

Normapolles Pollen from the Mississippi Embayment

GEOLOGICAL SURVEY PROFESSIONAL PAPER 865

*Work done in cooperation with the
Kentucky Geological Survey*



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By ROBERT H. TSCHUDY

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*Taxonomy and stratigraphic ranges of
Normapolles genera and species found
in Mississippi embayment rocks*



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NORMAPOLLES POLLEN FROM THE MISSISSIPPI EMBAYMENT

By ROBERT H. TSCHUDY

ABSTRACT

The Normapolles group of fossil pollen genera is extinct. Pollen types of the included genera are triaperturate, morphologically complex, and distinctly different from types produced by extant pollen genera. Genera included in this somewhat heterogeneous group were first described from the Late Cretaceous and early Tertiary of Europe. In recent years increasing mention has been made of Normapolles genera observed in pollen preparations from North American rocks, and several new genera, not known from Europe, have been described. Taxonomic evaluations of North American Normapolles genera and species, however, have been minimal. This paper lists and evaluates the Normapolles genera and species found in rocks from the Mississippi embayment province.

At the present time, 57 Normapolles genera have been reported from Europe, 47 from boreal Middle Europe and 10 from western Hungary. Only four Normapolles genera are common to the two European regions. In Mississippi embayment rocks I have found pollen assignable to 18 of the European Normapolles genera, to 2 additional genera previously described from the United States, and to 4 new genera that I have proposed. I have found and illustrated specimens of four additional potentially new genera, but have not named them because of insufficient numbers of specimens for diagnosis.

The development of Normapolles genera in the Mississippi embayment began with their first appearance in the Cenomanian. They increased in numbers, reaching a peak in the Campanian — Maestrichtian interval, then declined in numbers during the early Tertiary and finally disappeared at the end of middle Eocene time. This development approximately parallels the generic occurrence of the Normapolles group in Europe.

Some of the genera common to Europe and the Mississippi embayment show remarkably similar stratigraphic ranges, but the ranges of others are distinctly different in the two regions. Several genera apparently appear earlier in Mississippi embayment rocks than in European rocks. This phenomenon is at odds with the commonly held hypothesis that Europe is the center of development and dispersion of the Normapolles group as a whole. If a migration route from Europe to North America allowed some Normapolles genera to move from Europe to North America, an alternate hypothesis would allow other Normapolles genera originating independently in North America to migrate to Europe and, thus, appear there later in the stratigraphic record.

A total of 59 species assignable to Normapolles genera have been recognized from the Mississippi embayment. Of this number, 43 have been found in sufficient numbers that specific names could be assigned. Thirty-three of these species are confined to North America. This fact suggests that the North American genera were relatively isolated from their European counterparts.

Normapolles species by themselves, or in combination with pollen assemblages, have proved to be excellent indicators of the several segments of the Late Cretaceous-early Tertiary part of the stratigraphic column. The known range zone of each Normapolles species discussed is presented in a stratigraphic chart.

INTRODUCTION

The term "Normapolles" was proposed by Pflug (1953) to embrace a group of pollen form genera that possessed morphological characteristics distinctly different from the morphological characteristics of most modern pollen types. Pollen grains assigned to genera of the Normapolles group are commonly triangular and shallow lens-shaped (short axial), with apertures at the angles, although a few are spherical or nearly so. The apertures are complex and morphologically highly differentiated, sometimes to a degree that they have been referred to as having a "bizarre" construction. The morphology of the apertures and the associated wall structure, although vastly different within the group, is sufficiently distinctive that none of the included genera can be conveniently included in the porate, colpate, or colpiate morphotypes. Plants that produced pollen assigned to these genera are, so far as is known, extinct, and their relationships to modern genera, and indeed families, are still in the realm of conjecture. The Normapolles group is a group of convenience and neither genetic nor morphologic relationship among all included genera is implied.

Pollen genera assignable to the Normapolles group had their origin during the Cenomanian and became virtually extinct at the end of the Eocene. Their postulated center of origin and dispersal was in central Europe (Góczán and others, 1967, p. 435). In North America this group of genera is virtually limited to the Mississippi embayment and the eastern coast, although specimens assignable to Normapolles genera have been reported from rocks deposited to the west of the Late Cretaceous North American midcontinental epeiric sea. In North America also, pollen of Normapolles genera has been found only in rocks of Late Cretaceous and early Tertiary age.

Krutzsch (1959) enlarged the normapolles group by the addition of several new form genera from the European Cretaceous and early Tertiary. Góczán, Groot, Krutzsch, and Pacltová (1967), in the light of new knowledge of the fine morphology of these pollen grain types, in an excellent monographic work, reevaluated all the then-known Normapolles genera, erected several new genera and included more complete and accurate

diagnoses and diagrams, thus contributing to the clarification of many morphological details that serve to characterize the several genera. It is this European work by Góczán and his coworkers that provides the basis for an evaluation and listing of Normapolles genera and species from the Mississippi embayment area of the United States.

PREVIOUS REPORTS, NORTH AMERICAN

Previous reports of Normapolles genera from North America are largely confined to the eastern part of the United States; but four, the reports of Newman (1965), Drugg (1967), B. D. Tschudy (1971), and Chmura (1973), record Normapolles genera from the western part. Although new information has altered somewhat the circumscriptions of some genera, other genera are no longer valid, and some determinations were made on the basis of few specimens or poorly preserved material, the reader should note that the several authors at the times of publication assigned specimens to what they then considered to be appropriate Normapolles genera and species.

These reports can be divided into two categories: (1) reports that include taxonomic diagnoses or descriptions, and (2) reports that mention Normapolles genera but do not provide descriptions or taxonomic details.

TAXONOMIC REPORTS

The first mention of a Normapolles genus from the United States appeared in a publication by Krutzsch (1960a). In that report Krutzsch established the genus *Thomsonipollis*, basing his diagnosis upon specimens from the early Eocene of Europe and from lower Eocene rocks near Austin, Tex. Two other reports proposed new Normapolles genera from the United States. Stover (in Stover and others, 1966) erected the new monotypic genera *Choanopollenites* and *Kyandopollenites* from specimens found in the early Eocene of Texas. These genera, though not formally included in the Normapolles group, undoubtedly belong there because of their complex morphological characteristics. B. D. Tschudy (1971) found and described two new Normapolles genera from upper Campanian rocks of Montana. These new genera are *Siberiapollis* and *Montanapollis*.

The first North American descriptions of species belonging to heretofore strictly European Normapolles genera are found in a publication by Groot, Penny, and Groot (1961). They described one species each of *Turonipollis* (now *Complexiopollis*), *Sporopollis* (now *Pseudoplicapollis*), *Latipollis* (now *Complexiopollis*), *Quedlinburgipollis* and *Trudopollis*, two species of *Vacuopollis* and three species of *Plicapollis* from Upper Cretaceous rocks of the Eastern United States, thus firmly establishing the presence of Normapolles genera other than *Thomsonipollis* on the North American continent. Groot and Groot (1962) mentioned or described one

species each of the genera *Latipollis* (now *Complexiopollis*), *Plicapollis*, and *Extratropipollenites* from the Brightseat Formation (Paleocene) of Maryland; and Fredericksen (1973) described a species of *Plicapollis* from the Tertiary of Mississippi. From the Cretaceous of Colorado, Newman (1965) described one species each of *Conclavipollis* (now *Vacuopollis*) and *Trudopollis* and mentioned a species of *Sporopollis* (now *Pseudoplicapollis*). Chmura (1973) described one species of *Trudopollis* and mentioned one species of *Plicapollis* from the Cretaceous of California. The reports by Newman and Chmura are the only ones describing European Normapolles genera and species from pollen specimens obtained from Western United States. Two reports on Late Cretaceous palynomorphs from Delaware and New Jersey appeared in 1966. Gray and Groot (1966) provided descriptions of two species of *Plicapollis* and two species of *Trudopollis*, and Kimyai (1966) described a single species of *Conclavipollis* (now *Vacuopollis*). Elisk (1968), in discussing the palynomorph flora of the Paleocene of Texas, emended the genus *Thomsonipollis* and listed one species each of *Trudopollis*, *Plicapollis*, *Extratropipollenites*, *Choanopollenites* and two species of *Nudopollis*. More recently, R. H. Tschudy (1973b), in tracing the evolutionary development and stratigraphic distribution of the *Complexiopollis* lineage, described four new species of *Complexiopollis* and five new species of *Choanopollenites* from Cretaceous and lower Tertiary rocks of the Mississippi embayment region.

NONTAXONOMIC REFERENCES

Mention of the Genera *Extratropipollenites* and *Trudopollis* in Paleocene and lower Eocene rocks of Arkansas was made by Jones (1962), and in the same year Brown and Pierce (1962) figured specimens from the Turonian of Texas that probably belong to genera of the Normapolles group under the name of *Punctatricolporites*. Leopold and Pakiser (1964) listed the genera *Basopollis*, *Sporopollis* (now *Pseudoplicapollis*), *Complexiopollis*, *Latipollis* (now *Complexiopollis*), *Nudopollis*, *Minorpollis* and *Conclavipollis* (now *Vacuopollis*) from the Late Cretaceous of western Alabama. Engelhardt (1964) listed and illustrated two species of the genus *Extratropipollenites* from the Eocene Cockfield Formation of Mississippi. Drugg (1967) mentioned single species of the genera *Nudopollis* and *Vacuopollis* from the Late Cretaceous-early Tertiary transition of California. Doyle (1969) and Wolfe and Pakiser (1971) examined Upper Cretaceous rocks from the Atlantic Coastal Plain area and both recorded the genera *Atlantopollis*, *Complexiopollis*, *Praebasopollis*, *Pecakipollis*, *Trudopollis*, *Plicapollis* and *Pseudoplicapollis*. Doyle recorded *Vacuopollis* in addition, and Wolfe and Pakiser recorded in addition *Semioculopollis*, *Heidelbergipollis*, *Minorpollis*, *Primipollis*, *Neotriangulipollis*, and 14 new unnamed

genera. They made no attempt to record the morphological characteristics of any of these genera. Fairchild and Elsik (1969), in discussing the characteristic palynomorphs of the Gulf lower Tertiary, listed two species of *Nudopollis* and one species each of *Thomsonipollis* and *Choanopollenites*. R. H. Tschudy (1973a) recorded one species of *Kyandopollenites*, two species of *Nudopollis*, and the genus *Thomsonipollis* from the Eocene of the Mississippi embayment. Góczán, Groot, Krutzsch, Pacltová (1967, p. 511) reported that types similar to *Thomsonipollis magnificoides* are known from "the Laramie of Raton Pass, Alabama/U.S.A." (Undoubtedly the Upper Cretaceous Laramie Formation from Raton Pass, Colo.).

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I thank Sharon Van Loenen and Kathryn Dieterich for their assistance in the preparation of the samples and Kathryn Dieterich for photography of the specimens.

METHODS

The methods employed for processing samples and preparing slides are standard for this laboratory and have been reported previously (Tschudy, R. H., 1970). A minor modification in procedures is the employment of the synthetic resin "Histoclad" as a mounting medium for some of the slides, replacing the previously used medium "Permount."

FOSSIL POLLEN SAMPLE LOCALITIES

The samples from Cretaceous and Tertiary rocks used in this study are from the numbered USGS Paleobotany localities listed below. The locations and detailed descriptions of the Cretaceous and Paleocene localities have been presented previously (Tschudy, R. H., 1973b). The localities and detailed information from Eocene samples have also been given in a previous publication (Tschudy, R. H., 1973a). This information is repeated here because of the desirability of having accurate locality data available in the same publication that proposes new taxa.

USGS Paleobotany loc.	Locality	Stratigraphic unit
D3415 ---	Outcrop at an altitude of 510 ft on the south side of U.S. Highway 78, NW 1/4 sec. 34, T. 3 S., R. 15 W., Colbert County, Ala. Collected by W. W. Olive, U.S. Geological Survey, "probably from unit 4 described by Stephenson and Monroe, 1940, p. 46" (W. W. Olive, written commun., 1964).	Tuscaloosa Formation, Cenomanian.
D3265 ---	E. W. Berry field designation 6474. Collected at Broken	Eutaw Formation, Coniacian.

USGS Paleobotany loc.	Locality	Stratigraphic unit
D3260 ---	Arrow Bend of the Chattahoochee River about 13 miles below Columbus, Chattahoochee County, Ga. Matrix material from leaf locality collected by E. W. Berry, U.S. Geological Survey, 1909. Matrix submitted by Jack Wolfe, U.S. Geological Survey, 1963.	Cusseta Sand Member, Ripley Formation, Campanian.
D3412 ---	Type locality, near middle. Elevation 440 ft along bluff on left bank Tennessee River 0.3 mile downstream from river mile 185 and 0.9 mile east of crossroads north of Coffee Landing, Hardin County, Tenn. Collected by W. W. Olive, U.S. Geological Survey, 1964.	Coffee Sand, Campanian.
D3413 ---	From roadcut along east side Tennessee Route 22, 0.8 mile north of intersection with Tennessee Route 100, Henderson County, Tenn. Collected by W. W. Olive, U.S. Geological Survey, 1964.	Coon Creek Tongue of Ripley Formation, Maestrichtian.
D1967 ---	Type locality of McNairy Sand Member. West end of big cut in Southern RR. east of Dismal Swamp and Tusculumbia River. Base is approximately same elevation as track and is 40 ft northwest of railroad crossing. South center NW 1/4 SW 1/4, Chewala quadrangle, McNairy County, Tenn.	McNairy Sand Member of Ripley Formation Maestrichtian.
D1967-A_	0-14 in. above bottom of sequence.	Do.
B_	14-26 in. above bottom of sequence.	Do.
C_	26-38 in. above bottom of sequence.	Do.
	Collected by E. M. Cushing, U.S. Geological Survey, 1962.	

NORMAPOLLES POLLEN FROM THE MISSISSIPPI EMBAYMENT

USGS Paleobotany loc.	Locality	Stratigraphic unit	USGS Paleobotany loc.	Locality	Stratigraphic unit
D3416 ---	6 ft below unconformable contact with Owl Creek Formation; NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 10, T. 27 N., R. 11 E., Advance 7 $\frac{1}{2}$ -minute quadrangle, Stoddard County, Mo. Collected by W. W. Olive, U.S. Geological Survey, 1964.	Upper part of McNairy Sand, Maestrichtian.	D1849- D1850 ---	NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 6, T. 11 N., R. 11 W., De Soto Parish, La. Sample provided by W. W. Fairchild, Standard Oil Company of Texas, 1962.	Naborton Formation, Paleocene.
D3410 ---	Type locality. From right bank of Owl Creek, 2.5 miles northeast of Ripley, Miss.; E $\frac{1}{2}$ sec. 7, T. 4 S., R. 4 E., Tippah County, Miss. Collected by W. W. Olive, U.S. Geological Survey, 1964.	Owl Creek Formation, Maestrichtian.	D3138 ---	Upper half Naheola Formation from along Alabama Highway 17 in SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 3, T. 15 N., R. 2 W., Choctaw County, Ala. Sample provided by C. W. Copeland, Geological Survey of Alabama, 1963.	Naheola Formation, Paleocene.
D1966 ---	1.5 miles south-southwest of Cotton Plant, Miss., southwest wall of tributary to Guyton Creek along country road. S $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 8, T. 6 S., R. 3 E., Tippah County, Miss.	Clayton Formation, Paleocene.	D3268 ---	Type locality. From Coal Bluff on Alabama River, sec. 7, T. 11 N., R. 7 E., Wilcox County, Ala. Sample provided by H. T. Ames, Pennsylvania State Univ., 1963.	Coal Bluff Marl Member of Naheola Formation, Paleocene
D1966-A_	6 ft above basal limestone.	Do.	D3222 ---	0.2 mile east of bridge across Tucabum River on Lavaca-Pennington road on south side of new road-cut, sec. 22, T. 14 N., R. 1 W., Choctaw County, Ala. (See MacNeil, geologic map, 1946.) Collected by W. W. Olive and R. H. Tschudy, U.S. Geological Survey, 1963.	Nanafalia Formation, Wilcox Group, lower Eocene.
B_	9 ft above basal limestone.	Do.	D1854 ---	About 1 mile northeast of Ackerman, Miss., in railroad cut, Illinois Central Railway, at Blantons Gap, secs. 28 and 21, T. 17 N., R. 11 E., Choctaw County, Miss. (See Vestal, 1943, p. 30.) Collected by W. W. Olive, U.S. Geological Survey, 1962.	Wilcox Formation (formerly Ackerman Formation, type locality), lower Eocene.
C_	14 ft above basal limestone.	Do.	D1862 ---	From south wall of the valley of Potts Creek, about 75 yards east of road bridge, NW $\frac{1}{4}$ sec. 4, T. 6 S., R. 1 W., Marshall County, Miss. (See Vestal, 1954, p. 41.) Collected by W. W. Olive, U.S. Geological Survey, 1962.	Wilcox Formation (formerly Ackerman Formation), lower Eocene.
D_	15 ft above basal limestone.	Do.	D1846 ---	Sample F48, NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 12, T. 6 N., R. 13 W., Sabine Parish, La., elev 165 ft. (See Andersen, 1960, p. 74, 75, fig. 13.) Supplied through the courtesy of W. W. Fairchild, Standard Oil Co. of Texas, 1962.	Bayou Lenann Member of Pendleton Formation (type locality) (Andersen, 1960). In Wilcox Group, lower Eocene.
E_	17 ft above basal limestone.	Do.			
F_	20-23 ft above basal limestone. Collected by E. M. Cushing, U.S. Geological Survey, 1962.	Do.			
D3548 ---	Auger hole J. 12, about 1 mile from southwest corner Joppa 7 $\frac{1}{2}$ -minute quadrangle; Kentucky coordinates, South zone: E. 1,094,590 ft; N. 308,200 ft, McCracken County, Ky. [Depths are from top of auger hole]				
D3548-A_	Depth 93-98 ft.	Clayton Formation, Paleocene.			
B_	Depth 77-93 ft.	Porters Creek Clay, Paleocene.			
C_	Depth 62-77 ft.	Do.			
D_	Depth 52-62 ft. Collected by W. W. Olive, U.S. Geological Survey, 1965.	Do.			
D3285 ---	Channel of McCullough Fork, 300 ft N. Kentucky-Tennessee State line. Kentucky coordinates, South zone: E. 1,263,500 ft; N. 70,250 ft, Hazel quadrangle, Calloway County, Ky. Collected by W. W. Olive, U.S. Geological Survey, 1963.	Do.			

FOSSIL POLLEN SAMPLE LOCALITIES

5

USGS Paleobotany loc.	Locality	Stratigraphic unit	USGS Paleobotany loc.	Locality	Stratigraphic unit
D1851 ---	Sample F-129 from north side of Louisiana Highway 6, sec. 6, T. 6 N., R. 11 W., Sabine Parish, La. <i>Ostrea multilirata</i> zone. (See Andersen, 1960, p. 76.) Supplied through the courtesy of W. W. Fairchild, Standard Oil Co. of Texas, 1962.	Pendleton Formation (Andersen, 1960). In Wilcox Group, lower Eocene.	D3421 ---	NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, T. 16 S., R. 14 W., near south end of Calion Lake, Union County, Ark. Collected by H. N. Halberg, U.S. Geological Survey, 1964.	Cook Mountain Formation. In Claiborne Group, middle Eocene.
D1855 ---	North side of roadcut 1.5 miles west of corporate limit of Meridian, Miss., on U.S. Highway 80, secs. 15, 22, T. 6 N., R. 15 E., Lauderdale County, Miss. (See Foster, 1940, p. 67.) Collected by W. W. Olive, U.S. Geological Survey, 1962.	Uppermost part, Hatchetigbee Formation. In Wilcox Group, lower Eocene.	D4524 ---	Just above iron bridge over Techeva Creek, SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 16, T. 13 N., R. 1 W., Yazoo County, Miss. (Yegua Member of Lisbon Formation as used by Mellen, 1940, p. 14 and fig. 1.) Collected by E. H. Boswell, U.S. Geological Survey, 1970.	Cockfield Formation. In Claiborne Group, middle Eocene.
D1848 ---	Sample F-71, from bed of Two Mile Creek, 1.5 miles due south of U.S. Highway 79 bridge across Brazos River, Milam County, Tex. (Stop 2 of Houston Geol. Soc. Ann. Field Trip, 1959. See Smith, 1959.) Supplied through the courtesy of W. W. Fairchild, Standard Oil Co. of Texas, 1962.	Marquez Shale Member (of Stenzel, 1938) of Reklaw Formation. In Claiborne Group, middle Eocene.	D4525 ---	NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 11, T. 5 N., R. 11 E., Newton County, Miss. (stratigraphically about equivalent to D4526. E. H. Boswell, written commun., 1970). Collected by E. H. Boswell, U.S. Geological Survey, 1970.	Middle part, Cockfield Formation. In Claiborne Group, middle Eocene.
D1858 ---	Holly Springs Brick and Tile Co., Holly Springs, Miss., pit south of Mississippi Highway 78, Poorhouse or No. 2 pit, SE $\frac{1}{4}$ sec. 26, T. 3 S., R. 3 W., Marshall County, Miss. (See Vestal, 1954, p. 67-90.) Collected by W. W. Olive, U.S. Geological Survey, 1962.	Tallahatta Formation. In Claiborne Group, middle Eocene.	D4526 ---	SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 32, T. 4 N., R. 13 E., $\frac{1}{2}$ mile southeast of Rose Hill, Jasper County, Miss. (See DeVries, 1963, p. 22, fig. 6.) Collected by E. H. Boswell, U.S. Geological Survey, 1970.	Do.
D1856 ---	2.9 miles east of west city limits of Hickory, Miss., on U.S. Highway 80, NE $\frac{1}{4}$ sec. 32, T. 6 N., R. 13 E., Newton County, Miss. (See Priddy, 1961, p. 37.) Collected by W. W. Olive, U.S. Geological Survey, 1962.	Zilpha Clay. In Claiborne Group, middle Eocene.	D3224 ---	South bluff of Garland Creek, 2.6 miles east of steel bridge over Chickasawhay River, 2 miles from house at road fork straight east along log trail. 6 ft from top of formation, NW $\frac{1}{4}$ sec. 28, T. 1 N., R. 16 E., Clarke County, Miss. (See Holden and others, 1948, p. 60.) Collected by W. W. Olive and R. H. Tschudy, U.S. Geological Survey, 1963.	Upper part, Cockfield Formation. In Claiborne Group, middle Eocene.
D1852 ---	Sample F-130 from northeast side of Louisiana Highway 476, SE $\frac{1}{4}$ sec. 10, T. 5 N., R. 12 W., south of Negreet, Sabine Parish, La. (See Andersen, 1960, p. 87 and pl. 13.) Supplied through the courtesy of W. W. Fairchild, Standard Oil Co. of Texas, 1962.	Sparta Sand. In Claiborne Group, middle Eocene.	D3228 ---	NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 36, T. 6 N., R. 1 E., Riverside Park Jackson, Hinds County, Miss. Lignitic clay with borings. Collected by W. W. Olive and R. H. Tschudy, U.S. Geological Survey, 1963.	Do.
			D3227 ---	NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 36, T. 6 N., R. 1 E., Riverside Park, Jackson, Hinds County, Miss., 1 $\frac{1}{2}$ ft below coquina bed. (See Moore, 1965, p. 48.) Collected by W. W.	Moodys Branch Formation (reference section). In Jackson Group, upper Eocene.

