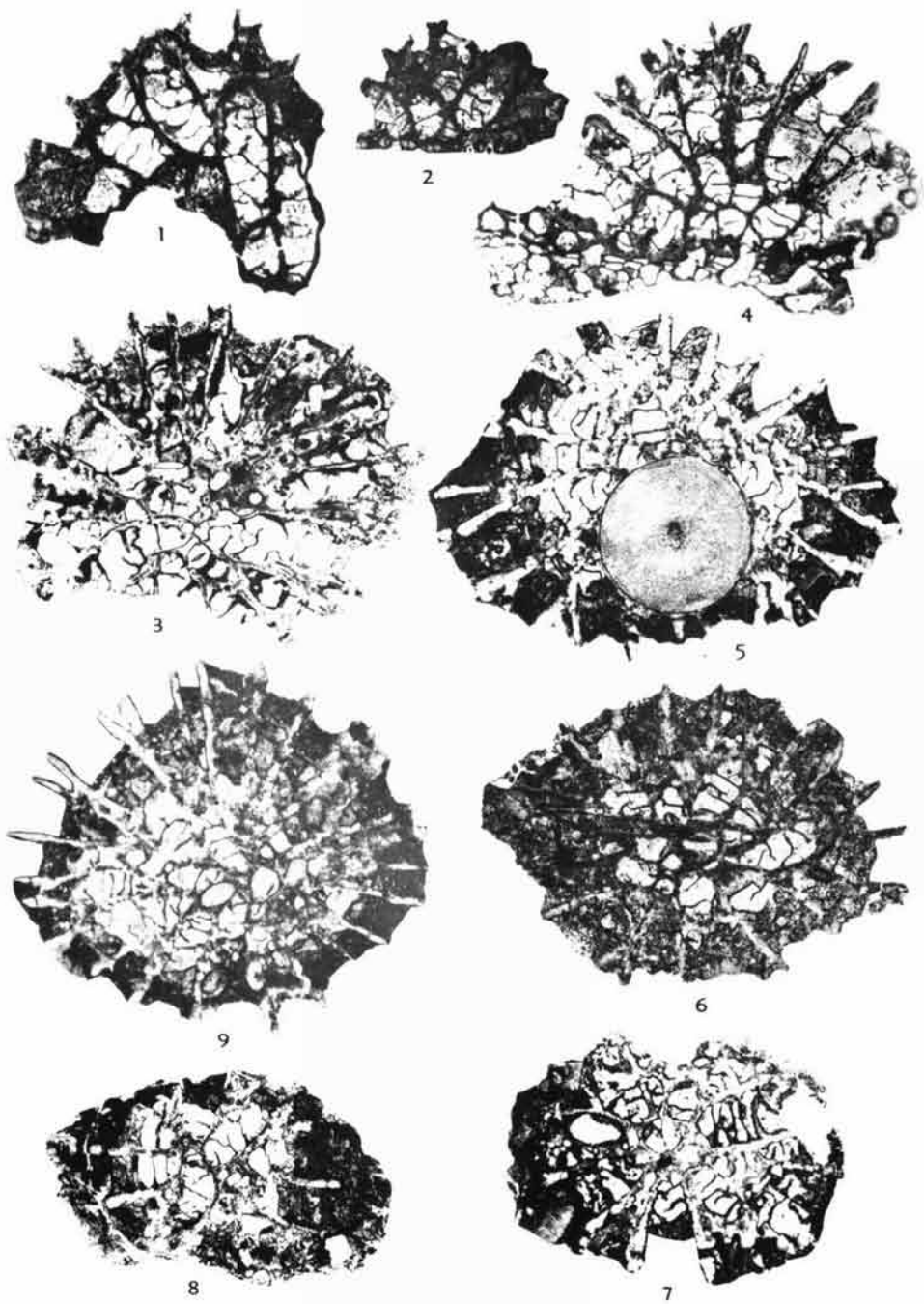


FIG. 2. Species of *Sutherlandia* COCKE & BOWSER from Pennsylvanian formations of Oklahoma and Kansas (see facing page).

