

The Devonian Colonial
Coral Genus *Billingsastraea*
and Its Earliest Known
Species

GEOLOGICAL SURVEY PROFESSIONAL PAPER 483-B



The Devonian Colonial Coral Genus *Billingsastraea* and Its Earliest Known Species

By WILLIAM A. OLIVER, JR.

CONTRIBUTIONS TO PALEONTOLOGY

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*The geographic and stratigraphic distribution of
Billingsastraea with a redescription of B. affinis
its earliest known species*



UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1964

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

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THE DEVONIAN COLONIAL CORAL GENUS *BILLINGSASTRAEA* AND ITS EARLIEST KNOWN SPECIES

By WILLIAM A. OLIVER, JR.

ABSTRACT

In North America, the compound rugose coral genus *Billingsastraea* ranges in age from late Early Devonian (middle Coblenzian) to latest Middle Devonian (late Givetian); it is not certainly known outside of North America, although it may occur in Europe and Australia. The genus is composed of astraeoid, thamnastraeoid, and aphroid corals with disphyllid structure. The oldest known species, *B. affinis*, is redescribed.

INTRODUCTION

In the course of a study of the compound rugose corals from the Middle Devonian Onondaga Limestone in New York, the holotype and only known specimen of *Billingsastraea affinis* (Billings), from the early Devonian Grande Grève Limestone in the Gaspé area, Quebec, was borrowed for comparison. *B. affinis* is of special interest because it is the oldest species of the genus now known.

The specimen of *B. affinis* was collected by Robert Bell in 1862. Since that time no additional specimens have been found although several field studies have been made in the area (Cumming, 1959, p. 1-6). The present description is of the holotype corallum. It is hoped that additional specimens will eventually permit an adequate description of the species.

The specimen is the property of the Geological Survey of Canada and is numbered GSC 3270. Thin sections were made by W. C. Pinckney, Jr.; photographs were made by R. H. McKinney (exteriors) and the author (thin sections). The typescript was critically read by D. J. McLaren and L. M. Cumming, Geological Survey of Canada and J. T. Dutro, Jr., and W. J. Sando, U.S. Geological Survey.

DISTRIBUTION OF *BILLINGSASTRAEA*

Billingsastraea affinis (Billings) is from the Indian Cove Member of the Grande Grève Limestone (limestone No. 8 of Logan, 1863, p. 393). The Grande Grève has generally been correlated with the Oriskany Formation (Billings, 1874, p. 2; Clarke, 1908, p. 250; Cooper and others, 1942, chart), although Cooper (in Cooper and others, 1942, p. 1762-1763) suggested that

"in all probability the top division is higher than any Oriskany exposed in New York." More recently, Boucot (1959, p. 738-739) suggested that the upper part of the Grande Grève (limestone No. 8 of Logan) falls within his Esopus Stage (1959, p. 738-739) which overlies the Deerpark (Oriskany) Stage and underlies the Schoharie (table 1).

Specimens of *Billingsastraea* are widespread but uncommon in the somewhat younger rocks of Schoharie age. Poorly preserved indeterminate specimens are known from the Schoharie Formation (Rickard Hill Member of Johnsen, 1957) in eastern New York. At Innerkip, Ontario, better specimens have been collected from the lower part of the Bois Blanc Formation, which Oliver (1960, p. 173) correlated with the Schoharie. The genus also occurs in the *Spirifer pinyonensis* zone of the Nevada Limestone, considered late Early Devonian (presumably Schoharie age) by Cooper and others (1942, chart), by House (1962, p. 252-253), and by Johnson (1962).

TABLE 1.—Correlation of the New York stratigraphic section with the European stages

[Based on Cooper and others (1942), Boucot (1959), Oliver (1960), and House (1962)]

	European stage	Standard New York section	North American stage (Cooper and others, 1942)	
Upper Devonian	Frasnian ?	Genesee Shale	Toughnioga	
		Tully Limestone		
Middle Devonian		Moscow Shale	Hamilton Group	Toughnioga
	Givetian	Ludlowville Shale Skaneateles Shale		
	?	Marcellus Shale		Cazenovia
	Eifelian	Onondaga Limestone		
Lower Devonian		Schoharie Grit	Esopus Stage of Boucot, 1959	
	Coblenzian	Esopus Shale		
		Oriskany Sandstone	Deerpark	
	Gedinnian	Helderberg Group	Helderberg	
Silurian				

