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

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**ABSTRACT**

Small tabulate corals assigned to *Sutherlandia* COCKE & BOWSHER, \(n.\) 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 & BOWSHER, \(n.\) 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 productivity spines; hemispherical forms typically encrust phylloid algal fragments, fenestrate bryozoans, large brachiopods, and rugose corals. A few specimens of *S. alani* COCKE & BOWSHER, \(n.\) sp., from the Oologah Formation are elongate, closely resembling isolated branches of *Acaciaipora* 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.

**Fig. 1.** Stratigraphic chart with asterisks marking units from which *Sutherlandia* COCKE & BOWSHER, \(n.\) 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

COELENERATA (ANTHOZOA)

Order TABULATA Milne-Edwards & Haime, 1850

Family FAVOSITIDAE Dana, 1846

Subfamily PSEUDOFAVOSITINAE 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, Visean, 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. stylifer and P. stylifer 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. stylifer septosa and faint ridges in a single corallite of P. stylifer stylifer. 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 tabulacbearing 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. stylifer 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. stylifer, have diameters of 24 mm. and 47 mm., respectively.
Shape and size of squamulæ 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 asceptate or marked by faint, broad, longitudinal ridges. Internally, squamulæ of a given corallite may be gently convex upward, distally inclined to planar, or subhorizontal plates which tend to alternate with squamulæ 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 bryozaons 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 bryozaon 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. Squamulæ 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 squamulæ 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 squamulæ alternate with those of the opposing wall. Complete plates which simulate tabulae are here interpreted as squamulæ 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 squamulæ which are irregular, gently convex distally, and sharply inclined. Squamulæ 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 squamulæ, crooked walls, and irregular squamulæ.

Internally, *Sutherlandia irregularis* is morphologically similar to *P. minus* Yakovlev in length and convexity of squamulæ but is readily differentiated on the basis of its more abundant squamulæ vertically, more highly irregular squamulæ, and smaller size. It is most similar to *S. alani* but separated from it by the more irregular squamulæ 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 & Bowsher 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 elipsoidal 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 corallite 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, *Pseudojovacites extraspersus* 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. seminolenis* 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.

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Sections cut through centers of corallla, all X6.8.

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 sparly 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 sparly object (ellipsoidal area below and left of center of photograph), Wewoka Formation, Tulsa County, Oklahoma.
1. Holotype (OU 5663) with central subcylindrical object encrusted by small organisms of undetermined nature, ×6.4.

2. Specimen (OU 5662) encrusted on cylindrical spar-filled object, ×6.4.

Fig. 3. Sutherlandia seminolensis Cocke & Bowsher, n. sp., from Seminole Formation south of Glenpool, Tulsa County, Oklahoma.
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. Squamulac 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 squamulac 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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REFERENCES