quarry at NW SW sec. 5, T. 27 N., R. 14 E., Washington County, Oklahoma. Those from the Stanton were collected from calcareous shales and calcarenites at the Fredonia Cement Plant, Fredonia, Wilson County, Kansas, in NW NW sec. 19, T. 29 S., R. 15 E., and from a calcarenite channel deposit exposed in a roadcut along Kansas Highway 47, two miles west of Altoona, Wilson County, Kansas in NW NE sec. 18, T. 29 S., R. 16 E. The Coffeyville specimen obtained from The University of Kansas Museum of Invertebrate Paleontology collection was labeled "from Coffeyville Brick Plant Quarry." Efforts to locate this fossil zone have proven futile. Specimens from the Dewey Formation are deposited in the University of Oklahoma Geology collections; those from Stanton and Coffeyville Formations are in The University of Kansas Museum of Invertebrate Paleontology. Holotype is OU 5654.

SUTHERLANDIA SEMINOLENSIS Cocke & Bowsher, n. sp.

Figure 3,1,2

Diagnosis.—Coralla are ellipsoidal to spherical and most circumscribe fossil fragments. Polygonal to circular corallites surround deep calices. Internally, squamulae are bladelike projections, distally concave and typically traverse less than one-third corallite diameter. Mural pores are abundant and somewhat more numerous in upper one-half of corallite. In distal areas, corallite walls bifurcate to form processes.

Description.—Ellipsoidal to spherical coralla comprised of smoothly polygonal to subcylindrical

corallites are typical of this species. They are moderately large, with diameters ranging from 5 to 12 mm. Mural pores are visible in well-preserved calices. All coralla surround crinoid stems or more commonly cylindrical spar-filled masses, which in some specimens are almost completely recrystallized productid spines.

In thin section corallite walls are crooked and range from 0.15 to 0.20 mm. proximally and 0.4 to 0.6 mm. distally. Mural pores are rare. Squamulae are numerous, with as many as 7 in 1 mm. vertically, ranging in thickness from 0.05 to 0.08 mm. If intersected perpendicular to their long axis, squamulae are concave upward and seem to float in matrix material; if intersected parallel to the long axis, they appear as almost straight spines which reach approximately one-third of the corallite diameter. A small number of squamulae near the base completely cross individual corallites.

Discussion.—The peculiar spinose nature of its squamulae clearly distinguishes this species from all other North American forms. The Permian species, *Pseudofavosites extraspinosus* SOKOLOV, has spinose squamulae but they are thinner, more widely spaced and are subhorizontal. The Permian form is larger; an illustrated specimen is more than 23 mm. in diameter; the maximum diameter of *S. seminolensis* is slightly less than 2 mm.

Material studied.—Specimens were collected from calcareous shale of the Seminole Formation approximately one mile south of Glenpool, Tulsa County, Oklahoma, at NW NW NW sec. 23, T. 17 N., R. 12 E., by Harrell Strimple, Curator,

Sections cut through centers of coralla, all $\times 6.8$.

1-4. *Sutherlandia irregularis* COCKE & BOWSHER, n. sp.

—1. Holotype (OU 5654), specimen broken from bryozoan fragment, Dewey Formation, Washington County, Oklahoma.—2. Specimen (OU 5655) attached to fenestrate bryozoan, Dewey Formation, Washington County, Oklahoma.—3. Specimen (KUMIP 4607) encrusted on cylindrical object (circular transverse section in left center of photograph), ?Coffeyville Formation, Montgomery County, Kansas.—4. Specimen (OU 5661) encrusted on bryozoan colony, Dewey Formation, Washington County, Oklahoma.

5-9. *Sutherlandia alani* COCKE & BOWSHER, n. sp.—5.