USGS Paleobotany loc	Locality	Stratigraphic unit	Sample	Locality	Formation
D3697-B --	Olive and R. H. Tschudy, U.S. Geological Survey, 1963. SE ¹ / ₄ SW ¹ / ₄ SE ¹ / ₄ sec. 32, T. 12 N., R. 2 W., Yazoo County, Miss., 124 ft above base of formation. Core samples of Yazoo Clay supplied through the courtesy of the Mississippi Geological Survey, 1963.	Yazoo Clay (core hole at type locality). In Jackson Group, upper Eocene.	D3292 --	coordinates, South zone: E. 1,298,250 ft; N. 89,250 ft, New Concord quadrangle, Calloway County, Ky. Collected by W. W. Olive, U.S. Geological Survey, 1962.	McNairy Sand Member of Ripley Formation, Maestrichtian.
D3699-A --	Jackson Ready-Mix Concrete Light Aggregate Quarry, SW ¹ / ₄ NE ¹ / ₄ NW ¹ / ₄ sec. 36, T. 7 N., R. 1 W., 7 miles west-southwest of Madison, Hinds County, Miss., 30 ft below top of formation. (See Priddy, 1960, p. 40, fig. 9.) Collected by R. H. Tschudy, U.S. Geological Survey, 1966.	Yazoo Clay. In Jackson Group, upper Eocene.	D3420 ---	From west bank of Grindstone Creek; Kentucky coordinates, South zone, E. 1,306,700 ft; N. 95,200 ft; Hamlin quadrangle, Calloway County, Ky. Collected by W. W. Olive U.S. Geological Survey, 1963.	Do.
D4383-A --	Steep bluff on right bank of Arkansas River, in E ¹ / ₂ secs. 19 and 30, T. 3 S., R. 10 W., Jefferson County, Ark. (See Wilbert, 1953, p. 114.) Collected by B. R. Haley and R. H. Tschudy, U.S. Geological Survey, 1969.	Jackson Formation or base of White Bluff Formation of Jackson Group (Wilbert, 1953), upper Eocene.	D4268-A --	From 1.15 miles north-northeast of Thomson Chapel, 550 ft north, 75 ft east of road junction, east side of U.S. Highway 60; 0.9 mile south of north edge Little Cypress 7 ¹ / ₂ minute quadrangle; Kentucky coordinates, South zone, E. 1,227,200 ft; N. 292,400 ft; Livingston County, Ky. Collected by W. W. Olive, U.S. Geological Survey, 1964.	Do.
D4407-B --	Center of east line NW ¹ / ₄ sec. 36, T. 5 N., R. 3 E., Whitmore quadrangle, St. Francis County, Ark. Sample from 2 ft above marl. (Marine fossils. B. R. Haley, written commun., Sept. 15, 1969.) Collected by B. R. Haley, U.S. Geological Survey, 1969.	Jackson Formation, upper Eocene.	D4268-B --	Grand Rivers, Livingston County Highway 453 road-cut, 0.3 mile northwest of Grand Rivers; about middle of 10-foot-thick black clayey silt bed; Kentucky coordinates, South zone: E. 1,271,500 ft; N. 254,800 ft; Livingston County, Ky. Collected by R. W. Swanson, U.S. Geological Survey, 1968.	Do.
			D4268-B --	Same locality, immediately above black clayey silt.	Do.

Four additional Late Cretaceous samples not included in previous publications were used in this study. These samples are not reference samples but are samples submitted for age determination by geologists working on the Kentucky cooperative mapping project. These samples were used because they yielded particularly good specimens of some of the taxa discussed.

Sample	Locality	Formation
D3002 ---	Drill hole 35 (depth 32-37 ft) immediately south of Kentucky Highway 444 on east side and adjacent to Beechy Creek; Kentucky	McNairy Sand Member of Ripley Formation, Maestrichtian.

TYPE SPECIMENS

All specimens illustrated in this report are preserved on slides deposited in the paleobotanical collections of the U.S. Geological Survey, Denver, Colo. All illustrated specimens are within black-inked circles marked directly on the slides; they may also be located on the slides by the mechanical-stage coordinates given with the type designations and in the plate explanations. In order that others may convert their mechanical-stage readings to those recorded for the specimens included in this report, the coordinates for the center point of a 1-×3-inch standard microscope slide are 108.0×12.3 mm. The method of accurately locating the center of a stan-

standard microscope slide has been described by R. H. Tschudy (1966, p. D78). With the slide label to the left, the vertical coordinates decrease toward the near edge of the slide, and the horizontal coordinates decrease toward the right edge of the slide.

Color transparencies of type and illustrated specimens described in this report are available from the U.S. Geological Survey laboratory, Denver, Colo., on a limited-time loan basis.

SYSTEMATIC DESCRIPTIONS

The genera belonging to the Normapolles group are discussed in alphabetical order. Newly proposed genera are presented at the end of the report. An arbitrary minimum of 10 good specimens was selected as a requirement before a name could be assigned to a new genus or new species. As a result of this decision several probable new taxa are mentioned but not named. As an aid to future workers, provisional descriptions are provided for these unnamed entities, but no formal diagnoses are made. For those genera and species already established, generic diagnoses are given. For many genera, these diagnoses are somewhat modified from the original German; a conscientious attempt has been made to retain the meaning expressed in the original versions. Direct word-for-word translation would have provided much more stilted diagnoses.

In several descriptions Góczán and others (1967) provided new wordings ("Neufassungen") for diagnoses of already established genera. These new wordings are not considered to be emendations by those authors, nor do I consider them to be emendations. For example, Góczán and others (1967), under the heading *Basopollis* Pflug, 1953b (p. 449), say "Wie aus der Diagnose zu ersehen ist, wurde sie unwesentlich verändert, sie ist vor allem weiter präzisiert worden. Dies ist heute möglich durch die Vielzahl neugefundener Formtypen. Die Bemerkungen zur Einheit in R. Potonié 1960, Syn. III (S. 126) sind überholt und waren auch wenig zutreffend."

The complex morphology of pollen grains assigned to the Normapolles group of genera has prompted several European workers to institute new terminology for some of the more unusual morphological features of the grains. Many of these new terms, such as "interloculum" (space between the ektexine and endexine), are defined in the "Morphological Encyclopedia of Palynology" by Kremp (1965). All the terms used by Góczán and others (1967) in the new wordings of generic diagnoses are defined in section D of their publication.

Skarby (1968) raised some doubtless valid objections to the interpretations of the so-called diagnostic characters used by Pflug (1953) and by others for differentiating some of the Normapolles genera. Skarby (1968, p. 3) claimed that "Several of these diagnostic characters are derived from incorrect observations or

misinterpretations of existing properties * * *." This claim is to some degree true. Unfortunately, Skarby was not familiar with the paper by Góczán and others (1967) in which the Normapolles genera are more accurately differentiated and morphological features present are more accurately described. This publication removes the bases for most of her objections. Skarby emended the genus *Extratropipollenites* to include 23 Normapolles genera and the Postnormapolles genus *Triatriopollenites*. She did not recognize characters, such as "atrium," "interloculum," "solution-meridian," "oculus," and "endanulus" as diagnostically significant. Certain other generic characteristics such as "praevestibulum" (in *Basopollis*), she suggested may be optical phenomena or misinterpretation as the result of poor lenses or poor observation.

I have observed the morphological features described in Góczán and others (1967) for certain European Normapolles genera in specimens from the Mississippi embayment. As a result of the careful observations recorded by Góczán and others (1967), I have experienced little difficulty in differentiating Normapolles genera on the bases established by the above publication. I do not believe that the extreme "lumping" of genera resorted to by Skarby serves any useful purpose. Furthermore, the inclusion by Skarby (1968) of such morphologically diverse genera as *Triatriopollenites*, *Complexiopollis* (*Latipollis*, *Turonipollis*), *Basopollis*, and *Plicapollis* in the genus *Extratropipollenites* is, I believe, totally unjustified.

Genus *BASOPOLLIS* Pflug, 1953

Type species. — *Basopollis orthobasalis* (Pf.) Pf.

Diagnosis. — ("New wording" from Góczán and others, 1967.) Pollen grains triangular, shallow lens-shaped to extreme triplane; equatorial contour rigid triangular to extremely concave triangular; the three equatorial germinals at the angles are sometimes strongly distorted but generally do not contribute particularly to the equatorial contour, so that normally the equatorial contour is not strongly interrupted. Polar axes of very different lengths. Wall several layered, the outer part thicker than the closely lying inner part; surface smooth or mostly with strong punctate sculpture. Sometimes with plicae (principally in those with a tendency to a triplane shape). Exopores vertical slit shaped, more or less symmetrical to the equator, with two lamella complexes in the exogerminal: (1) A relatively thick sculpture bearing outer layer without internal structure, and (2) a typical polyannulate complex that is present from the root of the exogerminal; these complexes are sometimes clearly structured with radially directed bacula. Pore canal index among the several form species very different, mostly above 0.3. Vestibulum present. Mesopore equatorial slit shaped with more or less gable-shaped protrusions of the upper

and lower lips; lips are, however, generally without thickenings. "Endopore" is developed from the inner wall as a straight margined or weakly concave atrium. No oculi or polpapillae. Mostly medium sized, but sometimes large forms.

Remarks. — Distinguished from *Complexiopollis* principally by the typical polyannulate exogerminals.

***Basopollis obscurocostatus*, n. sp.**

Plate 1, figures 1-12; text figure 1

Holotype. — Sample D1862, slide 3, prep. 2, coordinates 95.7×3.9. Wilcox Formation, Mississippi, lower Eocene.

Paratype. — Sample D1862, slide 3, prep. 2, coordinates 92.6×16.1. Wilcox Formation, Mississippi, lower Eocene.

Diagnosis. — Shape of pollen grains concave triangular in polar view, often distorted into the triplane form. Size 28 μ -42 μ in equatorial diameter (14 specimens). Wall of two principal layers, about 2 μ thick

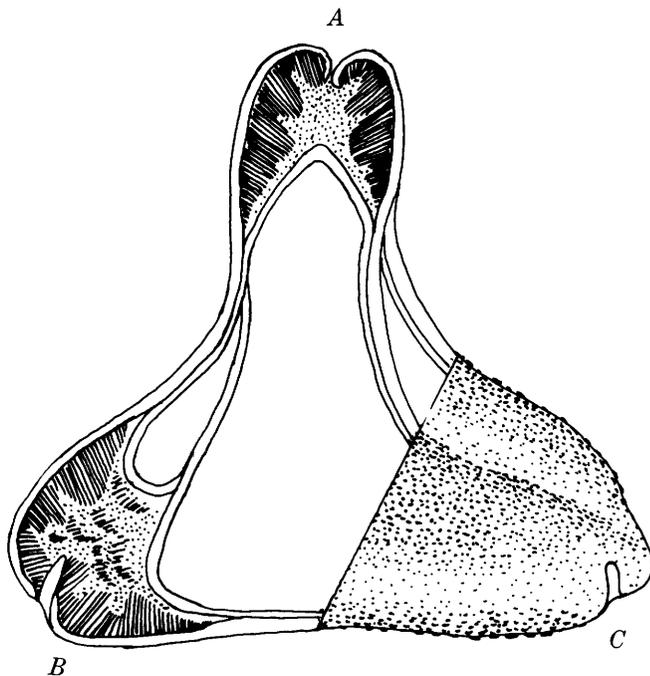


FIGURE 1. — *Basopollis obscurocostatus*, n. sp., ca. \times 2,000. A, Aperture in polar view showing polyvestibulate characteristic of the exogerminal. B, Aperture in equatorial or partial triplane view showing arcs and endexinal flaps. C, Surface view showing ornamentation.

in the interapertural areas. Presence of equatorial arcs or ribs gives the impression of a thicker wall when grains are oriented in strict polar attitude; arcs generally seen clearly only in triplane or equatorial view. Surface with scabrate to microverrucate sculpture. Ektexine about twice as thick as endexine. Apertural areas elongate. Exogerminals vertical slit shaped, bordered by characteristically polyannulate thickened ektexinal

walls. Outer layer of germinal areas thin, structureless; inner layer of radially projecting bacula of uneven lengths forming thereby one or more praevestibulae. Vestibulum at base of exogerminal prominent but narrow. Endexine at position of endogerminal separated into two gable-shaped flaps separated by a large equatorially oriented slit. Delicate atrium below flaps not observed in specimens examined.

Remarks. — *Basopollis obscurocostatus*, n. sp., is distinguished from *Basopollis orthobasalis* by its more prominent concave triangular shape, thinner walls, and the presence of arcs. The outer surfaces of *Basopollis basalis*, *B. atumescens*, and *B. ornatus* are smooth in contrast to the distinctly sculptured outer surface of *Basopollis obscurocostatus*.

Stratigraphic distribution. — Nanafalia, Wilcox, Pendleton, and Hatchetigbee Formations.

Genus CHOANOPOLLENITES Stover, 1966

Type species. — *Choanopollenites eximius* Stover, 1966 (in Stover and others, 1966), Kansas Univ. Paleont. Contr. Paper 5, p. 8, pl. 4, figs. 1a-1h.

The genus *Choanopollenites* and the stratigraphic distribution of its species have been discussed in a previous publication (Tschudy, R. H., 1973b). In that publication the following new species were proposed: *Choanopollenites consanguineus*, *C. transitus*, *C. discipulus*, *C. conspicuus* and *C. patricius*. Two other possible new species were mentioned but not named, owing to an inadequate number of good specimens.

cf. *Choanopollenites* sp.

Plate 1, figures 13-15; text figure 2

Sample D3138, slide 4, coordinates 88.5×13.2.

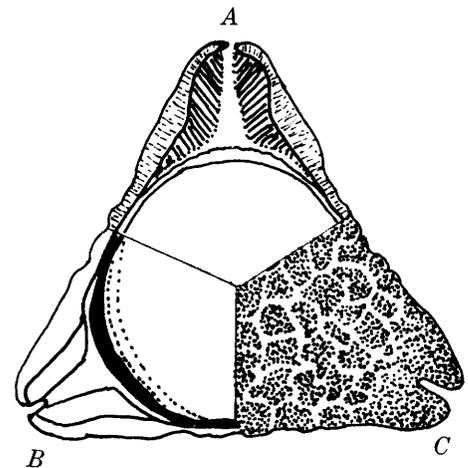


FIGURE 2. — cf. *Choanopollenites* sp., ca. \times 2,000. A, Aperture in polar view showing external prismatic layer and internal baculate layer. B, Same, showing the two endexinal flaps, one above the other. C, Surface view showing ornamentation.

Description. — Shape of pollen grain triangular in polar view; apertures at the angles. Size 26μ in equatorial diameter (one specimen). Wall about 1.5μ thick in interapertural areas, ektexine about twice as thick as endexine. Surface coarsely fossulate. Exogerminals vertical slit shaped. Ektexine in germinal areas two layered, the outer layer columellate (prismatic) structured, narrow adjacent to apertures, then becoming distinctly thicker toward the roots of the germinals. Inner layer of prominent, radially directed bacula. Interior of exogerminals narrow funnel shaped, wider at base than at tip. Vestibulum narrow. Endogerminal equatorial slit shaped bordered by crescent-shaped somewhat thickened lips of endexinal flaps. Endexine structureless, thinner in interapertural areas than adjacent to the endogerminals.

Stratigraphic distribution. — Naheola Formation only.

Genus **COMPLEXIOPOLLIS** Krutzsch, 1959,
emend. Tschudy, 1973b

Type species. — *Complexiopollis praeatumesces* Krutzsch, 1959, Palaeontographica, ser. B, v. 105, p. 135, pl. 31, figs. 39–54.

The genus *Complexiopollis* and the stratigraphic distribution of species from the Mississippi embayment assigned to the genus were presented in a previous publication by R. H. Tschudy (1973b). The following new species from Mississippi embayment rocks were proposed: *Complexiopollis funiculus*, *C. patulus*, *C. abditus*, and *C. microverrucatus*. One other possible new species was mentioned but, because too few specimens were found, was not named.

Genus **EXTREMIPOLLIS** Krutzsch, 1967

Type species. — *Extremipollis maastrichtiensis* Krutzsch, 1967 (in Góczán and others, 1967), Paläontologische Abhandlungen, ser. B, v. 2, no. 3, p. 463, pl. 6, figs. 7–10.

Diagnosis. — (From Krutzsch, in Góczán and others, 1967). Pollen grains spherical to triangular shallow lens shaped; exogerminals equatorial, located at the angles. Exogerminals provided with three pairs of club-shaped to blunt elongate monannulate annuli. Inner part of annuli sometimes with structure. Exopores vertical slit shaped, somewhat symmetrical to the equator, mostly gaping. Endogerminals with deep incidence to platea (similar to many *Trudopollis* species). Wall several layered, ratio of the outer to the inner complex about 1:1. Sculpture various. Structure seldom present in the exogerminals. No oculi, endannuli, arci, plicae; only seldom a weak interloculum. Medium-sized forms.

Remarks. — Distinguished from *Extratripolipollenites* by the presence of a strong incidence or cuneus, and ektexine and endexine of virtually the same thickness. Distinguished from *Extrapollis* by the

absence of a collarlike structure at the root of the germinals.

Extremipollis vivus, n. sp.

Plate 2, figures 1–10; text figure 3

Holotype. — Sample D3420, slide 2, coordinates 95.2×21.0 , McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Paratype. — Sample D3420, slide 4, coordinates 94.4×21.0 , McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Diagnosis. — Shape of pollen grains triangular to slightly concave triangular in polar view. Apertural areas prominently protruding; exclusive of apertural areas, pollen grains almost circular in equatorial outline. Size 20μ – 29μ in equatorial diameter (18 specimens). Wall of two principal layers about 1.5μ thick in the interapertural areas. Surface shallowly fossulate, almost smooth. Ektexine and endexine of about equal thickness in interapertural areas. Ektexine thickened, annulate and made up of two layers in the apertural areas; outer layer structureless, inner layer consisting of tightly packed, radially directed elongate bacula; presence of bacula difficult to distinguish in most specimens except at the inner part of the exogerminals. Exogerminals vertical slit shaped, slightly eccentric to the equator, sometimes gaping. Vestibulum narrow and almost absent. Endexine thin, less than 1μ thick, separated from ektexine by a narrow interloculum. Endopores about 4μ wide bordered by small endannuli. A prominent semicircular cuneus is present below each endopore.

Remarks. — This species is distinguished from *Extremipollis maastrichtiensis* by its concave rather than convex triangular equatorial outline and by its more elongate exogerminals. Many specimens were observed in sample D3420.

Stratigraphic distribution. — McNairy Sand Member, Ripley Formation.