In rocks of Middle Devonian age, specimens of *Billingsastraea* are widespread and more common. Three species occur in the Edgecliff Member of the Onondaga Limestone in New York (Eifelian age, Oliver, 1960); these and other species are known from equivalent and younger Middle Devonian formations in Missouri, Iowa, Indiana, Kentucky, Ohio, Michigan, southwest Ontario, New York, the Hudson Bay lowlands, Ellesmereland, and Northwest Territories.

The latest known specimens of *Billingsastraea* are from the lower part of the Cedar Valley Limestone in Iowa (Solon Member of Cooper, 1942) and the Tully Limestone in New York. Both of these formations have been assigned a Late Devonian (Frasnian) age at one time or another, but both are now considered as more probably of Middle Devonian age. The Cedar Valley is assigned to the late Middle Devonian by most recent workers (Cooper and others, 1942, p. 1750-1751; Downs and Youngquist, 1950, p. 667-668; Collinson and Scott, 1958, p. 5). The age of the Tully is still disputed and the most recent assignment is to the early Late Devonian (House, 1961; 1962, p. 255-256). Tully corals, however, are dominantly Middle Devonian (Hamilton) species, with a very few species that are limited to the Tully and none of the typical Upper Devonian forms. Brachiopod and conodont workers (for example Cooper, in Cooper and others, 1942, p. 1786-1788; and Hass, 1959, p. 1615) reported similar dominance of Tully faunas by Middle Devonian species.

Billingsastraea, therefore, ranges from rocks of Early Devonian (Coblentzian) to late Middle Devonian (Givetian) age. An early Late Devonian (Frasnian) extension of this range is possible.

In Europe, species from rocks of Early to Late Devonian age have been assigned to *Billingsastraea*. Prantl (1951) described two Lower Devonian species from Bohemia in which the septa are virtually limited to the tabularia which are surrounded by broad dissepimentaria. Most American species have complete septa extending from tabularia to the periphery of the corallites; some species show incomplete septa locally. The Bohemian species may represent an extreme example of the latter trend, although their Early Devonian age suggests that they may represent instead an independent development, not closely related to *Billingsastraea*.

Schouppé (1958) showed that the type species of *Phillipsastraea* has horseshoe-shaped dissepiments and that *Phillipsastraea* is therefore a senior synonym of *Pachyphyllum*. He proposed that species without horseshoe dissepiments, which had been placed in *Phillipsastraea*, be assigned to *Billingsastraea*. These species, however, differ from species of *Billingsastraea* by possessing a zone of septal thickening just outside of

the tabularium, whereas specimens of *Billingsastraea* have uniformly attenuate septa. Furthermore, the thickened-septa species are mostly of Late Devonian age. Schouppé failed to show that the "*Phillipsastraea*" type was polyphyletically derived from species of *Billingsastraea*, or indeed, that there was any relationship at all. On morphologic grounds, it seems necessary to keep the dominantly Middle Devonian *Billingsastraea* separate from the Late Devonian "*Phillipsastraea*."

In Europe then, only the specimens from the Lower Devonian in Bohemia are possibly assignable to *Billingsastraea*. Therefore, the genus is rare in Europe, if it occurs at all.

Other reported occurrences of *Billingsastraea* are limited to Australia. DeKoninck 1898, p. 53) cited *Phillipsastraea verneuili* (Milne-Edwards and Haime) from the Middle Devonian of New South Wales. This is the type species of *Billingsastraea*, originally described from North America. This citation was repeated by Benson (1922, p. 68), but the two specimens have never been illustrated or adequately described. Hill (1957, p. 46), in a review of Australian Devonian coral faunas, did not mention the occurrence and cited no other Australian specimens of *Billingsastraea*.