Holotype (OU 5656), specimen encrusted on crinoid stem, Wewoka Formation, Okmulgee County, Oklahoma.—6. Specimen (OU 5657) encrusting partially recrystallized productid spine (elongate object at left center of photograph), Oologah Formation, Tulsa County, Oklahoma.—7. Specimen (OU 5658) surrounding cylindrical sparry calcite object (near center of section), Oologah Formation, Tulsa County, Oklahoma.—8. Specimen (OU 5659) with attachment object either not present or not intersected by section, Oologah Formation, Tulsa County, Oklahoma.—9. Specimen (OU 5660) on cylindrical sparry object (ellipsoidal area below and left of center of photograph), Wewoka Formation, Tulsa County, Oklahoma.



FIG. 3. *Sutherlandia seminolensis* COCKE & BOWSHER, n. sp., from Seminole Formation south of Glenpool, Tulsa County, Oklahoma.

1. Holotype (OU 5663) with central subcylindrical object encrusted by small organisms of undetermined nature, $\times 6.4$.
 2. Specimen (OU 5662) encrusted on cylindrical spar-filled object, $\times 6.4$.

The University of Iowa Paleontological Repository. Several specimens from the same locality were loaned to us by P. K. Sutherland of the University of Oklahoma. Fifteen specimens were sectioned. All are deposited in the University of Oklahoma collections. Holotype is OU 5663.

SUTHERLANDIA ALANI Cocke & Bowsher, n. sp.
Figure 2,5-9

Diagnosis.—Specimens commonly spherical; a few are hemispherical or elongate. Corallites smoothly polygonal to subcylindrical. Squamulae traverse, approximately three-fourths of corallite diameter, and horizontal to faintly convex distally; few are irregular. Mural pores and processes present in the distal part of each corallite.

Description.—Although spherical forms dominate this species, hemispherical representatives are common; four elongate corals are similar internally to other *Sutherlandia alani* but in habit resemble isolated branches of *Acaciapora* MOORE & JEFFORDS (1941), a Lower Pennsylvanian squamulate form.

Internally, corallite walls are straight and range in thickness from 0.10 to 0.16 mm. proximally and 0.17 to 0.33 mm. distally. Mural pores, seen readily in open calices, are rarely observed in thin section. Most are near 0.17 mm. in diameter with a maximum of 0.20 mm. As many as 12 squamulae occupy a vertical distance of 1.3 mm.; proximally, a few squamulae seem to be complete.

Discussion.—*Sutherlandia alani* can be differentiated from *S. irregularis*, which it most closely resembles, by more regular and longer squamulae in the former. Only specimens of *S. irregularis* from the Coffeyville Formation have larger mural pores. The species here described can be separated from *P. minus* YAKOVLEV by its smaller size and more widely spaced squamulae. The Wewoka representatives of this species are larger, have a few more closely spaced squamulae, and slightly larger mural pores than do the Oologah forms, but similarity of squamulae makes placement in the same species reasonable.

Material studied.—More than 500 specimens from the Wewoka Formation were loaned by P.

K. Sutherland, University of Oklahoma, from which 20 thin sections were prepared. All were collected by A. Hanson from a single locality on the east shore of Lake Okmulgee, Okmulgee County, Oklahoma, in NE SW NE sec. 18, T. 13 N., R. 12 E., in the shale below the sandstone designated as PWK-12 (OAKES, 1963). Accompanying fossils include specimens of the alga *Gymnophyllum wardii* (HOWELL). Approximately 200 Oologah specimens were collected from a few hundred feet west of intersection of 31st Street and 145th E. Street, SW SE SE sec. 16, T. 19 N., R. 14 E., and from the center SW SW sec. 33, T. 20 N., R. 14 E., a few hundred feet south of U.S. Highway 44, Tulsa County, Oklahoma. A total of 76 thin sections were examined. All specimens are deposited at the University of Oklahoma Geology collection. Holotype is OU 5656.

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