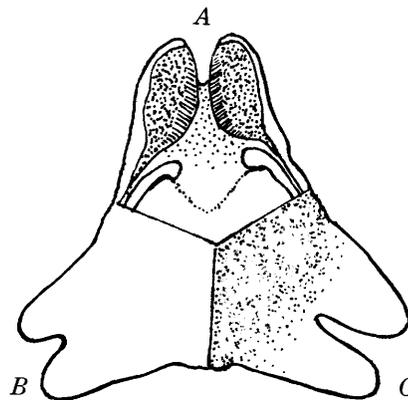


FIGURE 3. — *Extremipollis vivus*, ca. $\times 2,000$. A, Section view of germinal. B, Slit-shaped exogerminal showing short slit on one side of grain. Compare with C. C, Long slit on obverse side of grain. Surface ornamentation shown.

Extremipollis versatilis, n. sp.

Plate 2, figures 11-22; text figure 4

Holotype. — Sample D3420, slide 3, coordinates 97.6×11.5, McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Paratype. — Sample D3420, slide 3, coordinates 108.2×5.3, McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Diagnosis. — Shape of pollen grains triangular in polar view; apertural areas sometimes protruding and interrupting the triangular outline. Size 23μ - 31μ in equatorial diameter (25 specimens). Wall of two principal layers, about 2μ thick in interapertural areas. Surface coarsely fossulate. Ektexine of about same thickness as endexine or slightly thicker in interapertural areas. Ektexine prominently annulate and made up of two layers adjacent to the apertures; outer layer structureless, inner layer of prominent radially directed bacula. Exogerminals vertical slit shaped, slightly eccentric to the equator, seldom gaping. Vestibulum narrow, almost absent, present only at the extreme root of the exogerminals. Endexine thin, commonly less than 1μ thick and separated from the ektexine by an interloculum. Endopores 5μ - 6μ wide; a prominent semicircular to somewhat V-shaped cuneus present below each endopore. Inner lamella of endexine forming an inconspicuous additional atrium in some specimens.

Remarks. — Distinguished from *Extremipollis vivus* by the absence of endannuli, less protruding exogerminals, and coarser sculpture. Many specimens present in sample D4268-A. Several apparently somewhat transitional forms were observed. This variation is demonstrated by apparently thinner endexine and slightly more narrow and protruding exogerminals (pl. 2, figs. 20-22).

Stratigraphic distribution. — Coffee Sand, Coon Creek Tongue of Ripley Formation, and McNairy Sand Member of Ripley Formation.

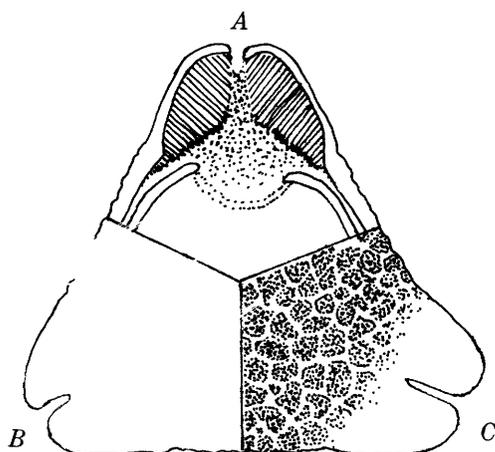


FIGURE 4. — *Extremipollis versatilis*, ca. $\times 2,000$. A, Sectional view of germinal. B, Short slit on one side of grain. C, Elongate slit on obverse side of grain. Surface ornamentation shown.

Extremipollis caminus, n. sp.

Plate 3, figures 1-18; text figure 5

Holotype. — Sample D3420, slide 4, coordinates 79.7×4.5, McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Paratype. — Sample D3420, slide 2, coordinates 84.3×14.8, McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Diagnosis. — Shape of pollen grains triangular to slightly concave triangular in polar view with prominent chimneylike protrusions (germinals) at the angles. Size 25μ - 41μ in equatorial diameter (30 specimens). Wall of two principal layers, about 1.5μ thick in the interapertural areas. Surface microverrucate with low relief.

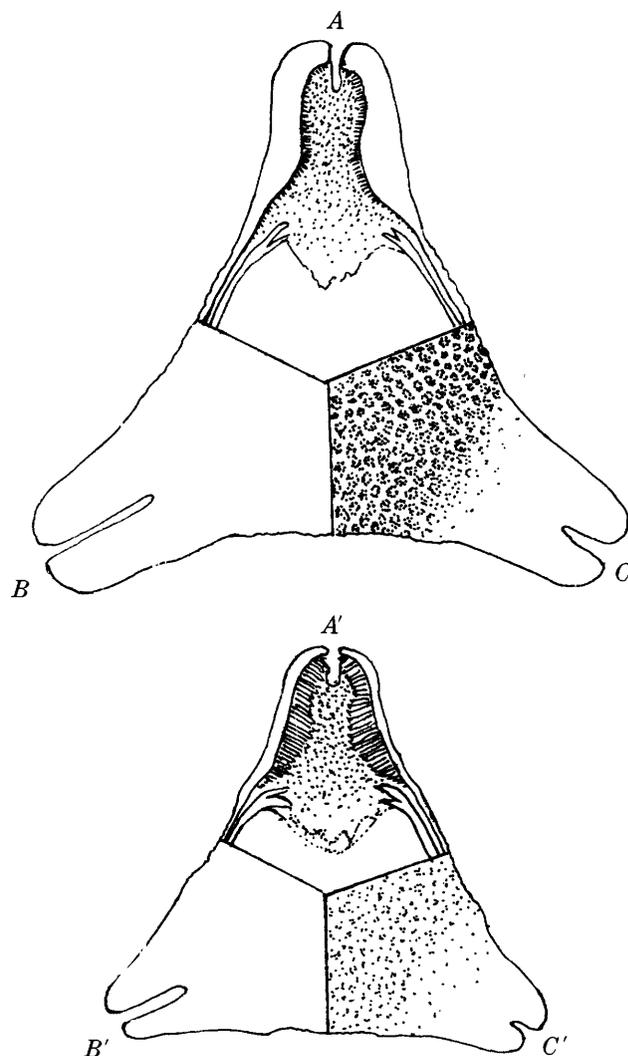


FIGURE 5. — *Extremipollis caminus*, ca. $\times 2,000$. A and A', Sectional view of aperture showing variation in development of the visible baculate layer and the splitting of the endexine at the margins of the endogerminals. B and B', Elongate apertural slit present on one side of grain is in contrast with length of slit on obverse side. C and C', Short apertural slit of exogerminal on obverse side; variation of surface sculpture of small and large specimens is also shown.

Ektexine and endexine of about equal thickness in interapertural areas. In germinal areas the ektexine is greatly thickened and structureless in the outer part; the inner part appears lined with short radially projecting bacula. Exogerminals vertical slit shaped, distinctly eccentric to the equator (one side of slit extends a much greater distance toward the pole than does the other side). Neck of exogerminal area with a prominent biconvex chamber widens toward the base. Vestibulum narrow and present only at the base of the exogerminal. Endexine thin, about 0.5μ thick and separated from the ektexine by a narrow interloculum. Endopore 6μ – 7μ wide subtended by a prominent U- or V-shaped cuneus. Endexine commonly splitting into two or more lamellae adjacent to the endopore.

Remarks. — This species is distinguished from all other species of *Extremipollis* by the long chambered neck of the exogerminal. The two drawings in text figure 5 show variation in the development of the ektexinal baculate layer and the finer surface ornamentation present on the smaller specimens.

Stratigraphic distribution. — McNairy Sand Member, Ripley Formation.

Genus INTERPOLLIS Krutzsch, 1960

Intratriporopollenites supplingensis Pf., 1953 (in Thomson and Pflug, 1953), *Palaeontographica*, v. 94, ser. B, p. 89, pl. 10, fig. 26.

Type species. — *Interpollis supplingensis* (Pf.) Krutzsch, 1960, *Geol. Gesell DDR. Berichte*, v. 5, no. 4, p. 305.

Diagnosis. — (“New wording” from Góczán and others, 1967.) Pollen grains triangular double-lens shaped, owing to an equatorial constriction, seldom single lens shaped because of a reduced constriction. Subequatorial contour mostly weakly convex triangular, sometimes also weakly concave triangular, seldom rounded triangular. Equatorial contour primarily strongly concave triangular with projecting rounded sectors at the angles. The polar regions often somewhat depressed and limited by band-shaped arcilike angle-to-angle differentiation of both hemispheres. Wall two layered, ratio of ektexine to endexine about 1:1; walls sometimes separated by weak local interloculi. Surface smooth or weakly sculptured; inner layer often intrapunctate. Germinals at the angles without annuli, with two small, somewhat round subequatorial proximal and distal exopores at each angle. The endopores are at the equator. The structured inner wall layer sometimes forms a distinct visible atrium. Forms small to maximum middle sized.

***Interpollis* cf. *I. supplingensis* (Pf.) Krutzsch, 1960b**

Plate 4, figures 1–21; text figure 6

Type specimen. — (Lectotype designation, Pflug, 1953, pl. 24, fig. 39).

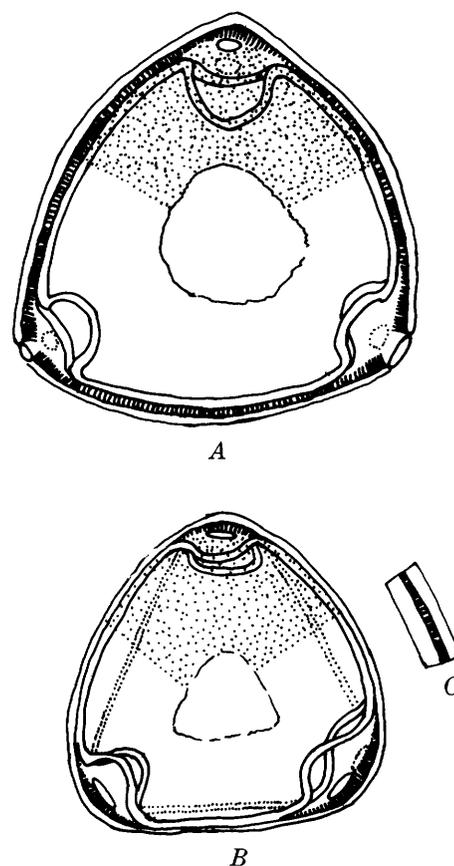


FIGURE 6. — *Interpollis* cf. *I. supplingensis*, ca. $\times 2,000$. A, Large specimen in which baculate interloculum shows clearly. B, Smaller specimen. Triangular equatorial contour shown on this figure. C, Bacula in interloculum visible only under oil immersion lens.

Synonymy. — *Intratriporopollenites supplingensis* Pf., in Thomson and Pflug, 1953.

Interporopollenites supplingensis Pflug, 1953.

Interpollis supplingensis (Pf.) Krutzsch, 1960b.

Remarks. — *Interpollis supplingensis* was first described by Pflug (in Thomson and Pflug, 1953) as *Intratriporopollenites supplingensis*. In a succeeding volume, Pflug (1953) transferred the species to *Interporopollenites supplingensis* without adding to the original diagnosis. Later, Krutzsch (1960b), after noting the presence of six exopores and an equatorial constriction, erected the new genus *Interpollis* and chose the species *Interpollis supplingensis* as the type species. Krutzsch did not provide a new diagnosis for the species, even though the original diagnosis by Pflug (in Thomson and Pflug, 1953) was extremely brief and inadequate. I am therefore including here a description of the Mississippi embayment forms that are similar to or conspecific with *Interpollis supplingensis*. This is not intended as an emendation.

Description. — Shape of pollen grains triangular to almost circular, equatorial constriction prominent in some specimens, in others scarcely evident. Size 16μ – 30μ

(30 specimens) in equatorial diameter, most grains in the 20μ – 25μ size range. Wall two layered, thin, about 1.5μ – 2μ thick; ektexine and endexine of about the same thickness separated by a very narrow baculate layer. Ektexine smooth, appearing granulate except in polar areas; granulate appearance due to presence of short bacula between ektexine and endexine. Appearance of polar scar or thin area is due to absence of bacula. Baculate layer of ektexine distinctly thicker in atria than in interapertural areas. Exogerminals six, two at each angle of grains, subequatorial or nearly so, one on each hemisphere; apertures circular or slightly elongate equatorially. Endogerminals three, equatorial, somewhat hourglass shaped in equatorial view, without annuli; endexine separated from ektexine in apertural areas by a vestibulum.

Remarks. — The original diagnosis lists the size of this species as 18μ – 40μ . I found only three specimens as large as 28μ , and two specimens in the 16μ range. The equatorial constriction is shown particularly well on plate 4, figures 6–13 and 16–18.

Stratigraphic distribution. — Cusseta Sand Member of Ripley Formation, Coon Creek Tongue of Ripley Formation, McNairy Sand Member of Ripley Formation, upper part of McNairy Sand, and Owl Creek Formation. One poor specimen (redeposited?) was observed in the Naborton Formation.

Interpollis microsuplicingensis Krutzsch, 1960b

Plate 4, Figures 22–25

Diagnosis. — (From Krutzsch, 1960b.) A very small form-species of *Interpollis*. Size 10μ – 20μ , in section 14μ – 17μ . Double-lens shaped. Equatorial contour concave triangular, subequatorial contour strongly triangular to weakly convex triangular. Surface shagrenate to finely extrapunctate.

Remarks. — Exopores very small, circular, about 1μ in diameter. Mississippi embayment specimens conform very well to the circumscription and illustrations of *Interpollis microsuplicingensis*.

Stratigraphic distribution. — Hatchetigbee and Reklaw Formations.

Interpollis intranodus, n. sp.

Plate 5, figures 1–15; text figure 7

Holotype. — Sample D3285, slide 1, coordinates 90.3×15.3 , Porters Creek Clay, Kentucky, Paleocene.

Paratype. — Sample D3285, slide 2, coordinates 97.7×21.7 , Porters Creek Clay, Kentucky, Paleocene.

Diagnosis. — Shape of pollen grain convex-triangular, equatorial constriction not evident on most specimens. Size 20μ – 36μ in equatorial diameter (11 specimens). Wall two layered, about 2μ thick. Ektexine and endexine of about equal thickness. Ektexine undulate to microrugulate, two layered; the outer layer structureless, the inner consisting of very short fine bacula. Bacula

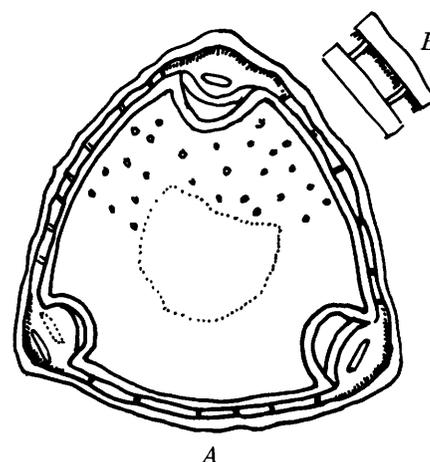


FIGURE 7. — *Interpollis intranodus*, ca. $\times 2,000$. A, Peglike bacula visible in interloculum and in surface view. B, Wall layers with large peglike bacula and also small dense bacula attached to ektexine.

present except in polar areas. Interloculum prominent; scattered interlaminar short peglike bacula or gemmae separate endexine from ektexine. Exopores equatorially elongate, small, six in subequatorial pairs at the angles, not clearly evident on all specimens. Endopores in endexine, and atria almost identical to those found in *Interpollis* c.f. *I. supplingensis*.

Remarks. — Distinguished from other species of *Interpollis* by the presence of scattered coarse bacula or gemmae separating the endexine and ektexine. Surface views of peglike bacula show particularly well on plate 5, figures 1, and 13–15.

Stratigraphic distribution. — Owl Creek and Clayton Formations, Porters Creek Clay, and Naheola Formation.

Genus *INTERPOROPOLLENITES* Weyland and Krieger, 1953

Type species. — *Interporopollenites proporus* Weyland and Krieger, 1953, *Palaeontographica*, ser. B. v. 95, p. 20, pl. 1, fig. 34.

Diagnosis. — (“New wording” from Góczán and others, 1967.) Compact triangular lens shaped; those with a weak equatorial constriction slightly double lens shaped. Equatorial contour from concave triangular to nearly circular. Polar axis always shorter than the equatorial axis. Wall always at least two layered; if more, two principal wall complexes recognizable; ratio of ektexine to endexine 1:1 to 1:5 and more. Sometimes without arci but mostly with arci, these very distinct in form and distribution (breadth, thickness, course); sometimes only plicallike folds present. Surface smooth to weakly sculptured; wall sometimes with structure (punctate, baculate). Seldom with an interloculum, in most species, however, with an endannulus. Endopores equatorial, at angles, mostly round to oval, never with strong incidence, cuneus, and so forth; inner lamella layer tightly attached. Six exopores present, at the

angles, one of each pair subequatorial on the distal and one on proximal side; exopores round, oval or polygonal, never very large; these may also be located somewhat laterally. The exogerminal is closed at the equator, and in some form-species this area may be thickened annuluslike to pointed. Forms small to medium-sized, very seldom larger representatives.

Interporopollenites turgidus, n. sp.

Plate 6, figures 1-18; text figure 8

Holotype. — Sample D3548-A, slide 1, coordinates 77.5×11.8, Clayton Formation, Kentucky, Paleocene.

Paratype. — Sample D3548-A, slide 2, coordinates 78.4×6.5, Clayton Formation, Kentucky, Paleocene.

Diagnosis. — Pollen grains triangular in polar view with very prominent hemispherical protrusions at the angles. Size 24μ – 29μ in equatorial diameter (10 specimens); hemispherical corner protrusions about one-third the diameter of the grains. Wall of two principal layers; the ektexine in the interapertural areas thin, about 0.5μ thick, in the apertural areas much thicker, owing to the presence of an additional internal baculate layer. Endexine much thicker than ektexine, in the interapertural areas 2μ – 3μ thick. Ektexine usually smooth, faint granular arcuslike sculpture extending from aperture to aperture present on some specimens. Two small exogerminals present in each of the three germinal areas, one on each side subequatorially; germinal pores may be elongate equatorially or in the polar direction. Exogerminal wall 2μ – 3μ thick, thinner toward the root of the prominent vestibulum. Bacula in the interior of the exogerminal areas very abundant and tightly packed, often somewhat difficult to observe. Endogerminal in the form of a circular equatorial pore, much larger than the exogerminal pores. Endexine adjacent to the pores with endannuli as much as 5μ thick; endexine in pore area may be split into several distinct lamellae.

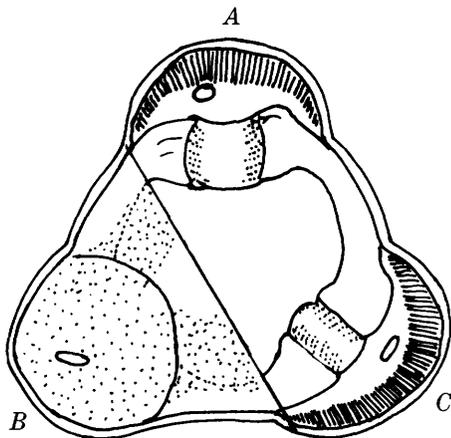


FIGURE 8. — *Interporopollenites turgidus*, ca. $\times 2,000$. A, B, Sectional views of apertures showing baculate areas, thick endexine, large equatorial endexinal pores and small nonequatorial exopores. C, Surface view showing nonequatorial exopore and faint arci.

Remarks. — Distinguished from *Interporopollenites proporus* by the faint arcuslike exterior sculpture and by the thickened ektexine in the exogerminal area.

Stratigraphic distribution. — Clayton Formation and Porters Creek Clay.

Genus **KYANDOPOLLENITES** Stover, 1966

Type species. — *Kyandopollenites anneratus* Stover (in Stover and others, 1966), Kansas Univ. Paleont. Contr. Paper 5, p. 6, pl. 3, figs. 1, 2.

Diagnosis. — (From Stover, 1966.) "Pollen isopolar, triaperturate; apertures aspidate, equatorial, compound. Outer aperture circular or nearly so, inner aperture elliptical, elongate. Grains circular in polar view, oblate in equatorial view. Exine relatively thick (5μ – 8μ), sexine thicker than nexine; endosexine lacking or very thin around apertures. Surface granulate on type species. Monotypic."

Kyandopollenites anneratus Stover, 1966

Plate 7, figures 1-5; text figure 9

Remarks. — Although Stover (in Stover and others, 1966) did not definitely assign *Kyandopollenites* to the Normapolles group, he did compare the genus with two Normapolles genera, *Emscheripollis* and *Papilopollis*. The size range of *Kyandopollenites* given by Stover is 47.5μ – 54μ . Specimens measured from our material increase the range slightly to 41μ – 58μ .

Stratigraphic distribution. — Wilcox and Pendleton (Andersen, 1960) Formations.

Genus **MEGATRIOPOLLIS** Góczán and Krutzsch, 1967

Type species. — *Megatriopollis santonius* Groot and Krutzsch, 1967 (in Góczán and others, 1967), Paläontologische Abhandlungen, ser. B, v. 2, no. 3, p. 477, pl. 10, figs. 17-22.