Family DISPHYLLIDAE

Genus BILLINGSASTRAEA Grabau

- 1851. [part] *Phillipsastraea* Milne-Edwards and Haime, p. 447.
- 1917. *Phillipsastraea* (*Billingsastraea*) Grabau, p. 957.
- 1937. *Billingsastraea* Grabau, Stumm, p. 437-438.
- 1949. *Billingsastraea* Grabau, Stumm, p. 35.
- 1951. *Billingsastraea* Grabau, Ehlers, and Stumm, p. 85.
- 1953. *Billingsastraea* Grabau, Ehlers, and Stumm, p. 1.
- 1956. *Billingsastraea* Grabau, Hill, p. 280.
- 1958. [not] *Billingsastraea* Grabau, Schouppé, p. 235-237.

Type species.—By monotypy, *Phillipsastraea verneuili* Milne-Edwards and Haime, 1851 (p. 447-448, pl. 10, fig. 5).

Horizon and locality of type species.—Stated by Milne-Edwards and Haime to be Wisconsin; generally assumed to be a drift specimen originating in the Onondaga or Bois Blanc Formations of Ontario or Michigan (Stumm, 1949, p. 35).

Diagnosis.—Astraeoid, thamnastraeoid, or slightly aphroid corals with calices having a central pit and a broad horizontal or reflexed peripheral platform. Septa are radially arranged and lightly to heavily carinate with zigzag or crossbar carinae. Major and minor septa extend from the periphery; minor septa terminate at the outer margin of the tabularium; major septa commonly extend to or almost to the axis. At their peripheral ends the septa abut against those in the adjacent corallite or are continuous into the next corallite.

The tabularium is narrow and composed of closely spaced, horizontal, complete tabulae. The dissepimentarium is composed of gently to strongly curved dissepiments that are horizontally arranged except next to the tabularia where they are inclined toward the corallite axes.

Remarks.—The above diagnosis is adapted from that of Stumm (1949, p. 35). It differs by the inclusion of zigzag and weakly carinate forms. The type species of *Radiastraea* Stumm (1937), *R. arachne*, has very weak zigzag carinae in some corallites, but carinae are totally lacking in others. Stumm listed *Radiastraea* in the synonymy of *Billingsastraea* but did not include its characters in his diagnosis.

The name *Billingsastraea* was established by Grabau (1917, p. 957) by merely using the word in a subgeneric sense. The genus was first defined by Stumm (1937, p. 437–438), and his definition has been generally accepted and used by later workers.

Phillipsastraea verneuili Milne-Edwards and Haime, the type species of *Billingsastraea*, has never been adequately described. Milne-Edwards and Haime (1851, p. 447–448, pl. 10, fig. 5) illustrated the surface of a single specimen and briefly described it in general terms. There is no indication that any subsequent description of the species was based on the type specimen. The species characters of *P. verneuili* are not known, but there is no reason to think that it doesn't fit the generally accepted generic concept. *B. verneuili* (Milne-Edwards and Haime), 1851, may be a junior synonym of *B. rugosa* (Hall) 1843.

Three groups of astraoid corals with the following characters are sometimes confused:

1. Uniformly attenuate septa: *Billingsastraea*.
2. Septa dilated at the borders of the tabularia: *Phillipsastraea* of most authors.
3. Septal dilation at borders of tabularia corresponding to row of horseshoe-shaped dissepiments: *Pachyphyllum* of authors.

Schouppé (1958) showed that the type species of *Phillipsastraea* has horseshoe-shaped dissepiments and that *Phillipsastraea* is therefore a senior synonym of *Pachyphyllum*. Schouppé (1958, p. 237) proposed that the species of group 2 (*Phillipsastraea* of authors) be included in *Billingsastraea* but presented no evidence to show that the former (primarily of Late Devonian age) were polyphyletically derived from the Middle Devonian *Billingsastraea*. The morphologic and stratigraphic evidence suggests either no relationship or a monophyletic origin instead, and *Billingsastraea* is here restricted to forms with uniform attenuate septa.

Billingsastraea affinis (Billings)

Plates 1 and 2

1874. *Phillipsastraea affinis* Billings, p. 11.
 1901. [part] *P. verneuili* Milne-Edwards and Haime. Lambe, p. 166.
 1908. *P. verneuili* Milne-Edwards and Haime. Clarke, p. 218.
 1953. *Billingsastraea affinis* (Billings). Ehlers and Stumm, p. 6, pl. 2, fig. 4.
 1955. *B. affinis* (Billings). Stumm, cards 231, 231.1, two new figs.