Diagnosis. — (From Góczán and Krutzsch, in Góczán and others, 1967.) Pollen grains triangular shallow lens shaped, equatorial contour triangular to triangular convex. The equatorial contour of the inner part of the pollen grains is circular (rund bis übrund). Wall of two principal layers, the outer thicker than the inner, the latter sometimes very thin. Surface variously strongly sculptured; sometimes with a structured layer in the inner part of the wall. Tendency to a "Schichtfuge" or interloculum between the two wall layers. Exogerminal with annulus or tumescens, it is, however, monannulate, although sometimes showing fine structure in the inner part. Exopores vertical slit shaped, lying weakly asymmetrical to the equator. With vestibulum. Endogerminal without essential thickening, with a fairly wide endopore that is generally bounded by a shallow atrium. The opening of the innermost wall layer is similarly formed. No oculi, arci, plicae, and so forth. Forms medium sized.

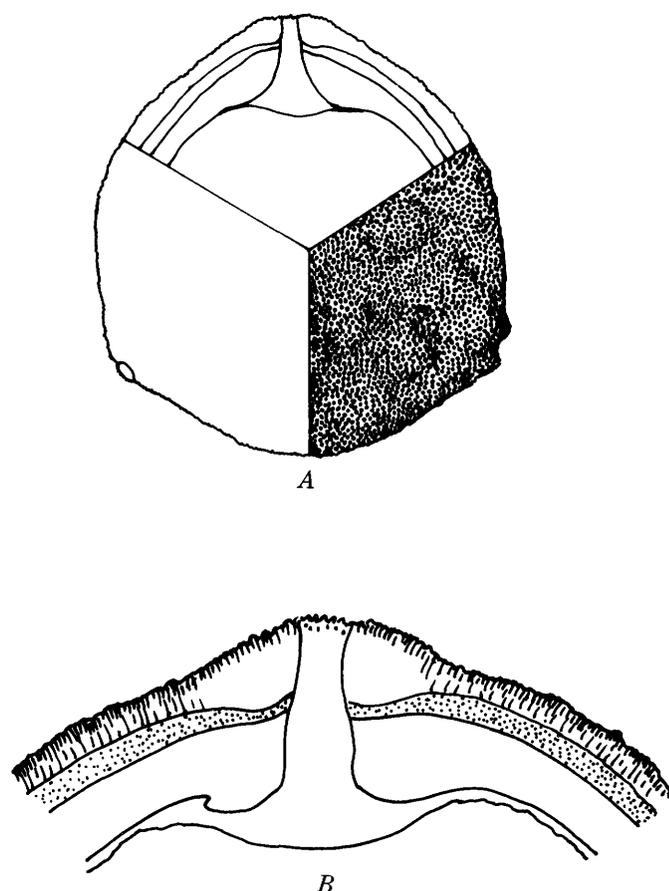


FIGURE 9. — *Kyandopollenites anneratus* Stover, 1966. A, Pollen grain, ca. $\times 1,000$, showing sectional view of aperture and surface sculpture. B, Sectional view of pore, $\times 2,000$, showing three prominent wall layers.

Megatriopollis? sp.

Plate 7, figures 6-10; text figure 10

Description. — Shape of pollen grains triangular to slightly convex-triangular in polar view. Size 25μ – 29μ in equatorial diameter (two specimens). Wall thin, two layered, 1μ – 1.5μ thick in interapertural areas. Surface smooth or finely punctate, owing to the structure of the outer wall. Exogerminals vertical slit shaped, ektexine adjacent to exogerminals in the form of labra, outer part of labra structureless, inner part fine structured, in our specimens radially directed bacula observed. Endexine very thin, separated from ektexine by a narrow interloculum. No discernible vestibulum. Atrium large, with plane or slightly concave inner boundary.

Remarks. — This species was not named, because too few specimens were available. The specimens observed differ from the circumscription of the genus by the absence of a recognizable vestibulum. However, the presence of a vestibulum is not clearly represented in the photographs of the type species.

Stratigraphic distribution. — Coffee Sand and Porters Creek Clay.

Genus MINORPOLLIS Krutzsch, 1959

Type species. — *Minorpollis minimus* Krutzsch, 1959, *Palaeontographica*, ser. B, v. 105, p. 141, pl. 32, figs. 10-14.

Diagnosis. — (“New wording” from Góczán and others, 1967.) Pollen triangular shallow lens shaped, seldom somewhat triplanoid because of slightly longer polar axis; equatorial contour round to strongly triangular with sometimes a crooked side contour. Wall two layered, presence distinguishable. Surface smooth to finely sculptured. With three equatorial germinals at the angles; exogerminal with oval to vertical slit-shaped outer opening, with annulus, tumescence, or labrum. Without oculus. Endogerminal variously structured, sometimes with endannulus; endopores displayed as equatorial elongated oval to vertical oval. Sometimes with indications of plicae. Often secondary folding but without solutions. Size: 6μ to about 15μ ; only very small forms assembled here.

Minorpollis minimus Krutzsch, 1959

Diagnosis. — (From Krutzsch, 1959.) A lens-shaped form-species of *Minorpollis* with a weak tendency to sinuose folding, somewhat rigid equatorial contour, sometimes with a weak constriction of the *Turonipollis* type. Exine two layered, very thin, surface shagreenate, exogerminal with long club-shaped annulus. Endexine relatively thick, sometimes with weak endannulus. Endopores equatorially elongate, no typical atrium present. Size 8μ – 11μ .

Minorpollis aff. M. minimus

Plate 8, figures 1-9; text figure 11

Description. — Shape of pollen grains triangular with rounded angles in polar view, apertural areas slightly swollen, interrupting the outline. Size 13μ – 16μ in equatorial diameter (27 specimens). Wall no more than 1μ thick in interapertural areas, ektexine and endexine of about equal thickness. Ektexine thin, smooth. Exogerminal oval to short vertical slit shaped; ektexine adja-

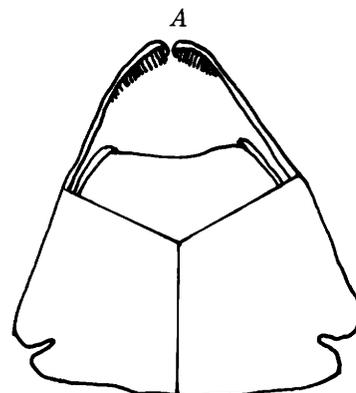


FIGURE 10. — *Megatriopollis?* sp., ca. $\times 2,000$. Sectional view of aperture (A), showing baculate area adjacent to exogerminal, deep atrium, wide endogerminal, and interloculum.

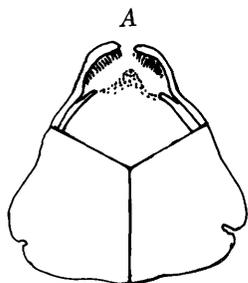


FIGURE 11. — *Minorpollis* aff. *M. minimus*, ca. $\times 2,000$. A, Sectional view of aperture showing baculate area and triangular extension of the endexine below the exogerminal.

cent to the exogerminal two layered, the outer layer structureless, the inner layer of short radially projecting bacula. Baculate area readily visible in some specimens, obscure in others; ektexinal walls adjacent to exogerminal annulate to labrate. Endexine thin and with irregular margin below the exogerminal, commonly with a pointed or triangular outward projecting extension. This extension subtends two oval vestibulumlike areas immediately below the baculate layer of ektexine. Endogerminal probably equatorial slit shaped; exogerminal slit smaller.

Remarks. — The specimens found are all larger than the size mentioned by Krutzsch (1959) for *Minorpollis minimus* (8μ – 11μ). Otherwise our specimens appear to conform to the circumscription of the species. The pollen grains are similar to grains of *Pseudoplicapollis serenus* except that they do not possess plicae. Furthermore, *Minorpollis* aff. *M. minimus* has a different stratigraphic range.

Stratigraphic distribution. — Clayton Formation and Porters Creek Clay.

Genus NUDOPOLLIS Pflug, 1953

Extratropipollenites endangulatus Pflug, 1953 (in Thomson and Pflug, 1953), *Palaeontographica*, ser. B, v. 94, p. 72, pl. 6, fig. 37.

Nudopollis endangulatus (Pflug) Pflug, 1953, *Palaeontographica*, ser. B, v. 95, p. 108, pl. 25, fig. 24.

Type species. — *Nudopollis endangulatus* (Pf.) Pflug.

Diagnosis. — (“New wording” from Góczán and others, 1967.) Pollen grains triangular shallow lens shaped, the three equatorial germinals located at the angles, sometimes very prominent; germinals monannulate, seldom polyannulate. Equatorial contour from slender concave triangular (with sometimes slightly irregular sides) to triangular concave extending to forms with only slightly elongate exogerminals. Central body round to triangular convex. Without or with weak plicae. Wall variously thick, the outer part mostly thicker than the sometimes thinner inner part. Intermediate development is observed in some form species; for example, in “*endangulatus*” a fairly pronounced structure layer is developed and enlarged in the germinal region to form the mesopore. Surface smooth to occasionally weakly sculptured. Exopores vertical slit shaped, and weakly

asymmetrical to the equator, opening outward, toward the inner part oval-round, that is with a strongly constricted canal ending. Annuli sometimes with distinct structure in the outer wall (punctate-baculate). The mesopore is developed as a basketlike filter. Endogerminal without thickening; endopores formed as large, variously deep, half circular atria. No arci, oculi only as a tendency, interloculum seldom (probably only as a secondary development). Medium-sized forms.

Nudopollis endangulatus (Pflug) Pflug, 1953

Diagnosis. — (From Pflug, in Thomson and Pflug, 1953.) 25μ – 35μ . Contour strongly triangular to weakly concave. Inner contour convex triangular, not circular. Long pore canal. Annulus with pointed tip. Endexine thinner than ektexine, mostly very thin, the ektexine closely appressed at all points. No solution meridian, exine shagreenate.

Nudopollis aff. *N. endangulatus*

Plate 8, figures 10–11

Remarks. — Few specimens found. Both the ektexine and the endexine are very thin in interapertural areas. “Filter apparatus” very poorly developed in *N. endangulatus* in contrast to its development in *N. terminalis*.

Stratigraphic distribution. — Nanafalia Formation.

Nudopollis terminalis (Thomson and Pflug) Pflug, 1953

Extratropipollenites terminalis Thomson and Pflug, 1953, *Palaeontographica*, ser. B, v. 94, p. 71, pl. 6, fig. 31.

Nudopollis terminalis (Thomson and Pflug) Pflug, 1953, *Palaeontographica*, ser. B, v. 95, p. 161, pl. 22, figs. 1–6.

Diagnosis. — (From Pflug and Thomson, 1953.) 20μ – 24μ . Contour convex. Inner contour more triangular than round. Pore canal not more than 8μ long, centripetally conically expanded. Without vestibulum but with atrium. Endexine at best half as thick as ektexine. Exine smooth to shagreenate, at the atrium intrabaculate.

Nudopollis terminalis subsp. *hastiformis*

Diagnosis. — Annulus with pointed tips.

Nudopollis terminalis subsp. *hebeformis*

Diagnosis. — Annulus with blunt tips.

Remarks. — *Extratropipollenites terminalis*, including the two subspecies, was transferred to *Nudopollis terminalis* by Pflug (1953) on the explanation of plate 22, p. 161. The subspecies *N. hastiformis* according to the International Rules of Botanic Nomenclature must become *Nudopollis terminalis terminalis*. However, the illustrations of the two subspecies do not clearly distinguish the two. Variation within the species is such that no good purpose is served by attempting to recognize the subspecies. They are mentioned here as a means of including the complete original diagnosis.

Nudopollis aff. *N. terminalis* (Thomson and Pflug) Pflug, 1953

Plate 8, figures 16-25

Remarks. — The specimens illustrated most closely approximate *Nudopollis terminalis terminalis*. There is a recognizable stratigraphic size difference observed in this species. The Paleocene specimens range from 22μ to about 30μ in equatorial diameter, whereas those from the Eocene range from 22μ to about 38μ in equatorial diameter. No specimens larger than 30μ were observed in Paleocene or older samples. The size range of *N. terminalis* given by Thomson and Pflug is 20μ – 40μ .

Stratigraphic distribution. — All formations from Porters Creek Clay through the Cockfield Formation.

Nudopollis thiergartii¹ (Thomson and Pflug, 1953 [non R. Pot., 1951]) Pflug, 1953

Extratropopollenites thiergartii Thomson and Pflug, 1953, *Palaeontographica*, v. 94, ser. B., p. 71, pl. 6, fig. 43
Nudopollis thiergartii (Thomson and Pflug) Pflug, 1953, *Palaeontographica*, v. 95, ser. B., p. 109.
Nudopollis thiergartii (Thomson and Pflug, 1953 [non R. Pot. 1951]) Pflug, 1953, *Berichte Geol. Gesel DDR.*, v. 5, no. 4, p. 326 (Lectotype designation by Krutzsch, 1960b).

Diagnosis. — (From Thomson and Pflug, 1953.) 12μ – 35μ . Contour convex to weakly concave, inner contour always circular. Endexine tightly appressed to ektexine, scarcely recognizable, without solution meridian or with it only intimated. Rodlet layer not evident. Exine shagreenate to faded intrarugulate. Pore canal sometimes gaping centrifugally. Praevestibulum sometimes suggested.

Nudopollis thiergartii subsp. meridium Pflug, 1953, in Thomson and Pflug, 1953

Diagnosis. — 25μ – 50μ . Small canal-shaped solution meridian, exine smooth to shagreenate. Ektexine in interapertural areas less than 2μ thick. Contour concave.

Nudopollis thiergartii subsp. conspicuus Pflug, 1953, in Thomson and Pflug, 1953

Diagnosis. — 25μ – 35μ . Contour mostly concave to interrupted concave. No solution meridian. Shallow fossulate sculpture. Ektexine in interapertural areas more than 2μ thick.

Nudopollis thiergartii subsp. minutus Pflug, 1953, in Thomson and Pflug, 1953

Diagnosis. — 12μ – 25μ . Contour mostly weakly convex. Minute semicircular solution meridian. Shallow fossulate sculpture. Ektexine in interapertural areas less than 2μ thick.

Remarks. — The species *Nudopollis thiergartii* is discussed in detail by Krutzsch (1960b, p. 326). Krutzsch designated the specimen plate 6, figure 43, of Thomson and Pflug (1953) as the lectotype. This specimen was originally designated as *Nudopollis thiergartii* subsp. *conspicuus*. Krutzsch called attention to the fact that according to International Rules of Botanic

¹Originally spelled *thiergartii*. International Code of Botanical Nomenclature, Article 73 recommends the change from "i" to "ii" when the name of a person ends in a consonant.

Nomenclature this subspecies must be designated as *Nudopollis thiergartii* subsp. *thiergartii*. Both Pflug (1953, p. 109) and Krutzsch (1960b, p. 326) indicated that this species is variable and complex. Diagnoses of subspecies included here for completeness.

Nudopollis aff. *N. thiergartii*

Plate 8, figures 12-15

Remarks. — Fairchild and Elsik (1969) indicated that this species is present in the Paleocene and early Eocene and becomes virtually extinct at the end of early Eocene time.

Stratigraphic distribution. — McNairy Sand through the Tallahatta Formation in our reference samples.

Genus PECAKIPOLLIS Kr. and Paclt., 1967

Type species. — *Pecakipollis bohemiensis* Kr. and Paclt., 1967, *Palaontologische Abhandlungen*, ser. 8, v. 2, no. 3, p. 486, pl. 12, figs. 14-20.

Diagnosis. — (From Kr. and Paclt., in Góczán and others, 1967.) Pollen grains triangular shallow lens shaped, equatorial contour interrupted triangular to circular. Equatorial contour of the central body circular, the three equatorial germinals at the angles affect the contour strongly. Wall of two principal layers, ratio of about 1:1, not thick, without structure. Surface with weak sculpture, punctate, shagreenate to weak irregularly wrinkled. No interloculum. Exogerminals with slightly thickened plump labra, thereby forming a large vestibulum. Exopore weakly vertical slit shaped to elongate oval, outer opening arranged weakly asymmetric to the equator. On inspection the exogerminal appears as a shallow to equilateral triangle, or correspondingly a blunt-tipped trapezoid. The outer opening of the endogerminal is constructed of an equatorial elongate slit in the outer lamella with a straight or weakly convex outer margin. The inner opening is constructed by one or more broad fringed to jagged-appearing atria formed by the divided ends of the lamellae on both sides of the inner opening. No (or in any case, no typical) plicae, arci, oculi, and so forth, are developed. Forms small to at most medium sized.

cf. *Pecakipollis* sp.

Plate 9, figures 1-5; text figure 12

Remarks. — One specimen, 23μ in equatorial diameter, was found. This specimen appears to possess most of the characteristics of *Pecakipollis*. The ektexine of this specimen is 1.5μ – 2μ thick, very much thicker than the endexine. A "Schichtfuge" appears to be present between the ektexine and endexine. The ends of short bacula can be seen in the large vestibula. Insufficient specimens were found to provide an adequate evaluation of this taxon.

Stratigraphic distribution. — Coon Creek Tongue of Ripley Formation.

Genus *PLICAPOLLIS* Pflug, 1953, emend. Tschudy

Type species. — *Plicapollis sarta* Pflug, 1953, *Palaeontographica*, v. 95, ser. B, p. 97, pl. 19, figs. 7–9.

Diagnosis. — Pollen grains triangular flat lens shaped to triplanoid. Equatorial contour varies from triangular convex to triangular concave. Wall of two principal layers, ratio about 1:1, surface sculpture smooth to verrucate. With plicae, these generally prominent. Three germinals equatorially arranged at the angles. Exogerminals usually with somewhat strong annuli; annuli sculptured on the inner face with radial bacula, sometimes strongly, sometimes less so. Pore canal index less than 0.3. Exopores shallowly vertical slit shaped to circular, commonly symmetrical with the equator. With vestibula. Endogerminals slightly to strongly thickened adjacent to the somewhat equatorial slit shaped to oval or circular endogerminals (seen in equatorial view); in polar view, they possess a somewhat straight to weakly convex or concave boundary. No arci, no oculi; a "Schichtfuge" or narrow interloculum may be present. Mostly small to medium-sized forms.

Remarks. — In the original short diagnosis, Pflug (1953) referred to *Plicapollis* as tricolporate with pores all equatorial. Góczán and others (1967) enlarged upon the diagnosis without emending it, as follows:

Diagnosis. — ("New wording" from Góczán and others, 1967.) Pollen grains triangular flat lens shaped to triplanoid. Equatorial contour varies from triangular convex to triangular concave. Wall with two principal layers, ratio about 1:1, surface mostly smooth. With plicae, these more or less prominent, sometimes reduced. Three germinals equatorially arranged at the angles. Exogerminals with somewhat strong annuli; annuli sculptured on the inner face with radial bacula, sometimes strongly, sometimes less so. Pore canal index less than 0.3. Exopores vertical slit shaped, terminating outward, mostly approximately symmetrical with the equator. With vestibulum. Endogerminals not thickened, with somewhat equatorial slit shaped to elongated oval pores (seen in equatorial view); in polar view they possess a more or less straight to weakly convex or concave boundary. No arci, no oculi, no interloculum. Mostly small to medium sized forms.

Góczán and others (1967) categorized the exogerminals as being vertical slit shaped and stated that the

endogerminals were not bordered by thickenings. The photographs provided by these workers do not show these details with sufficient clarity to rule out the possibility that some of the species included in the genus *Plicapollis* may possess circular pores and a thickened endexine adjacent to the endogerminals. Specimens from Mississippi embayment rocks otherwise conforming to the circumscription of *Plicapollis* all possess definite unequivocal pores. (See pl. 9, figs. 6–24; pl. 10, figs. 1–21.) Most of the specimens from the Mississippi embayment assigned to the genus *Plicapollis* also show a somewhat pronounced thickening of the endexine adjacent to the endogerminals. Rather than creating a new genus to accommodate these specimens, I have emended the somewhat inadequate original diagnosis to include them.

Plicapollis usitatus, n. sp.

Plate 9, figures 6–14; text figure 13

Holotype. — Sample D3260, slide 2, coordinates 89.8×10.3, Cusseta Sand Member, Ripley Formation, Alabama, Campanian.

Paratype. — Sample D3260, slide 1, coordinates 110.8×17.7, Cusseta Sand Member, Ripley Formation, Alabama, Campanian.

Diagnosis. — Shape of pollen grains triangular, with rounded rather than blunt angles. Plicae present, extending from base of germinals to adjacent germinals over the poles. Size 16 μ –22 μ in equatorial diameter (16 specimens). Wall thin, about 1.5 μ thick in interapertural areas. Ektexine and endexine of about equal thickness and separated by a very narrow interloculum or "Schichtfuge"; ektexine smooth. Exogerminals circular pores, surrounded by ektexinal annuli. Ektexine in apertural areas two layered; outer layer thin and structureless, inner consisting of an elongate baculate layer; bacula longer near exopore, decreasing in length toward the root of the germinal. Vestibulum prominent, roomy, 4 μ –5 μ deep. Endexine at base of germinals, somewhat annulate, sometimes splitting into several lamellae. Endogerminals larger than exogerminals, circular to oval

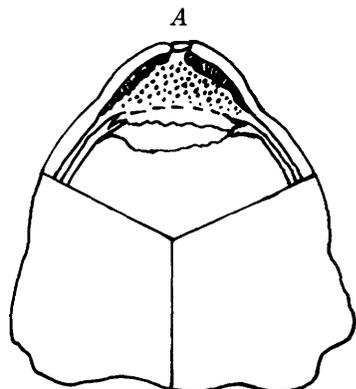


FIGURE 12. — cf. *Pecakipollis* sp., ca. \times 2,000. A. Sectional view of aperture.

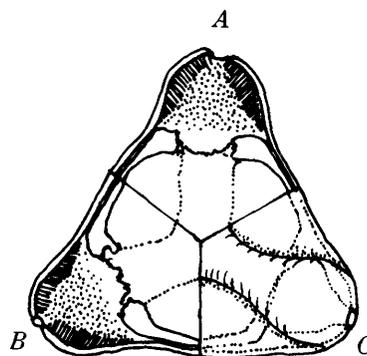


FIGURE 13. — *Plicapollis usitatus*, ca. \times 2,000. A, B, Sectional views of germinals, showing dense baculate layer, narrow interloculum, and annulate endogerminals. C, Surface view showing pore and plica.

with irregular margins.

Stratigraphic distribution. — Cusseta Sand Member of Ripley Formation, Coffee Sand, Coon Creek Tongue of Ripley Formation, and McNairy Sand Member of Ripley Formation.

***Plicapollis retusus*, n. sp.**

Plate 9, figures 15–24; text figure 14

Holotype. — Sample D3412, slide 3, coordinates 112.5×2.4, Coffee Sand, Tennessee, Campanian.

Paratype. — Sample D3412, slide 4, coordinates 106.0×19.9, Coffee Sand, Tennessee, Campanian.

Diagnosis. — Pollen grains triangular to slightly concave triangular, with blunt, slightly swollen angles (apertural regions). Plicae prominent, extending from the base of the germinal region to adjacent germinals over the poles. Size 20μ – 28μ , mostly about 23μ , in equatorial diameter (14 specimens). Wall thin, 1.5μ – 2μ thick in interapertural areas; ektexine and endexine of about equal thickness, separated in some specimens by a very narrow interloculum; ektexine microverrucate. Exogerminals circular pores surrounded by ektexinal annuli. Ektexine in apertural areas two layered; the outer layer thin and structureless, the inner consisting of somewhat robust radially directed bacula. Vestibulum prominent, roomy, about 5μ deep. Endexine at base of germinal enlarged, somewhat annulate, commonly split into several lamellae. Endogerminal larger than exogerminal, oval in equatorial direction and with irregular margins.

Remarks. — Pollen of *Plicapollis retusus* can be distinguished from that of *Plicapollis usitatus* by its more blunt termination of the germinals, by its slightly larger size, and by its microverrucate, rather than smooth, surface sculpture.

Stratigraphic distribution. — Coffee Sand and Coon Creek Tongue of Ripley Formation.

***Plicapollis vacuus*, n. sp.**

Plate 10, figures 1–9; text figure 15

Holotype. — Sample D3412, slide 4, coordinates 87.0×3.1, Coffee Sand, Tennessee, Campanian.

Paratype. — Sample D3412, slide 1, coordinates 78.9×17.7, Coffee Sand, Tennessee, Campanian.

Diagnosis. — Shape of pollen grains triangular with rounded angles (apertural areas); usually straight sided, sometimes slightly concave or convex. Delicate plicae extend from the base of each aperture and join over the poles. Size 16μ – 23μ in equatorial diameter, most specimens about 18μ (based on 16 specimens). Wall about 1μ thick in interapertural areas, ektexine and endexine of about equal thickness; sometimes a narrow interloculum or “Schichtfuge” can be distinguished between the two wall layers; ektexine smooth to microverrucate. Exogerminal a circular pore in the ektexine. Ektexine in germinal areas generally one layered, structureless, and without thickening. In the in-

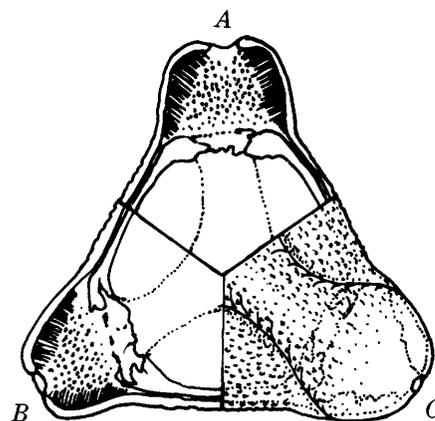


FIGURE 14. — *Plicapollis retusus*, ca. $\times 2,000$. A, B, Sectional views of germinals showing baculate layer, narrow interloculum and annulate endogerminals. C, Surface view showing surface sculpture, pore, and plica.

terior of the wall near the pore, scattered short bacula are visible, more abundant near the pore than at the base of the germinals. In occasional specimens bacula are aggregated near the exopore and form a labrum or slight annulus. Vestibulum prominent, about 3μ deep. Endexine thin, terminating at base of germinal with little or no thickening. Endogerminal oval in equatorial direction with irregular margins.

Remarks. — Pollen assignable to *Plicapollis vacuus* can be distinguished from that of *Plicapollis usitatus* and *Plicapollis retusus* by the virtual absence of aggregates of bacula in the exogerminal, by the possession of thinner walls, and by its generally smaller size.

Stratigraphic distribution. — Coffee Sand and McNairy Sand Member of Ripley Formation.

***Plicapollis rusticus*, n. sp.**

Plate 10, figures 10–21; text figure 16

Holotype. — Sample D3412, slide 4, coordinates 110.9×9.4, Coffee Sand, Tennessee, Campanian.

Paratype. — Sample D3412, slide 1, coordinates 108.0×11.8, Coffee Sand, Tennessee, Campanian.

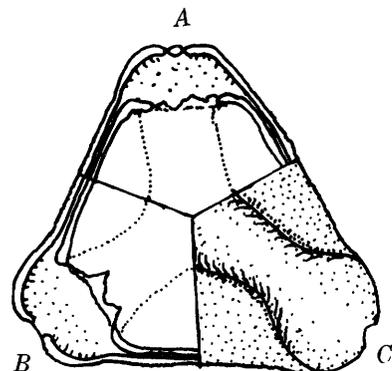


FIGURE 15. — *Plicapollis vacuus*, ca. $\times 2,000$. A, B, Sectional view of apertures, showing only scattered bacula, circular pores, and narrow interloculum. C, Surface view showing plica.

Diagnosis. — Shape of pollen grains triangular to slightly concave triangular in polar view, with blunt corners (apertural areas). Plicae extend from the base of the germinals over the poles to adjacent germinals. Size 22μ – 29μ in equatorial diameter (14 specimens). Wall 1.5μ – 2μ thick in interapertural areas, ektexine slightly thicker than endexine and separated from it by a narrow interloculum, extexine verrucate with low relief. Exogerminals circular pores surrounded by annulate, two-layered ektexine; outer layer structureless, inner layer of tightly packed, radially directed bacula. Vestibulum prominent, about 4μ deep. Endexine enlarged, somewhat annulate at the endogerminals, separating into indistinct lamellae. Endogerminal oval in equatorial direction with irregular margins.

Remarks. — Pollen of *Plicapollis rusticus* is distinguished from that of other species by its prominent verrucate sculpture and its somewhat larger size.

Stratigraphic distribution. — Coffee Sand.

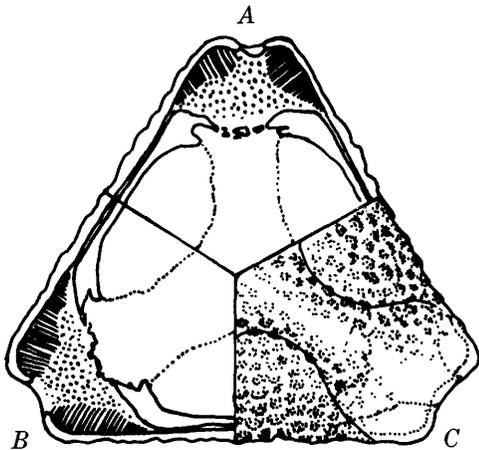


FIGURE 16. — *Plicapollis rusticus*, ca. $\times 2,000$. A, B, Sectional views of apertures, showing circular pores, baculate areas, interloculum, and annulate endexine. C, Surface view showing sculpture and plicae.

Genus POMPECKJOIDAEPOLLENITES Krutzsch, 1967

Type species. — *Pompeckjoidaepollenites subhercynicus* (Krutzsch, 1954) Krutzsch, 1967 (in Góczán and others, 1967), *Paläontologische Abhandlungen*, ser. 8, v. 2, no. 3, p. 491, pl. 13, fig. 25.

Synonymy. — A guide to the synonymy of the species *P. subhercynicus* is provided by Krutzsch (in Góczán and others, 1967, p. 492).

Diagnosis. — (From Krutzsch, in Góczán and others, 1967) Pollen shallow triangular to oval lens shaped, equatorial contour triangular convex to round. Wall with two distinct principal layers separated by an interloculum. Surface fine to distinctly punctate (LO-pattern) with a columella layer as the interior limit of the outer-wall section. Outer wall, in addition, sometimes with structure (baculate, tubulate, and so forth). With three equatorial germinals at the angles.

Exogerminals with annuli, these mostly radial baculate structured. Exopores not vertical slit shaped, but, at most, only vertical oval or, in general, only circular. Endopori connected over the poles by the development of platea, whereby the pole regions sometimes can have endexinous islands. With or without endannuli in the equatorial region (when viewed in optical section). Small to medium sized, rarely large forms.

Remarks. — This genus is listed by Góczán and others (1967) as *Pompeckjoidaepollenites* (Pflug, 1953) n. emend. W. Kr. However, *Pompeckjoidaepollenites* was not listed as a genus by Pflug (1953) but only as a section of the genus *Trudopollis*. Pollen assignable to this new genus can be distinguished from that now included in *Trudopollis* by the presence of round to oval exopores rather than vertical slit-shaped germinals and by the presence of fully developed platea.

***Pompeckjoidaepollenites* aff. *P. subhercynicus* (Kr., 1954) Kr., 1967**

Plate 11, figures 1–8

Remarks. — The lectotype for *Trudopollis subhercynicus* (now *Pompeckjoidaepollenites subhercynicus*) is the specimen-plate 4, figure 12, of Potonié (1934). (See Krutzsch, 1961.) The original description of this taxon, in the light of more recent observations and interpretations of the fine structure of Normapolles genera, is somewhat misleading. I have therefore included below a description of the Mississippi embayment specimens that I believe are closely related to *Pompeckjoidaepollenites subhercynicus*.

Description. — Shape of pollen grains convex triangular to almost circular in polar view, apertural areas slightly protruding. Size 21μ – 26μ in equatorial diameter (10 specimens). Wall of two principal layers, about 2μ thick in the interapertural areas, surface smooth, appearing scabrate to microverrucate, owing to the presence of bacula in the interloculum. Ektexine and endexine of about equal thickness in interapertural areas; ektexine thickened and annulate and consisting of two distinct layers at the apertures. Outer ektexine layer structureless, inner layer of radially projecting bacula that appear to fill the vestibula. Exogerminals consist of circular pores opening into a parallel-walled channel. Endexine in the form of three platea separated by a solution meridian over the poles. Individual platea cup shaped and separated from the ektexine by a prominent interloculum, inner layer of ektexine provided with short bacula that project into the interloculum. Platea may become disattached from the ektexine and lie at random in the cell lumen. Outer margins of the endexine thickened, club shaped (in optical section) adjacent to the apertures; the thickened part may extend part way poleward along the inner margins of the platea. Endexine appears to separate into additional lamellae at the apertures.

Stratigraphic distribution. — Reklaw Formation.

Genus *OCULOPOLLIS* Pflug, 1953

Type species — *Oculopollis concentus* Pflug, 1953, *Palaeontographica*, v. 95, ser. B, p. 110, pl. 19, figs. 45-49.

Diagnosis. — (“New wording” from Góczán and others, 1967.) Central part of pollen grains shallow lens shaped, one hemisphere with a concave and one with a convex surface. The three equatorial germinals located at the angles possess typical, sharply limited oculi in both hemispheres, these oculi strongly influence the shape and contour of the grains, although more so on one hemisphere than on the other. Equatorial contour generally is triangular convex to circular, mostly with interrupted outline. Surface smooth to strongly sculptured, wall sometimes also strongly structured. Exogerminals strong, monannulate, commonly with structure. Exopores in the form of vertical slits, mostly asymmetrical to the equator, pore canal opening outward, strongly constricted toward the inner part. Vestibulum mostly shallow slit shaped; sometimes with interloculum. Endogerminals with only weak thickenings of both outer lamellae of the endexine; endopores small, forming shallow atria with concave borders. The innermost wall lamella forms a wide atrium at the germinal. Small, mostly medium sized, seldom large forms.

Remarks. — The diagnosis of the genus *Oculopollis* is included here even though specimens of *Oculopollis* were not observed, because the diagnosis of *Pseudoculopollis* (Góczán and others, 1967) refers directly to the diagnosis of *Oculopollis*. Specimens of *Pseudoculopollis* were found in the Mississippi embayment samples.

The *Oculopollis* complex includes the genera *Bohemiapollis*, *Oculopollis*, *Pseudoculopollis* and *Semioculopollis*. Góczán and others (1967) suggested that the genera *Oculopollis*, *Bohemiapollis*, and *Pseudoculopollis* could be combined into one genus with three subgenera and that *Semioculopollis* species represent a transition group between *Oculopollis* and *Trudopollis*.

Genus *PSEUDOCULOPOLLIS* Góczán, Kr. and Paclt., 1967

Type species. — *Pseudoculopollis principalis* (Weyl. and Krg.) Krutzsch, 1967 (in Góczán and others, 1967), *Paläontologische Abhandlungen*, ser. B, v. 2, no. 3, p. 495, pl. 14, figs. 7-13.

Diagnosis. — (From Góczán and others, 1967). As in *Oculopollis*, but the swellings of the three oculi join over the pole in one hemisphere.

Pseudoculopollis admirabilis, n. sp.

Plate 11, figure 9-18; text figure 17

Holotype. — Sample D3420, slide 5, coordinates 81.5×9.8, McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Paratype. — Sample D3420, slide 1, coordinates

102.3×14.4, McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Diagnosis. — Shape of pollen grains circular in polar view with three equally spaced strongly protruding germinals with well-developed oculi. Extensions of ocular swellings extend over one pole, oculi not present or poorly developed on other hemisphere. Size 27μ-32μ in equatorial diameter (36 specimens). Surface granulate to finely rugulate. Wall consisting of two principal layers, about 1.5μ-2μ thick in the interapertural areas; ectexine about half as thick as endexine. Interloculum absent or very narrow. Exogerminals in the form of vertical slits, slightly subequatorial, slit extending farther toward the pole on the hemisphere bearing fused oculi. Prominent annulate thickenings of the ectexine present adjacent to the exogerminals; annulate area structureless. A prominent, though somewhat narrow, vestibulum is present between the endexine and ectexine in the germinal areas. Endexine with labra or small annuli adjacent to the mesogerminal pore. Mesopores small, somewhat circular and about 4μ in diameter. An interior lamella of the endexine forms a shallow submesoporal atrium.

Remarks. — *Pseudoculopollis admirabilis* can be distinguished from *P. principalis* by the finer, less strong rugulate sculpture and by the much better development of the fused oculi on one hemisphere. The species *P. concentricoides* is smooth.

Stratigraphic distribution. — McNairy Sand Member, Ripley Formation.

Pseudoculopollis sp. A

Plate 12, figures 1-6; text figure 18

Remarks. — Only one specimen of this species was observed. It differs from other species of *Pseudoculopollis* by the presence of arci extending from

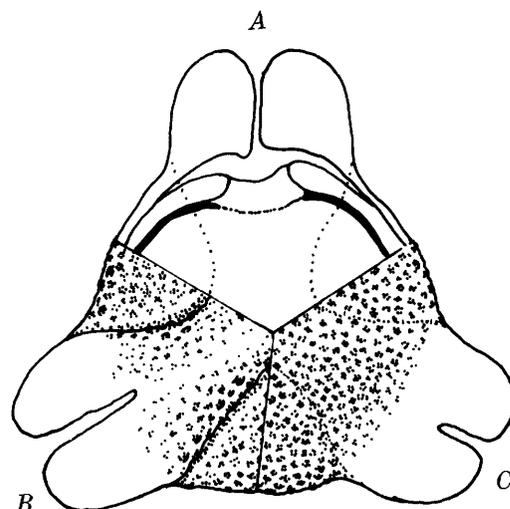


FIGURE 17. — *Pseudoculopollis admirabilis*, ca. × 2,000. A, Sectional view of aperture. B, Elongate slit-shaped exogerminal and oculus fused over the pole on one side of grain. C, Short slit-shaped exogerminal and absence of oculus on obverse side of grain. Surface sculpture shown on B and C.

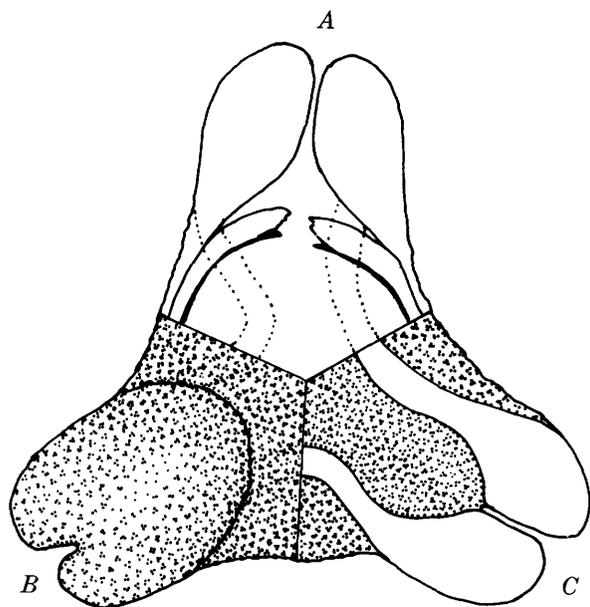


FIGURE 18. — *Pseudoculopollis* sp. A, ca. $\times 2,000$. A, Sectional view of aperture. B, Oculus on one hemisphere. C, Absence of oculus in obverse hemisphere. Arci present in this hemisphere only.

the oculi over one hemisphere to adjacent oculi. The specimen observed is 86μ in equatorial diameter. A very small submesoporal atrium was observed. I consider one specimen inadequate for the erection of a new genus or species and am including a drawing and illustrations to demonstrate an additional variation in the *Oculopollis* complex.

Stratigraphic distribution. — McNairy Sand Member of Ripley Formation.

Genus **SEMIOCULOPOLLIS** Góczán, W. Kr. and Paclt., 1967

Type species. — *Semioculopollis minutus* W. Kr. and Paclt., 1967 (in Góczán and others, 1967), Paläontologische Abhandlungen, ser. B, v. 2, no. 3, p. 503, pl. 16, figs. 13–15.

Diagnosis. — (From Góczán and others, 1967.) Pollen grains shallow lens shaped, equatorial contour weakly convex triangular, whereby the three equatorial germinals enter strongly in the contour. Wall of several layers, with two chief segments, occurrence of these distinctive, often the inner somewhat thicker than the outer. Surface smooth to finely sculptured. Germinal opening assembled somewhat as in *Oculopollis*, only the enlargement of the oculi is not typical, mostly somewhat strongly developed only on one side; the oculi can, however, be almost absent. Only small to medium-sized forms.

***Semioculopollis* sp. A**

Plate 12, figures 7–13; text figure 19

Description. — Pollen grains circular in polar view with prominent protruding oculi surrounding the germinal apertures. Oculi present on one hemisphere only and do not extend to the pole. Size 23μ – 25μ in equatorial

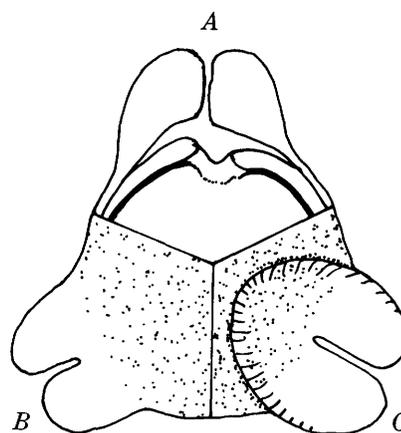


FIGURE 19. — *Semioculopollis* sp. A., ca. $\times 2,000$. A, Sectional view of aperture. B, Short slit-shaped exogerminal on one side of grain. C, Oculus and elongate slit-shaped exogerminal on obverse side of grain. Granulate surface sculpture shown on B and C.

diameter (three specimens), surface granulate. Wall two layered, ektexine about half the thickness of the endexine in interapertural areas; no intercolulum. Exogerminals in the form of vertical slits, slightly sub-equatorial, slit extending farther toward pole on the hemisphere with oculi. Large annulate thickenings adjacent to exogerminals, about 4μ – 5μ high and 4μ – 5μ broad on each side of exogerminal, annulate area structureless. A prominent roamy vestibulum is present between the endexine and ektexine. Endexine with slight annuli adjacent to the mesopores. Mesopores small, 2μ – 3μ in diameter. Interior lamella of endexine forms a shallow submesoporal atrium.