Occurrence of type material.—"Indian Cove, Gaspé, in the Gaspé limestone No. 8" (Billings, 1874, p. 11). Gaspé limestone group, Grande Grève Formation, Indian Cove Member of Cumming (1959, p. 4, 24). Lower Devonian, Esopus Stage, *Etymothyris* zone of Boucot (1959, p. 737–739).

Diagnosis.—*Billingsastraea* with small corallites and calices that are deep and steep sided, with a boss and a flat calicular platform. The dissepiments are arranged in arched layers and are smaller and more steeply inclined toward the tabularia.

External features.—Astraoid and thamnastraoid colonies of unknown size. The holotype consisted of two fragments 7.9 by 7.0 by 2.2 cm, and 6.7 by 5.7 by 3.0 cm; one horizontal and one vertical slice for thin sections have now been removed from the first of these. Corallites are irregularly prismatic and subparallel in the preserved parts of the corallum. The distance between adjacent corallite axes (essentially a measure of corallite diameter) ranges from 9.6 to 15.6 mm and averages 12.8 mm (table 2).

The surface of the holotype corallum is somewhat worn but seems to preserve the shape of several calices. The sides of the calicular pits are almost vertical; bottoms are flat with a calicular boss formed by the axial ends of the septa; depths to the top of the boss range from 3.0 to 3.5 mm. The calicular platforms are flat with low radiating septal ridges.

Internal features.—The septa are radially arranged. Major septa extend from the corallite margin to the tabularium where they zigzag and turn slightly; a few septa reach the axis or meet other septa. Minor septa are commonly limited to the dissepimentarium, although one or two per corallite may be nearly as long as the major septa. Peripherally the septa may continue into the next corallite, but commonly they alternate in position forming a zigzag boundary. All septa are attenuate and of equal thickness. The number of major septa per corallite in the holotype ranges from 18 to 21 and averages 19.4 (table 2).

TABLE 2.—Standard statistics of holotype corallum

[All measurements in millimeters]	
Number of corallites.....	16
Number of septa (n) :	
Observed range.....	18-21
Mean.....	19.4
Standard deviation.....	1.1
Coefficient of variation.....	5.6
Tabularium diameter (d ^t) :	
Observed range.....	3.7-4.8
Mean.....	4.3
Standard deviation.....	.3
Coefficient of variation.....	6.9
Correlation coefficient (r) of n and d ^t32
Probability of r being significant.....	.30
Axial distance (d ^a) (mean d ^a is a measure of corallite diameter) :	
Observed range.....	9.6-15.6
Mean.....	12.8

Short zigzag carinae are well developed on all septa in the dissepimentarium. At the inner edge of the dissepimentarium they are spaced 7 to 10 per 2.5 mm. The carinae are very steeply inclined in all but the innermost part of the dissepimentarium (pl. 1, figs. 2 and 5).

The dissepimentaria occupy a large part of each corallum. In longitudinal sections the dissepiments form an arched pattern, being steeply inclined at the tabularium margins, and nearly horizontal near corallite boundaries. The dissepiments tend to increase in size away from the tabularium.

In the holotype the tabularia range in diameter from 3.7 to 4.8 mm and average 4.3 mm. Tabulae are incomplete, forming an arched pattern. Individual tabulae are convex in the axial region, convex or concave peripherally. They are closely spaced.

Microstructure.—Preservation of the holotype is not adequate for detailed description of microstructure; however, two types of skeletal tissue can be discerned. The septa and carinae, except for thin surface layers, are composed of dark tissue, in contrast to the dissepiments, tabulae, and thin surface layers of the septa, which are uniformly lighter in color. A similar contrast has been noted by the writer in several other species of *Billingsastraea* and *Heliophyllum*. Better preserved specimens of other species suggest that the darker tissue is composed of pinnately arranged fibers.

Remarks.—The above description is based on the holotype corallum. Measurements and counts are from 16 corallites within this 1 colony (table 2).

Billingsastraea affinis differs from other species of the genus by the shape of its calice (steep sides, flat peripheral platform) and by the arrangement of its tabulae and dissepiments. Other species have raised calice rims and lack the calicular boss; both features are reflected in dissepiment and tabula arrangements.

Billings (1874, p. 11) first described *B. affinis* but did not illustrate it. Subsequently, Lambe (1901, p. 166) and Clarke (1908, p. 218) placed the species in synonymy with *B. verneuili*, basing the latter on Onondaga Limestone specimens that are now referred by the present writer to *B. rugosa* (Hall). The holotype corallum of *B. affinis* falls within the range of *B. rugosa* in corallite and tabularium diameters and number of septa but differs by the shape of the calicular pit and platform and by the arrangement of the dissepiments.

B. affinis was first illustrated by Ehlers and Stumm (1953, pl. 2, fig. 4); a polished longitudinal section was illustrated by Stumm (1955, card 231). The holotype was not thin sectioned prior to the present work, and no illustrations of transverse sections have been published previously. All descriptions including this one are based on the holotype.

Material.—Holotype and only known specimen, GSC 3270.

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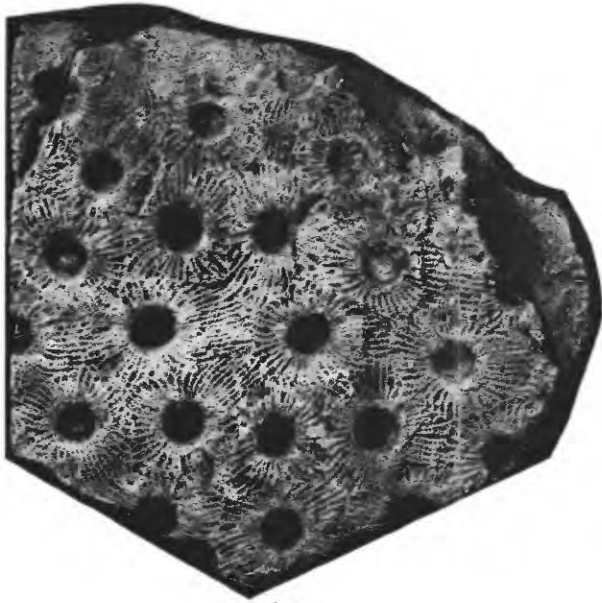
PLATES 1 and 2

PLATE 1

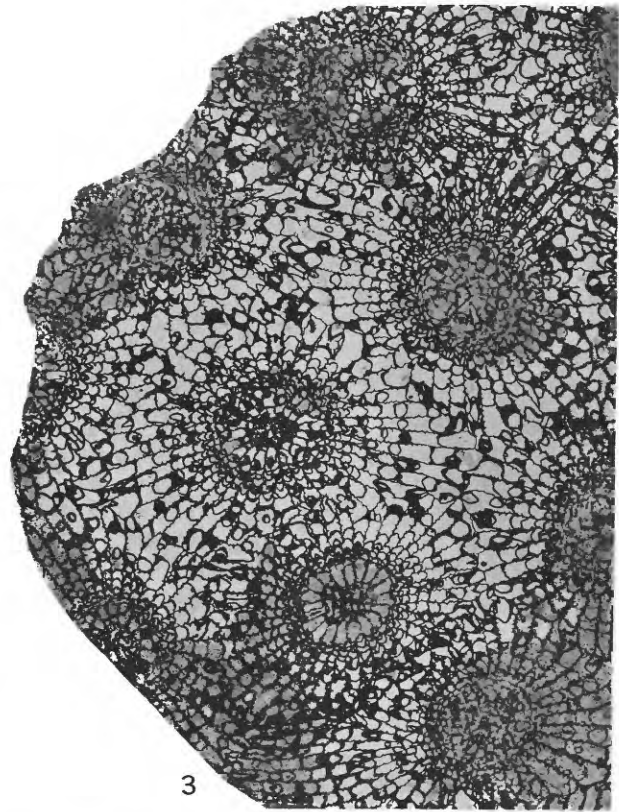
FIGURES 1-5. *Billingsastraea affinis* (Billings) (p. B3).

Holotype G.S.C. 3270.