Remarks. — This species appears to differ from other species of *Semioculopollis* by the presence of larger, more protruding oculi. Too few specimens were observed to justify the diagnosis and typification of a new species.

Stratigraphic distribution. — Cusseta Sand Member of Ripley Formation and McNairy Sand Member of Ripley Formation.

Genus **PSEUDOPLICAPOLLIS** Krutzsch, 1967

Type species. — *Pseudoplicapollis palaeocaenicus* Krutzsch, 1967 (in Góczán and others, 1967), Paläontologische Abhandlungen, ser. B, v. 2, no. 3, p. 496, pl. 14, figs 26–31.

Diagnosis. — (From Krutzsch, in Góczán and others, 1967.) Pollen grains triangular shallow lens shaped, somewhat thickened in the region of the always present plicae. Equatorial contour triangular (with sometimes weakly interrupted sides) to triangular convex with slightly blunted angles. Wall thin, composed of two principal layers, with a ratio of about 1:1. Surface smooth to weakly microsculptured. With three equatorial germinals at the angles; exogerminals with annuli, inner with only weak structure, sometimes also appearing smooth but slightly thickened and not elongate. Exopores small, canal index much under 0.3, vertically

elongate and often weakly asymmetrical to the equator, opening outward. Sometimes with a roomy vestibulum. Endogerminals not thickened, with equatorial slit-shaped opening; the plicae terminating internally with small points — that is, the tips triangular to obtuse triangular in the endopores. No oculi, no intercolium, and so forth. Throughout small to sometimes medium-sized forms.

Remarks. — Krutzsch (in Góczán and others, 1967) erected the genus *Pseudoplicapollis* to accommodate those pollen grains previously included in the genus *Sporopollis*. A new generic designation was required because the holotype of the genus *Sporopollis* is a gleichenoid spore and distinctly different from the pollen grains previously included in the genus. Krutzsch also transferred previously designated *Sporopollis* species to *Pseudoplicapollis*, including *Pseudoplicapollis pseudosporites* (Pflug) Krutzsch, n. comb., and *P. peneserta* (Pflug) Krutzsch, n. comb. He transferred *Trudopollis proparvus* Pflug, 1953, to *Pseudoplicapollis proparvus* (Pflug) Krutzsch, n. comb., and named one new species, *Pseudoplicapollis palaeocaenicus*, and designated it as the type species.

***Pseudoplicapollis endocuspis*, n. sp.**

Plate 13, figures 1-7; text figure 20

Holotype. — Sample D3265, slide 1, coordinates 101.2×6.7, Eutaw Formation, Georgia, Coniacian.

Paratype. — Sample D3265, slide 3, coordinates 107.5×9.2, Eutaw Formation, Georgia, Coniacian.

Diagnosis. — Shape of pollen grains slightly convex triangular with somewhat acute angles. Size 16μ–22μ in equatorial diameter, (11 specimens) slightly inflated delicate plicae extend from each angle (germinal) over the poles to adjacent germinals. Wall two layered, thin, less than 1μ thick in interapertural areas, about 1.5μ thick at the apertures. Ektexine smooth, enlarged at apertures in the form of a slight labrum, two layered at aperture, outer layer structureless, inner layer consisting of very short radially directed bacula. Exogerminals short, vertical slit shaped. Vestibulum narrow, inverted V-shaped. Endexine thin, provided with acute angled points or flaps in the germinal area as extensions of the plicae. Endogerminal elongate equatorially between the pointed endexinal extensions.

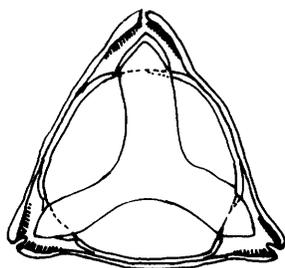


FIGURE 20. — *Pseudoplicapollis endocuspis*, ca. × 2,000.

Remarks. — In general appearance this species is similar to *Pseudoplicapollis palaeocaenicus*. The latter species, however has a finely punctate surface sculpture and coarser plicae.

Stratigraphic distribution. — Eutaw Formation, Coffee Sand, Coon Creek Tongue of Ripley Formation, McNairy Sand Member of Ripley Formation, McNairy Sand, Clayton Formation, and Porters Creek Clay. Single grains were observed in the Wilcox and Tallahatche Formations, but these may have been redeposited.

***Pseudoplicapollis serenus*, n. sp.**

Plate 13, figures 8-12; text figure 21

Holotype. — Sample D3412, slide 2, coordinates 84.7×13.0, Coffee Sand, Tennessee, Campanian.

Paratype. — Sample D3412, slide 4, coordinates 87.7×6.5, Coffee Sand, Tennessee, Campanian.

Diagnosis. — Shape of pollen grains slightly convex triangular with blunt or obtuse angles. Germinals slightly inflated, interrupting the equatorial contour. Size 13.5μ–19μ in equatorial diameter (17 specimens). Delicate, slightly inflated plicae extend from apertural regions over the poles. Wall two layered, about 1μ thick in interapertural areas and about 2μ thick at apertures. Ektexine and endexine of about equal thickness. Ektexine smooth, inflated at apertures in the form of a thickened labrum or annulus; two layered near apertures; outer layer structureless, inner layer of short, radially directed bacula. Exogerminals short, vertical slit shaped. Endexine provided with pointed obtuse angled flaps in the germinal areas that are extensions of the endexinal plicae. Vestibulum prominent, in polar view appearing as two somewhat oval chambers, one on each side of the plica extension. Endogerminals wide, horizontal slit shaped, located between the pointed extremities of the flaps.

Remarks. — This species is distinguishable from other species of *Pseudoplicapollis* by its obtuse, blunt germinal regions and by the double oval shape of its vestibulum. It is distinguished from *Minorpollis* by the presence of distinct plicae.

Stratigraphic distribution. — Coffee Sand.

***Pseudoplicapollis* sp. A**

Plate 13, figures 13-17; text figure 22

Description. — Pollen grains triangular in polar view

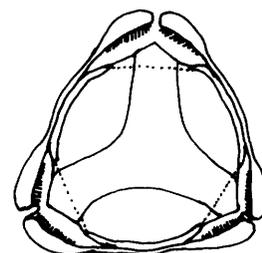


FIGURE 21. — *Pseudoplicapollis serenus*, ca. × 2,000.

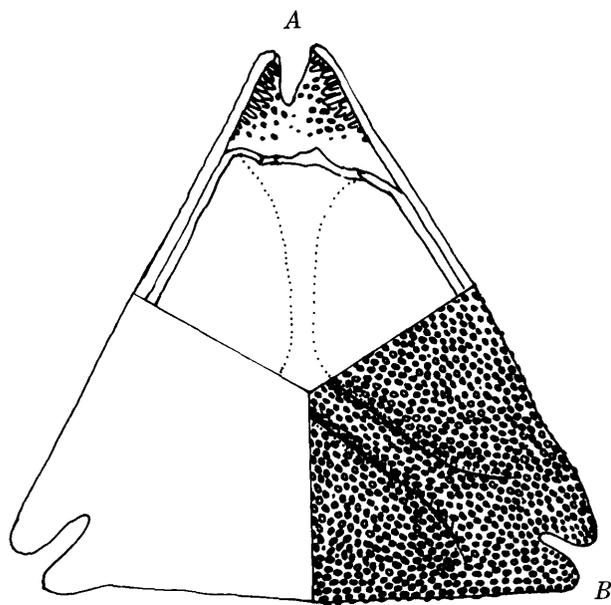


FIGURE 22. — *Pseudoplicapollis* sp. A., ca. $\times 2,000$. A, Sectional view of aperture showing scattered robust bacula, and endogerminal. B, Surface view showing delicate plica and microverrucate surface sculpture.

with almost straight sides. Size 25μ – 36μ in equatorial diameter (eight specimens). Very slightly inflated delicate narrow plicae extend from each angle over the poles. Wall two layered, about 1μ thick in interapertural areas, 2μ to 3μ thick at the apertures. Surface microverrucate to verrucate with low relief. Ektexine inflated at apertures to form a slight labrum; outer layer thin, structureless, inner layer of short robust loosely arranged bacula. Exogerminals equatorial, vertical slit shaped. Vestibulum narrow, poorly defined. Endexine thin, with somewhat rounded slightly elevated terminations in the vestibulum as extensions of the plicae. Endogerminals elongate equatorially with irregular margins.

Remarks. — This species can be distinguished from other species of *Pseudoplicapollis* by its larger size. Too few specimens were found to allow for naming this taxon.

Stratigraphic distribution. — Nanafalia and Wilcox Formations.

Genus PSEUDOVACUOPOLLIS Krutzsch and Pacltová, 1967

Type species. — *Pseudovacuoipollis intraconcavus* Krutzsch (in Góczán and others, 1967), *Paläontologische Abhandlungen*, ser. B, v. 2, no. 3, p. 499, pl. 15, figs. 1–5.

Diagnosis. — (From Krutzsch and Pacltová, in Góczán and others, 1967.) Pollen grains triangular shallow lens shaped to triangular concave, with a tendency to a constriction of the equatorial contour in the interapertural areas. Germinals equatorial at the angles. Wall of several layers, variously thick, the proportion between the several layers varies among the different formspecies. The outer principal wall layer [ektexine] sometimes has an inner thickening in the interapertural

areas. Surface smooth to weakly and shallowly verrucate; sometimes with columella layer as an inner limit to the outer wall complex. With or without an interloculum. Inner wall complex possessing several smooth lamellae; often very thin. Exogerminals with structured annuli; monannulate or polyannulate. Exopores vertical slit shaped to oval. Endogerminals with several stepped, sometimes deeply sunken, atria, the almost platealike solution areas sometimes reach near the polar regions. Irregular endannuli or exfoliation of the lamellae sometimes weakly developed at the sides of the atria. Inner wall layers only seldom clearly developed, most often absent. No plicae, oculi, arci, and so forth. Forms mostly small to medium sized.

Remarks. — The characteristics of this genus are very similar to those of *Vacuopollis*; indeed, Krutzsch and Pacltová (in Góczán and others, 1967) suggested that both could rank as subformgenera of the same genus. They distinguish the two genera principally by the tendency toward development of a constriction in the interapertural areas and a greater differentiation of the endexine in *Pseudovacuoipollis*.

***Pseudovacuoipollis involutus*, n. sp.**

Plate 14, figures 1–12; text figure 23

Holotype. — Sample D3416, slide 2, coordinates 92.9×6.4 , McNairy Sand, Missouri, Maestrichtian.

Paratype. — Sample D3416, slide 2, coordinates 104.7×10.7 , McNairy Sand, Missouri, Maestrichtian.

Diagnosis. — Shape of pollen grains slightly concave triangular to extreme concave triangular in polar view; a constriction in the interapertural areas commonly present. Size 15μ – 23μ in equatorial diameter (17 specimens). Wall of two principal layers, 1μ – 1.5μ thick in the interapertural areas. Surface smooth. Ektexine in interapertural areas sometimes conspicuously thickened internally, becoming less so at bases of germinal areas. Ektexine thickened and annulate, consisting of two layers adjacent to the vertical slit-shaped exogerminal; outer layer structureless, inner layer consisting of com-

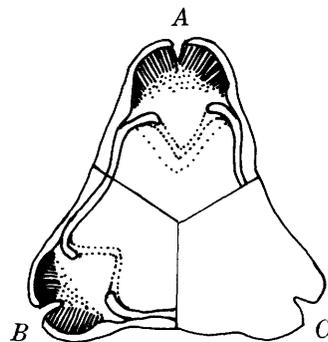


FIGURE 23. — *Pseudovacuoipollis involutus*, ca. $\times 2,000$. A, B, Sectional views of apertures showing baculate layer, V-shaped endogerminals, and interapertural ektexinal thickening. C, Surface view.

pact, radially directed bacula. Endexine thin, less than 1μ thick with weakly developed endannuli adjacent to the atria. Inner margins of atria V-shaped in polar view. Inner layers of endexine poorly developed, secondary atria only occasionally visible.

Remarks. — This species differs from *Pseudovacuopollis intraconcavus* Krutzsch, 1967, and *P. triangulatus* (Ross) Krutzsch, 1967, by possessing a smooth surface and poorly developed accessory atria.

Stratigraphic distribution. — Coffee Sand, Coon Creek Tongue of Ripley Formation, McNairy Sand Member of Ripley Formation, and McNairy Sand.

Genus THOMSONIPOLLIS Krutzsch, 1960, non Elsik, 1968

Type species. — *Thomsonipollis magnificus* (Thoms. and Pflug) Krutzsch, 1960a, Freiberger Forschungshefte, v. C86, p. 58. Holotype, Th. and Pf., 1953, pl. 9, fig. 112.

Diagnosis. — (From Krutzsch, 1960a.) Pollen grains 25μ – 50μ in diameter possessing three germinals that are complex, nonprotruding, and equatorially or slightly subequatorially arranged. Equatorial contour round to convex triangular and (in uncrumpled condition) oval to spherical shaped. The polar axis sometimes can be considerably shorter than the equatorial axis producing a lens-shaped pollen grain. Wall always many layered with three lamella complexes. The outermost bears mostly a strong baculalike to mushroom-shaped sculpturing that only seldom reveals the underlying exolamella. The middle wall complex is developed as many layered, unstructured, hyaline smooth lamellae oppressae (primarily in the intergerminal areas) and as lamellae conspicuae (at the germinals). Innermost complex unstructured, thin, yet with a refractive index different from the middle layer, and thereby easily separable from it. No interlocula, only seldom are "Schichtfuge" developed between the three wall complexes (these as a result of corrosion?). Germinal opening: "Exopore" equatorial slit shaped, oval or circular, about 5μ in diameter. "Mesopore" arises from the outer lamellae of the middle wall complex, these are reflexed inward, and undergo differentiation in the form of thickening, annulus formation, exfoliation, and so forth. The innermost lamellae of the middle wall complex are likewise variously strongly differentiated and form several roomy oval to circular "atria," just as do — only with a regular boundary — the third inner wall complex (= "endopores" — Atrium).

Thomsonipollis magnificus (Th. and Pf. 1953) Krutzsch, 1960a

Plate 14, figures 13–20

Synonymy. — See Krutzsch, 1960a.

Diagnosis. — ("New wording" from Krutzsch, 1960a.) A form species of *Thomsonipollis* with thick to very thick wall, inclusive of the structure layers of the extragerminal about 2μ – 4μ thick; considerable lamellae differentiation in the region of the middle wall complex, whereby often three lamella groups are recognizable, their thickenings, exfoliations, and so forth, swell toward the

germinals. Size 25μ – 50μ , mostly 30μ – 35μ .

Stratigraphic distribution. — Naborton, Naheola, Nanafalia, Wilcox, Pendleton (Andersen, 1960), Hatchetigbee, and Reklaw Formations.

Thomsonipollis magnificoides Krutzsch, 1960a

Plate 15, figures 1–8

Diagnosis. — (From Krutzsch, 1960a.) A form species of *Thomsonipollis* with a thinner and finer wall, inclusive of the structure layers of the extragerminals, only 1.5μ – 2μ thick. Innermost lamellae of the middle wall layer interrupted only in form of steps; exfoliation, thickening, and so forth, almost completely lacking. "Mesopore" relatively broad. Size 27μ – 40μ , mostly 30μ – 33μ .

Remarks. — At the extremes, *Thomsonipollis magnificus* and *Thomsonipollis magnificoides* can be distinguished readily. However, specimens with intermediate wall thicknesses are difficult to place in the appropriate species.

Stratigraphic distribution. — Same as for *Thomsonipollis magnificus*.

Thomsonipollis aff. *T. magnificoides*

Plate 15, figures 9–20; text figure 24

Description. — Shape of pollen grains almost circular in polar view, inflated lens shaped, almost spherical. Size 16μ – 27μ in equatorial diameter, average 22μ (15 specimens). Wall of two principal layers about 1.5μ thick in interapertural areas, ectexine and endexine of about equal thickness. Ektexine with coarsely clavate-baculate sculpture, clavae not tightly spaced, endexine hyaline, structureless. Triporate, pores equatorial or nearly so. Endexine (middle layer of Krutzsch) thinning adjacent to exopore, then the upper part of the endexine turns inward forming a short channel. Inner layer (of Krutzsch) visible only as a hyaline refractive line below the germinals.

Remarks. — These specimens differ from *Thomsonipollis magnificus* by their smaller size, more delicate

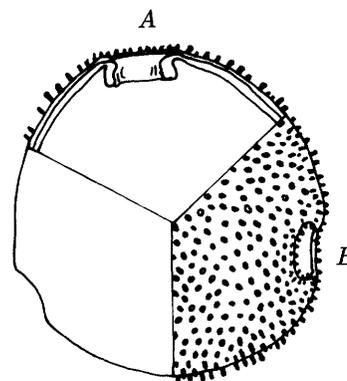


FIGURE 24. — *Thomsonipollis* aff. *T. magnificoides*, ca. $\times 2,000$. A, Sectional view of aperture showing reflexed endexine and thin wall. B, Surface view showing circular exorgerminal, and scattered ectexinal bacula and clavae.

and thin walls, more widely spaced sculpturing, and less structured germinals. They differ from *T. magnificoides* principally by their smaller size and more widely spaced sculpturing. Even though no observed specimen was as large as the average size *T. magnificoides* and the bacula and clavae are more scattered, I am reluctant to erect a new species on the basis of these minor characteristics.

Stratigraphic distribution. — Owl Creek Formation, Clayton Formation, one specimen observed in a sample from the Porters Creek Clay. The stratigraphic range of this form is significantly different from that of *Thomsonipollis magnificoides*.

Thomsonipollis expolitus, n. sp.

Plate 16, figures 1–12; text figure 25

Holotype. — Sample D3410–C, slide 4, coordinates 74.5×11.5, Owl Creek Formation, Mississippi, Maestrichtian.

Paratype. — Sample D3410–C, slide 1, coordinates 104.6×21.4, Owl Creek Formation, Mississippi, Maestrichtian.

Diagnosis. — Pollen grains almost circular in polar view; germinals usually not protruding. Size 16 μ –24 μ in equatorial diameter (18 specimens). Wall of two principal layers about 1.5 μ thick. Ektexine and endexine of about equal thickness. Surface smooth to weakly microscabrate. Exogerminals circular pores. Endexine hyaline, structureless, thinning adjacent to exopore, then the upper part of endexine turns inward forming a prominent annulus with somewhat irregular inner margin. Endogerminal of approximately the same size as exogerminal. Inner wall layer (of Krutzsch) visible only as a refractive line below the germinals.

Remarks. — This species is somewhat similar to *Thomsonipollis gracilis* Krutzsch and Lenk, 1967 (in Góczán and others, 1967), except that the latter has a much more flexible wall and less pronounced infolding of the endexine adjacent to the germinal openings. (Holotype: plate 4 explanation, figs. 13a, b, in Kunert and Lenk, 1964, p. 412).

Stratigraphic distribution. — Owl Creek Formation.

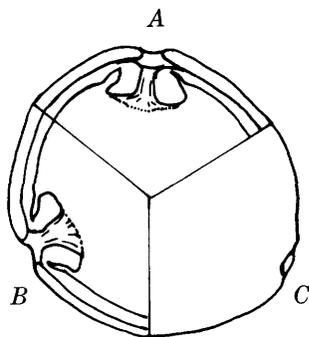


FIGURE 25. — *Thomsonipollis expolitus*, ca. $\times 2,000$. A, B, Sectional views of apertures showing the relatively thick wall and the reflexed inward enlargement of the endexine at the apertures. C, Surface view.

Genus *TRUDOPOLLIS* Pflug, 1953, emend. Krutzsch, 1967

Extratropopollenites pertrudens Pf., 1953 (in Thoms. and Pflug, 1953) p. 74, pl. 6, fig. 74 (and other figures).

Trudopollis pertrudens (Pf.) Pflug, 1953, p. 98, pl. 22, figs. 12, 18.

Trudopollis pertrudens (Pf.) Pflug, 1953, Lectotype designated by Krutzsch, 1967 (in Góczán and others, 1967), same specimen as in Thoms. and Pf., 1953, pl. 6, fig. 74.

Type species. — *Trudopollis pertrudens* (Pflug) Pflug, 1953.

Diagnosis. — (From Krutzsch, in Góczán and others, 1967.) Pollen grains shallow to oval lens shaped; equatorial contour triangular to convex triangular or circular. Wall several layered, always two principal layers recognizable, often with “Schichtfuge” or interloculum. Surface always more or less clearly fine sculptured. Wall also sometimes with columella layer or other structure. With three equatorial germinals located at the angles. Exogerminals with tumescens, annulus, or similar thickening that sometimes strongly affects the contour; the inner part almost always with structure (radial baculate, punctate, and so forth), structured part either free or compact and terminates in a variously large vestibulum, not covered by a wall layer. Pore canal index less than 0.3. Outer part of exopores vertical slit shaped, opening nearly symmetrical with the equator. Endopores sometimes with weak thickenings around the atrium; atria of different shapes and variously deep.