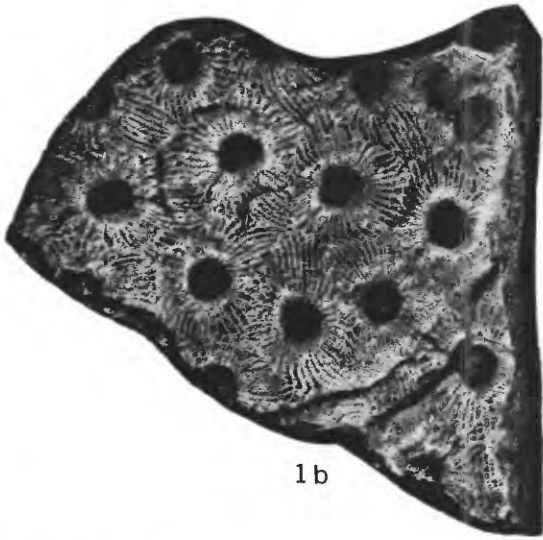
- 1a-b. Surface of two parts of corallum, $\times 1$.
2. Transverse thin section of a part of the corallum in fig. 1a, $\times 1$.
3. Part of transverse thin section, $\times 2\frac{1}{2}$.
4. Longitudinal thin section taken at left end of corallum as seen in figure 1a, before thin section in fig. 2 was cut off, $\times 1\frac{1}{2}$.
5. Part of longitudinal thin section, $\times 5$. Note calice profile in figs. 4 and 5.



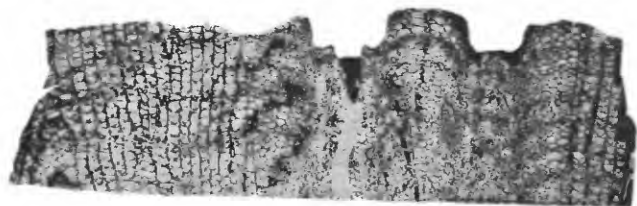
1a



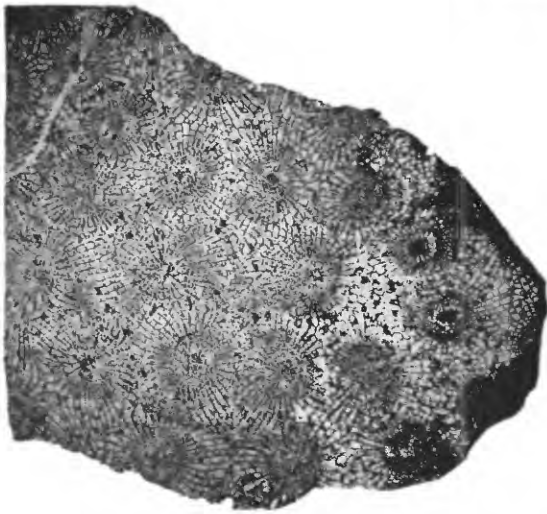
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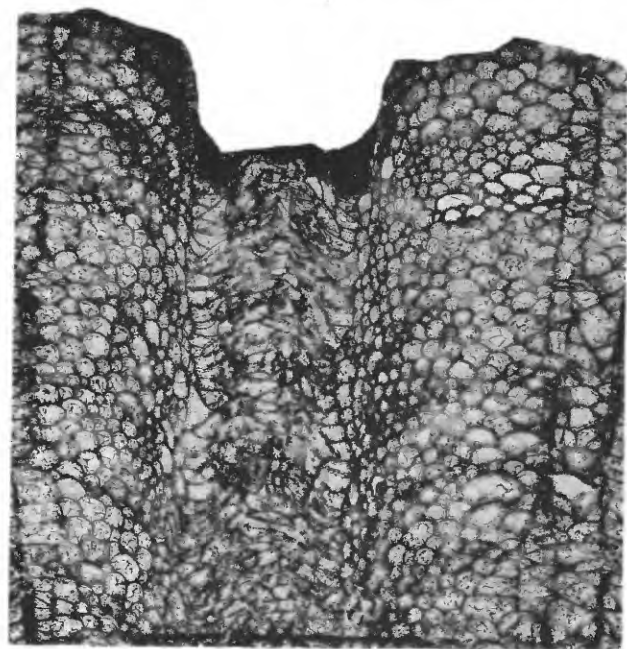
1b



4



2



5

BILLINGSASTRAEA AFFINIS (BILLINGS)