No solution channels over the poles; sometimes also the endopores lie asymmetrical to the equatorial oculi that occasionally are present as attachments (accessory developments).

Remarks. — Krutzsch (in Góczán and others, 1967) emended the genus *Trudopollis* to exclude those species with an endexinal solution channel over the poles (those species with platea) and possessing circular or oval exogerminals (rather than vertical slit-shaped exogerminals). The excluded species were placed in the genus *Pompeckjoidaepollenites*.

Trudopollis variabilis, n. sp.

Plate 16, figures 13–22; text figure 26

Holotype. — Sample D3412, slide 2, coordinates 109.7×14.1, Coffee Sand, Tennessee, Campanian.

Paratype. — Sample D3412, slide 2, coordinates 99.5×14.8, Coffee Sand, Tennessee, Campanian.

Diagnosis. — Shape of pollen grains triangular to convex triangular or circular with protruding equatorial germinals. Size 22 μ –29 μ in equatorial diameter (20 specimens). Wall two layered, about 1.5 μ thick, no interloculum observed; ektexine and endexine of about equal thickness. Ektexine verrucate usually with low relief; in some specimens verrucae larger in the apertural regions. In apertural areas, ektexine greatly thickened, annulate, indistinctly layered, the outer layer structureless, the inner with diffuse structure consisting of

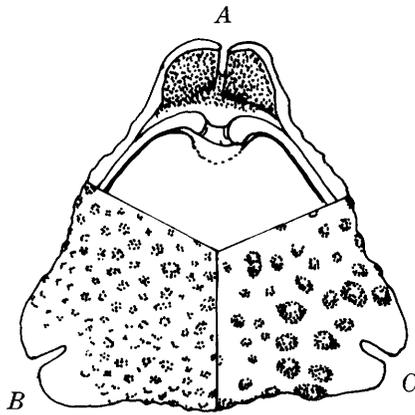


FIGURE 26. — *Trudopollis variabilis*, ca. $\times 2,000$. A, Sectional view of aperture. B, Surface view showing verrucae. C, Surface view showing more robust verrucae present on some specimens.

tightly packed radially directed rodlets or bacula whose free ends are usually clearly visible in the vestibulum. Vestibulum shallow. Exogerminal vertical slit shaped. Mesogerminal a more or less circular pore. Endexine in pore area with labra or endannulus. Inner layer of endexine forms a shallow submesoporal atrium.

Remarks. — Pollen grains of this species are somewhat similar to those described as *Trudopollis acinosus* by Gray and Groot (1966), except that in their specimens they observed a distinct interloculum and an ektexine about twice as thick as the endexine. Furthermore, they reported no endannulus.

Pollen grains of *Trudopollis meekeri* Newman (1965) also bear some similarity to *T. variabilis*. However, in *T. meekeri* an interloculum is present, and the endexine is distinctly thinner than the ektexine. In *T. variabilis* an interloculum is lacking, and the ektexine and endexine are of about the same thickness.

Specimens of *Trudopollis* from the Mississippi embayment are difficult to compare with European forms for the following reasons: About 80 species have been reported; many of the early descriptions are inadequate; the photographs do not show clearly the morphological details required for species identification. None of the species described by Pflug (1953) and Thomson and Pflug (1953) possess a verrucate surface. However, some of the species described as having a fossulate surface sculpture may be irregularly verrucate.

Stratigraphic distribution. — Cusseta Sand Member of Ripley Formation, Coffee Sand, Coon Creek Tongue of Ripley Formation.

***Trudopollis plenus*, n. sp.**

Plate 17, figures 1–9; text figure 27

Holotype. — Sample D3138, slide 4, coordinates 113.6 \times 10.0, Naheola Formation, Alabama, Paleocene.

Paratype. — Sample D3138, slide 1, coordinates 91.3 \times 16.7, Naheola Formation, Alabama, Paleocene.

Diagnosis. — Shape of pollen grains convex triangular

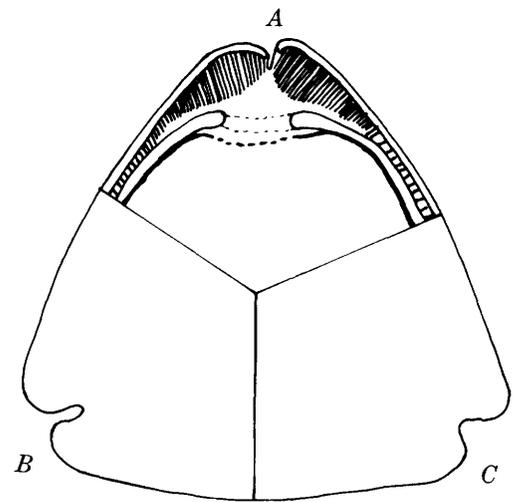


FIGURE 27. — *Trudopollis plenus*, ca. $\times 2,000$. A, Sectional view of aperture showing the endogerminal and the baculate layer of exogerminal region extending into the well-developed interloculum. B, C, Surface views.

to almost circular in polar view, with only slightly protruding equatorial germinal areas. Size 22 μ –31 μ in equatorial diameter (based on 21 specimens). Wall of two principal layers 1.5 μ thick in the interapertural areas. Ektexine and endexine of about equal thickness and separated by a prominent interloculum. Ektexine two layered, the outer surface smooth and structureless, the inner composed of short bacula which extend across the interloculum. Baculate layer provides the appearance of a scabrate or microverrucate surface, although the outer surface is smooth. Faint plicae visible on some specimens. Ektexine thickened, annulate near apertures; bacula much elongated in this area, tightly packed and projecting radially with somewhat free ends in the vestibulum. Exogerminals consist of short, meridionally directed equatorial or slightly sub-equatorial slits. Endexine with a labrum adjacent to the mesogerminal. Mesogerminal somewhat circular, larger than exogerminal; vestibulum very narrow. Inner lamella of endexine separates near mesogerminal and forms an atriate endogerminal whose margins are irregular and appear granulate.

Remarks. — Some specimens have a torn or somewhat eroded incidence or solution notch, but most specimens do not show this.

Stratigraphic distribution. — Naborton and Naheola Formations.

Trudopollis cf. *T. artifex* Weyl. and Krg., 1953

Plate 17, figures 18–20; text figure 28

Diagnosis. — (From Weyland and Krieger, 1953.) About 25 μ . Contour rigid triangular. Free lamella complex strong. Weak oculus. Cubiculum with nearly circular cross section, almost fully closed to the annulus. Strong endexine. The clear annulus intimus is here characteristic. No solution meridian. Intrabaculate

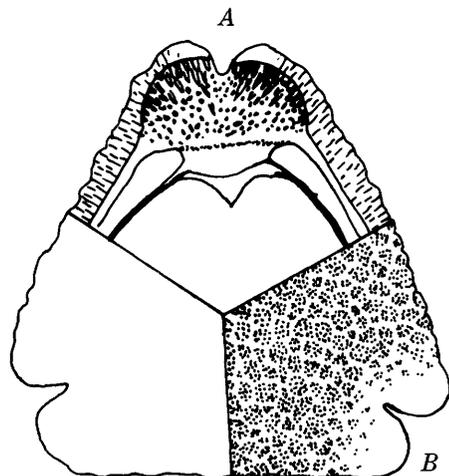


FIGURE 28. — *Trudopollis* cf. *T. artifex*, ca. $\times 2,000$. A, Sectional view of aperture showing short bacula, radial structure of ectexine, interloculum, and endogerminal. B, Surface view showing sculpture.

structure in the ectexine.

Description. — (Mississippi embayment specimens) Shape of pollen grains rigid triangular in polar view with rounded apertural areas. Size 24μ – 28μ in equatorial diameter (three specimens). Wall of two principal layers, separated by a prominent interloculum; wall 3μ – 4μ thick; ectexine and endexine of about equal thickness. Surface irregularly fossulate with low relief. Ektexine thinner in apertural areas than in interapertural areas; with prominent radial structure. Exogerminal meridionally slit shaped, the lips not tightly appressed. Exogerminal opening into a large cubiculum; short bacula project inward throughout roomy cubiculum. Endexine with definite labra adjacent to mesogerminal. Inner lamella of endexine forms a short V-shaped notch. Atria not prominent if present.

Remarks. — *Trudopollis artifex* differs slightly from the Mississippi embayment specimens by possessing a slight oculus and a tightly closed cubiculum. However, our specimens seem to conform otherwise to the circumscription and illustration of *Trudopollis artifex*.

Stratigraphic distribution. — Coon Creek Tongue of Ripley Formation.

***Trudopollis* sp. A**

Plate 17, figures 10–12; text figure 29

Description. — Shape of pollen grains triangular to slightly concave triangular in polar view. Size 22μ – 23μ in equatorial diameter (two specimens). Surface smooth. Wall consists of two principal layers, about 1.5μ thick in the interapertural areas. Endexine about twice as thick as ectexine except in apertural areas. No interloculum. Ektexine in apertural areas two layered, the outer layer structureless and externally smooth, the inner consisting of very tightly packed radially directed bacula whose free ends are visible in the prominent vestibulum. Exogerminals equatorial, meridionally slit shaped. Endex-

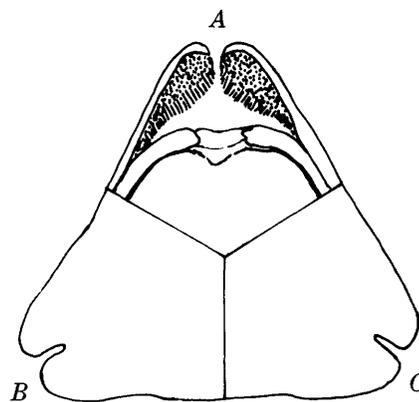


FIGURE 29. — *Trudopollis* sp. A, ca. $\times 2,000$. A, Sectional view of aperture. B, C, Surface views.

ine with slight labrum adjacent to the mesopore, mesopore somewhat circular, larger than exogerminal; inner lamella of endexine forming a very narrow sub-mesogerminal atrium.

Remarks. — Somewhat similar to *Trudopollis rector* Pflug, 1953, but without interloculum, and to *Trudopollis nonperfectus* (Pflug, in Thoms. and Pf., 1953) but with apparently thicker endexine.

Stratigraphic distribution. — Coffee Sand.

***Trudopollis* sp. B**

Plate 17, figures 13–14; text figure 30

Description. — Shape of pollen grains convex triangular to triangular in polar view. Size 25μ – 29μ in equatorial diameter (four specimens). Wall of two principal layers separated by a very narrow “Schichtfuge”, wall 1μ – 1.5μ thick in interapertural areas. Endexine and ectexine of about equal thickness. Surface scabrate to microverrucate with low relief. Exogerminals equatorial, meridionally slit shaped. Ektexine in apertural areas enlarged, annulate, apparently structureless; annulus

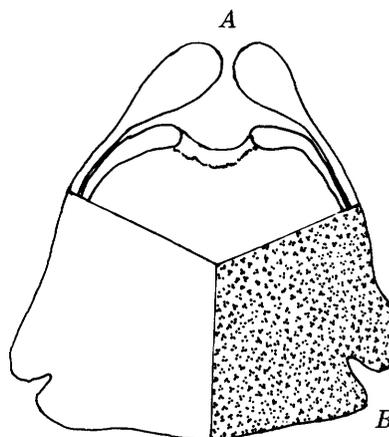


FIGURE 30. — *Trudopollis* sp. B, ca. $\times 2,000$. A, Sectional view of aperture showing apparently structureless ectexinal annulus, narrow interloculum, and slightly enlarged endexine at margin of the endogerminal. B, Surface view showing scabrate-microverrucate sculpture.

tear shaped with rounded contour in the roof of the vestibulum. Vestibulum prominent. Endexine with labra adjacent to the mesogerminal. Inner lamella of endexine does not form a recognizable inner atrium. A semicircular notch present below the mesogerminal.

Remarks. — *Trudopollis* sp. B can be distinguished from *T. variabilis* by its slightly thinner wall, the teardrop-shaped structureless annulus in contrast to the larger, more angular annulus of *T. variabilis* and by the much finer surface sculpture.

Stratigraphic distribution. — Naborton Formation.

***Trudopollis* sp. C**

Plate 17, figures 15-17; text figure 31

Description. — Shape of pollen grains triangular to slightly convex triangular in polar view; germinal areas rounded and slightly protruding. Size 31μ in equatorial diameter (one specimen). Wall of two principal layers separated by a narrow "Schichtfuge." Wall about 2μ thick in interapertural areas. Endexine slightly thicker than ektexine. Surface scabrate to densely microverrucate with low relief. Exogerminals equatorial, meridionally narrow slit shaped. Ektexine in apertural areas enlarged, annulate, structureless except for innermost part. Inner part of annulus studded with short pointed bacula whose free ends project into the vestibulum. Endexine with slight labra adjacent to the mesogerminal. Endexine of two distinct lamellae. No obvious atrium observed. A semicircular notch is present below the mesogerminal.

Remarks. — Very similar to sp. B except for its larger size; has more robust annuli, more dense and smaller verrucae, and a recognizable definite two-layered endexine.

Stratigraphic distribution. — Pendleton Formation (Andersen, 1960).

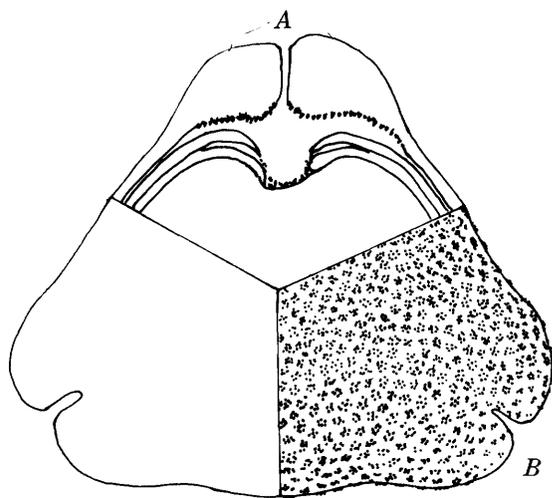


FIGURE 31. — *Trudopollis* sp. C, ca. $\times 2,000$. A, Sectional view of aperture showing inner part of ektexinal annulus with short bacula, narrow interloculum, and the two lamellae of the endexine. B, Surface view showing sculpture.

Genus VACUOPOLLIS Pflug, 1953

Type species. — *Vacuopollis percentus* Pf., 1953, *Palaeontographica*, ser. B., v. 95, nos. 4-6, p. 104, pl. 20, figs. 24-26.

Diagnosis. — ("New wording" from Góczán and others, 1967.) Pollen grains triangular shallow lens shaped, seldom triplanoid. Equatorial contour extends from weakly convex triangular with slightly interrupted or uninterrupted sides to strongly triangular to weakly triangular concave. Corners sometimes strongly rounded. Wall with two principal layers, thickness of the entire wall and thickness of the individual wall segments very different. Surface smooth to weakly microsculptured. Mostly without structure in the extragerminal region. With three equatorial germinals located at the angles. Exogerminals with annuli, sometime labroid, seldom strongly thickened, often with prominent baculate structure layer (=conclave pro parte, according to Pflug, 1953); exopore vertical slit shaped terminating outward, more or less symmetrical with the equator. Pore canal index less than 0.3. Mostly with a wide vestibulum. Endogerminal not thickened, at the pore endexine somewhat split into lamellae; therefore, two to three, seldom more, stepped atria in succession and with shallow concave, semicircular or seldom deeper margins. No oculi; seldom an interloculum indicated. No plicae or arci. Forms small to medium sized.

***Vacuopollis munitus*, n. sp.**

Plate 18, figures 1-19; text figure 32

Holotype. — Sample D3416, slide 1, coordinates 74.1×11.8 , McNairy Sand, Missouri, Maestrichtian.

Paratype. — Sample D3416, slide 1 coordinates 82.7×18.7 , McNairy Sand, Missouri, Maestrichtian.

Diagnosis. — Shape of pollen triangular to slightly

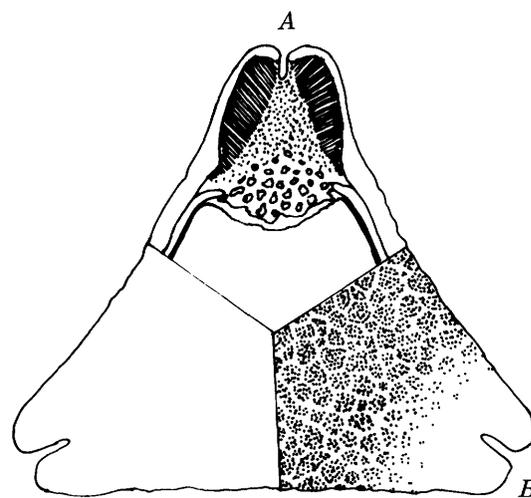


FIGURE 32. — *Vacuopollis munitus*, ca. $\times 2,000$. A, Sectional view of aperture, showing baculate layer, internal verrucae in atrium, and two-layered endexine. B, Surface view showing shallow fossulate sculpture.

concave triangular in polar view. Apertural areas only slightly bulging at the angles. Size 23μ – 28μ in equatorial diameter (19 specimens). Wall of two principal layers, 2μ – 3μ thick in the interapertural areas. Surface shallowly fossulate. Ektexine distinctly thicker than endexine, on some specimens two to three times as thick. Exogerminal vertical slit shaped, equatorial; the ektexine thickened (annulate) adjacent to the pore canal and consisting of two layers — an outer structureless area and an inner layer of tightly packed radially directed bacula. Baculate layer not visible on most specimens. Endogerminal very wide, extending almost entirely across base of apertural area. Endexine thin, consisting of two distinct layers broken up at the endogerminal to form one or more atria with somewhat irregular margins. Endexine in atria broken up into somewhat prominent isolated internal verrucae.

Remarks. — This species of *Vacuopollis* is somewhat similar to *V. orthopyramis* except that it has a distinctly thicker ektexine.

Stratigraphic Distribution. — McNairy Sand Member of Ripley Formation, McNairy Sand.

Genus OSCULAPOLLIS, n. gen.

Type species. — *Osculapollis aequalis*, n. sp.

Diagnosis. — Shape of pollen grains triangular to concave triangular, sometimes slightly convex triangular in polar view. Wall variously thick, endexine always thin. "Schichtfuge" or interloculum present. Surface smooth to slightly sculptured. Exogerminals in the form of small circular pores surrounded by annulate ektexine; ektexine in germinal areas two layered, outer layer structureless, inner of radially directed bacula. Narrow vestibulum present. Endogerminals somewhat circular, larger than exogerminals, endexine not enlarged adjacent to endogerminals.

Remarks. — The presence of porate exogerminals in *Osculapollis* distinguishes it from *Trudopollis* and *Vacuopollis*.

***Osculapollis aequalis*, n. gen., n. sp.**

Plate 18, figures 10–20; text figure 33

Holotype. — Sample D3412, slide 4, coordinates 102.6×3.2 , Coffee Sand, Tennessee, Campanian.

Paratype. — Sample D3412, slide 3, coordinates 98.5×2.5 , Coffee Sand, Tennessee, Campanian.

Diagnosis. — Shape of pollen grains triangular, mostly concave triangular in polar view, with blunt apertural regions at the angles. Size 20μ – 25μ in equatorial diameter (12 specimens). Wall about 1.5μ thick in interapertural areas, ektexine and endexine of about equal thickness and separated by a narrow interloculum. Surface smooth. Faint plicae or plicallike folds sometimes discernible. Exogerminals small circular equatorial pores surrounded by an annulate ektexine. Ektexine in germinal areas two layered, outer layer structureless and of uniform thickness over entire surface of grains, inner

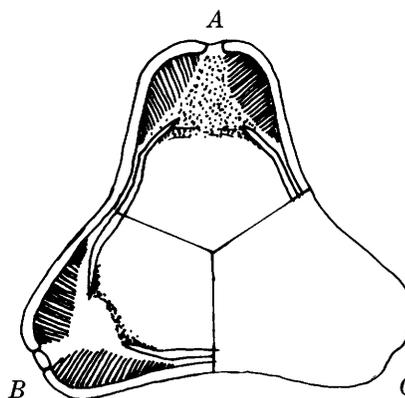


FIGURE 33. — *Osculapollis aequalis*, ca. $\times 2,000$. A, B, Sectional views of apertures showing baculate layer, narrow interloculum, and thin endexine. C, Surface view, psilate.

layer of radially directed bacula that become progressively shorter toward the root of the exogerminal; end view of bacula in neck of exogerminal shows a granular appearance. A narrow vestibulum present. Endogerminal somewhat circular, larger than exogerminal and with irregular margin. Endexine thin, not enlarged adjacent to endogerminal, sometimes split into two lamellae in germinal areas.

Stratigraphic distribution. — Cusseta Sand Member of Ripley Formation and Coffee Sand.

***Osculapollis perspectus*, n. sp.**

Plate 18, figures 21–27, text figure 34

Holotype. — Sample D3412, slide 3, coordinates 104.1×16.3 , Coffee Sand, Tennessee, Campanian.

Paratype. — Sample D3412, slide 3, coordinates 105.7×13.7 , Coffee Sand, Tennessee, Campanian.

Diagnosis. — Shape of pollen grains triangular to convex triangular with apertures at the angles. Apertural areas only slightly protruding. Size 20μ – 29μ in equatorial diameter; most grains 20μ – 24μ in diameter (based on 13 specimens). Wall 2μ – 3μ thick in interapertural areas and smooth; ektexine about twice as thick as endexine,

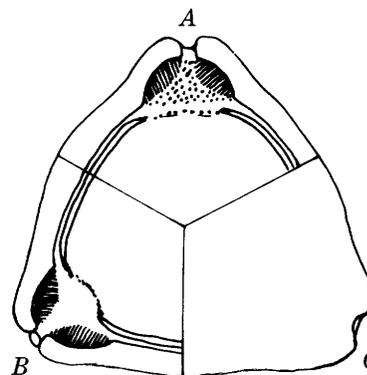


FIGURE 34. — *Osculapollis perspectus*, ca. $\times 2,000$. A, B, Sectional views of germinals showing small semicircular baculate areas, thick ektexine, narrow interloculum, and thin endexine. C, Surface view, psilate.

separated from it by a narrow interloculum. Exogerminals in the form of small circular pores surrounded by an annulate ektexine. Ektexine in pore areas two layered; outer layer smooth, and slightly thicker at base of the exogerminal than at the tip; inner layer consisting of a small, somewhat semicircular area of radially directed bacula. Endexine thin, about 0.5μ thick. A small, narrow vestibulum is present. Endogerminal larger than exogerminal, circular with distinctly irregular margins or lips.

Remarks. — *Osculapollis perspectus* can be distinguished from *O. aequalis* by its thicker ektexinal wall, its much smaller baculate areas, and the more acute angles at its germinals.

Stratigraphic distribution. — Coffee Sand.

Osculapollis sp. A

Plate 18, figures 28-31; text figure 35

Description. — Pollen grains concave triangular in polar view with blunt angles. Size 29μ - 34μ in equatorial diameter (two specimens). Wall about 2μ thick in interapertural areas, endexine thinner than ektexine, surface smooth. Surface has the appearance of being granulate because of the presence of short bacula in the interloculum which separates ektexine from endexine. Exogerminals equatorial, in the form of small circular pores in the center of blunt apertural regions. Ektexine in pore areas two layered, outer layer structureless, slightly thicker at pore margin than otherwise; inner layer of crowded short bacula that become progressively shorter toward the root of the germinals and merge with bacula in the interloculum. No vestibulum, atrium roomy. Endexine thin, terminating in a plane margin at the base of the atrium.

Stratigraphic distribution. — Wilcox Formation.

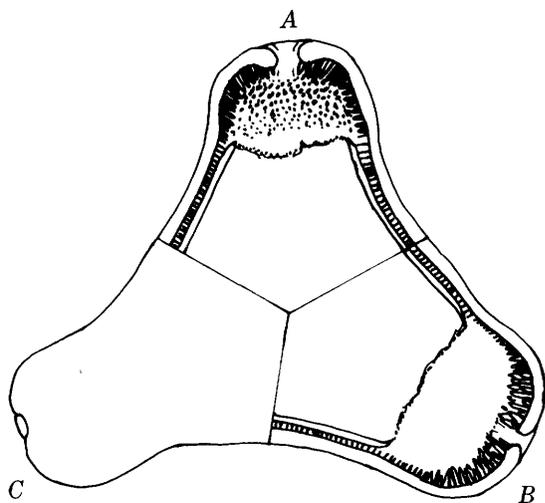


FIGURE 35. — *Osculapollis* sp. A., ca. $\times 2,000$. A, B, Sectional views of apertures showing small equatorial exopores, baculate areas with bacula continuing into the interloculum, and thin endexine. C, Surface view, psilate.

Genus *PRAECURSIPOLLIS*, n. gen.

Type species. — *Praecursipollis plebius*, n. sp.

Diagnosis. — Pollen grains convex triangular in polar view with apertures at the angles. Size 16μ - 21μ in equatorial diameter (20 specimens). Wall two layered, thin, ektexine about the same thickness as endexine, the combined layers about 1μ thick. Surface smooth, occasionally wall wrinkled, but this is incidental. Exogerminals circular pores, bordered by labra or small annuli. Ektexine in vicinity of pores two layered, the outer layer structureless, the inner consisting of very short radially directed bacula (often difficult to see). A shallow vestibulum present, as well as an atrium formed by the splitting of the endexine into two distinct layers in the vicinity of the endopore. Endopores slightly larger than exopores.

Remarks. — Distinguished from *Neotriangulipollis* by porate exogerminals and by two distinct endexinal lamellae adjacent to the endopores.

Praecursipollis plebius, n. gen., n. sp.

Plate 19, figures 1-10; text figure 36

Holotype. — Sample D3265, slide 3, coordinates 87.0×5.5 , Eutaw Formation, Georgia, Coniacian.

Paratype. — Sample D3265, slide 4, coordinates 78.4×7.1 , Eutaw Formation, Georgia, Coniacian.

Diagnosis. — Monotypic. Same as for genus.

Stratigraphic distribution. — Eutaw Formation.

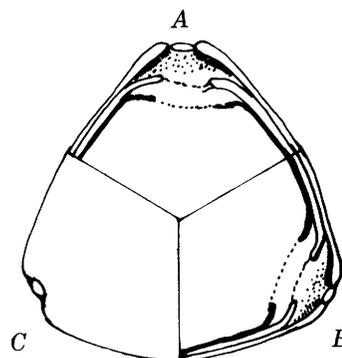


FIGURE 36. — *Praecursipollis plebius*, ca. $\times 2,000$. A, B, Sectional views of apertures, showing pores, narrow baculate area, and split endexine forming two atria. C, Surface view, psilate.

Genus *PSEUDATLANTOPOLLIS*, n. gen.

Type species. — *Pseudatlantopollis simulatus*, n. sp.

Diagnosis. — Shape of pollen grains triangular, slightly concave triangular, to slightly convex triangular in polar view, with equatorial germinals at the angles. Wall of two principal layers, ektexine thicker than endexine in the interapertural areas. Ektexine tectate, reticulate to foveolate with prominent columella layer. Exogerminals in the form of circular pores. Endexine thin in interapertural areas, separated into three to four bands or layers at the apertures, thus forming three or more irregularly defined successive atria.

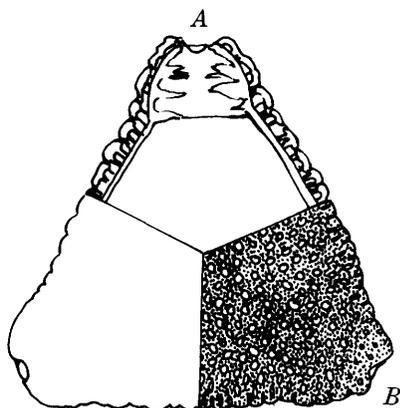


FIGURE 37. — *Pseudatlantopollis simulatus*, ca. $\times 2,000$. A, Sectional view of aperture showing tectate structure of ektexine and successive endexinal atria. B, Surface view showing foveolate-reticulate sculpture.

Pseudatlantopollis simulatus, n. gen., n. sp.

Plate 19, figures 11-28; text figure 37

Holotype. — Sample D1967-B, slide 10, coordinates 100.0×18.9 , McNairy Sand Member, Ripley Formation, Tennessee, Maestrichtian.

Paratype. — Sample D1967-B, slide 9, coordinates 111.9×18.9 , McNairy Sand Member, Ripley Formation, Tennessee, Maestrichtian.

Diagnosis. — Shape of pollen grains triangular, more often slightly concave triangular, sometimes slightly convex triangular in polar view with equatorial germinals at the angles of the grains. Size $20\mu-26\mu$ in equatorial diameter (35 specimens). Wall of two principal layers, $3\mu-4\mu$ thick in the interapertural areas. Ektexine thicker than endexine. Ektexine tectate with prominent reticulate sculpture; bacula supporting tectum easily seen at the periphery of the grains. Lumina of reticulum of same size over entire surface of the grains. Exogerminals in the form of circular pores, ektexinal sculpture somewhat thinner near pores. Endexine thin in interapertural areas, and separated into three to four bands or layers at the apertures to form three or more irregularly defined successive atria. Depth of apertural region including atria $5\mu-7\mu$.

Remarks. — This taxon bears some resemblance to *Proteacidites*. In the latter genus, however the endexine is not separated at the germinals, but all the lamellae are fused to form an endexinal annulus. Specimens of *Proteacidites* sp. are found in some of the samples that yield *Pseudatlantopollis simulatus*. These specimens of *Proteacidites* also differ from *Pseudatlantopollis* by possessing a reticulum whose lumina in the interapertural areas are distinctly larger than those at the poles or near the apertures. *Pseudatlantopollis simulatus* also bears a close resemblance to *Atlantopollis*, specifically *Atlantopollis reticulatus*, except that *Atlantopollis* is characterized by a vertical slit-shaped exogerminal, and the exogerminal of the genus *Pseudatlantopollis* is a circular pore.

Stratigraphic distribution. — Cusseta Sand Member of Ripley Formation, McNairy Sand Member of Ripley Formation, and Owl Creek Formation.

Genus ENDOINFUNDIBULAPOLLIS, n. gen.

Type species. — *Endoinfundibulapollis distinctus*, n. sp.

Diagnosis. — Pollen grains triangular to slightly convex triangular in polar view with the germinals at the angles. Size $20\mu-25\mu$ in equatorial diameter (11 specimens). Wall thin, two layered, combined thickness in interapertural areas about 1μ . Surface smooth or nearly so. Exogerminals short vertical slit shaped; ektexine adjacent to germinals labrate, two layered, the outer layer smooth and structureless, the inner layer of short, very tightly packed, radially directed bacula, baculate area tapering toward the root of the germinal. Structure in the inner layer often difficult to see. Vestibulum large, prominent double cone shaped. Endexine thin, reflexed inward in the form of a funnel at the apertures, endopore circular, $2\mu-3\mu$ in diameter at the base of the reflexed endexine. No endannulus, no interloculum.

Endoinfundibulapollis distinctus, n. gen., n. sp.

Plate 20, figures 1-11; text figure 38

Holotype. — Sample D4268-B, slide 1, coordinates 78.5×21.9 , McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Paratype. — Sample D4268-B, slide 2, coordinates 79.2×15.1 , McNairy Sand Member, Ripley Formation, Kentucky, Maestrichtian.

Diagnosis. — Monotypic, diagnosis as for genus.

Remarks. — The reflexed endexine is somewhat similar to that observed in *Longanulipollis*, except that the endexine is much thinner. Furthermore, the structure of the ektexine in the region of the exogerminals is entirely different. One specimen of *Endoinfundibulapollis distinctus* was observed to have a serendipitous air bubble within one endogerminal (pl. 20, figs. 1-5) that clearly demonstrates the size and shape of the endopore.

Stratigraphic distribution. — Coffee Sand and McNairy Sand Member of Ripley Formation.

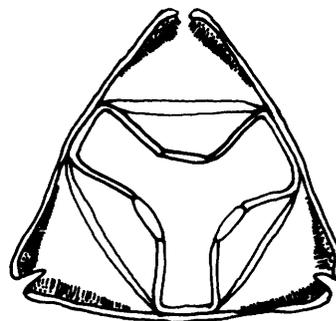


FIGURE 38. — *Endoinfundibulapollis distinctus*, ca. $\times 2,000$. Apertures showing ektexinal vertical slit, baculate layer, and reflexed funnel-shaped endexine and endopore.

NEW GENUS A

Plate 20, figures 12-14, text figure 39

Description. — Pollen rigid triangular to slightly concave triangular in polar view. Size 31μ in equatorial diameter (one specimen). Wall thin, two layered, combined thickness about 1μ . Ektexine fine verrucate to microverrucate. Germinals at the angles of the grain. Exogerminal a short vertical slit-shaped opening surrounded by a two-layered ektexine with an annulus. Outer layer structureless, inner layer of short radially directed bacula. Endexine forming a mesogerminal below a narrow vestibulum. A wide atriate endogerminal is developed centripetal to the mesogerminal. Base of atriate endogerminal marks an abrupt change in contour of the grains. Atrium roomy, 6μ - 9μ deep. Centrifugal to the endogerminal, the endexine forms several internal partial annular ridges in the walls of the atrium.

Remarks. — This genus is distinguished from *Triangulipollis* by the more prominent atrium that marks a change in the outer contour of the grain and by the presence of annular ridges in the neck of the germinal. It is distinguished from *Santonipollis*, a genus that it superficially resembles, by its much shorter, more compact baculate area and by the presence of a prominent mesogerminal near the outer part of its germinals.

Stratigraphic distribution. — Eutaw Formation.

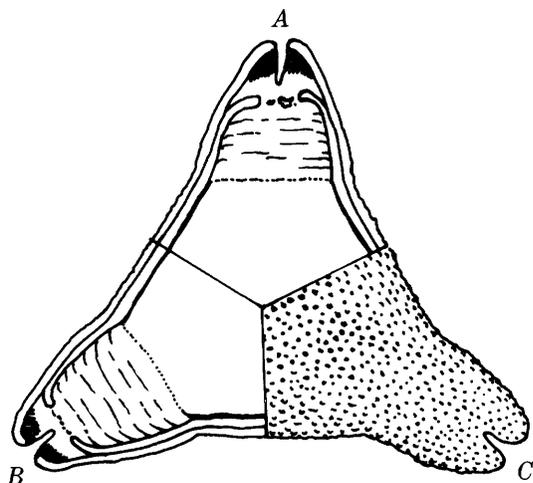


FIGURE 39. — New genus A, ca. $\times 2,000$. A, B, Sectional views of germinals showing baculate area, prominent mesogerminal, and deep atriate endogerminal. C, Surface view, verrucate.

NEW GENUS B

Plate 20, figures 15-17; text figure 40

Description. — Pollen triangular shallow lens shaped, with slightly bulging angles (germinals). Size 18μ - 21μ in equatorial diameter (three specimens). Wall thin, about 1μ thick in interapertural areas; ektexine and endexine of about equal thickness; ektexine smooth. Exogerminal in the form of an elongate vertical slit. Aperture

bordered by a prominent annulus tapering toward the root of the germinal. Ektexine in apertural area two layered, the outer of uniform thickness and structureless, the inner consisting of radially projecting tightly packed bacula. Vestibulum prominent, roomy. Endexine thin, projecting inward below the exogerminals and the vestibulum forming a short, parallel-walled channel. Endogerminals at base of infolded endexine. Endexinal apertures small circular pores; margins of endexine adjacent to pore slightly thickened.

Remarks. — Distinguished from *Longanulipollis* by the presence of a prominent baculate layer adjacent to the exogerminal and by a much thinner endexine. This genus is somewhat similar to *Endoinfundibulapollis* in the possession of a reflexed endexine; however, the exogerminal development is much more prominent in new genus B, and it possesses a slight endexinal thickening adjacent to the endopore.

Stratigraphic distribution. — Coffee Sand.

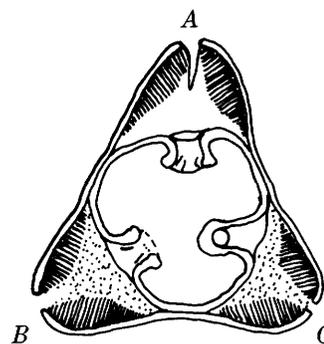


FIGURE 40. — New genus B, ca. $\times 2,000$. A, B, Sectional views showing slit-shaped exogerminals, baculate layer, and inward-projecting endexine forming channeled endopore. C, Endopore channel twisted, showing equatorial view of pore.

NEW GENUS C

Plate 20, figures 18-20; text figure 41

Description (Incomplete). — Pollen grains triangular in polar view with large apertural regions at the angles. Size 28μ in equatorial diameter (one specimen). Surface smooth. Exogerminal vertical slit shaped, ektexine adjacent to exogerminals thin, inner part of wall studded with scattered, radially directed fairly coarse bacula, arranged somewhat in the form of successive annular ridges. Vestibulum prominent. Endexine thick, particularly in the apertural region. Endopores small surrounded by thick unstructured annuli. Endexine thicker than ektexine.

Remarks. — I have been unable to determine with certainty whether what appear to be heavy endexinal arcs are actual, or whether their purported appearance is caused by the irregular wrinkling of the specimen in the interapertural regions.

Stratigraphic distribution. — Owl Creek Formation.



FIGURE 41. — New genus C, ca. $\times 2,000$. Sectional views of apertures with short bacula in outer part and prominent endexinal thickenings adjacent to the endopores.

NEW GENUS D

Plate 20, figures 21-23; text figure 42

Description. — Pollen grains circular to convex triangular in polar view, with equally spaced equatorial apertures. Size 44μ in equatorial diameter (one specimen). Wall of two principal layers, about 2μ thick in interapertural areas, ektexine and endexine of about equal thickness separated by a narrow interloculum. Surface smooth. Exogerminal in the form of a vertical narrow slit extending about half the distance to the poles. Ektexine

of uniform thickness except near the exogerminal, where it narrows abruptly. Endexine also narrows near the exogerminal, then thickens in the mesogerminal region, then thins again in the interapertural areas. Inner portion of endexine shows continuous exfoliation pattern within the large roomy atrium. Irregular short bacula form a somewhat annulate pattern more prominent in the middle part of atrium than above or below. Innermost layer of endexine is visible only as a lower limit to the atrium and at the sides as a thin, more refractive layer.

Remarks. — This specimen is included in the Normapolles assemblage because of the vertical slit-shaped exogerminal and the complicated exfoliation pattern of the endexine present in the large atrium.

Stratigraphic distribution. — Owl Creek Formation.

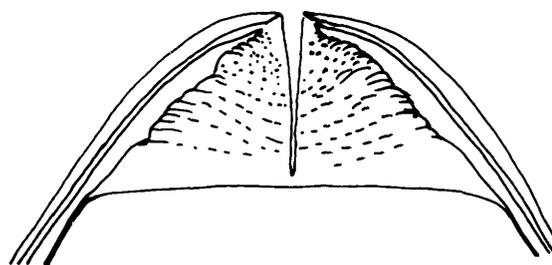


FIGURE 42. — New genus D. One aperture, ca. $\times 2,000$. Deep vertical slit, extexine, interloculum, and exfoliation pattern within the atrium shown.

KEY TO MISSISSIPPI EMBAYMENT NORMAPOLLES GENERA

A conspicuous feature of the pollen grains of many Normapolles genera is the presence of vertical slit-shaped exogerminals. Other Normapolles genera, in contrast, possess circular porate exogerminals. Pollen of some Normapolles genera or species may possess an exogerminal constructed of only a slit or vertically oval exogerminal. Those pollen grains, whose exogerminals might be misinterpreted because of small size or orientation of the specimens, have been keyed to both the slit-shaped and the porate categories below.

- A. Exogerminals, 6; 3 subequatorial on each hemisphere
 - B. Wall thin, with an equatorial constriction, usually with interloculum ---- *Interpollis*
 - BB. Wall thick, without equatorial constriction, no interloculum ----- *Interporopollenites*
- AA. Exogerminals, 3; equatorial or nearly so
 - C. Exogerminals vertical slit shaped
 - D. Endogerminals (mesogerminals) prominently equatorial slit shaped at right angle to exogerminal opening
 - E. Typical polyannulate exogerminal with at least one prominent praevestibulum ----- *Basopollis*
 - EE. No praevestibulum in exogerminal
 - F. Ektexine and endexine thin, both of about equal thickness.
 - G. Plicae prominent, terminating in a triangular point within vestibula ----- *Pseudoplicapollis*
 - GG. No typical plicae present ----- *Complextopollis*
 - FF. Ektexine significantly thicker than endexine ----- *Choanopollenites*
 - DD. Endogerminals somewhat circular to oval
 - H. Prominent oculi present on one hemisphere only
 - I. Oculi joined over one pole by a prominent external thickening ----- *Pseudoculopollis*
 - II. Oculi clearly isolated—not connected over one pole -- *Semioculopollis*

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- HH. Prominent oculi not present
- J. Large roomy atria or vestibula extending more than half the apertural radius (measured from the exterior of the exogerminals toward the pole to the inner limit of the atria or vestibula); openings of endogerminals much larger than those of exogerminals.
 - K. Endogerminals with a deep V-shaped incidence or cuneus.
 - L. Ektexine conspicuously thickened and protruding adjacent to pore canal; endexine of only one distinct layer or lamella. ----- *Extremipollis*
 - LL. Ektexine usually not prominently thickened and protruding adjacent to the pore canal; endexine thin, consisting of two or more distinct layers at the endogerminals, forming thereby successive atria. ----- *Vacuopollis*
 - KK. Endogerminal borders shallow crescent shaped ----- *Megatriopollis*
 - JJ. Atria or vestibula much smaller, extending half or less the apertural radius.
 - M. Small forms, 16μ or less in diameter. ----- *Minorpollis*
 - MM. Larger forms, usually larger than 20μ in diameter.
 - N. With a prominent vestibulum.
 - O. Diameter of endogerminal openings only slightly smaller than diameter of vestibulum; exogerminals labroid; no interloculum ----- *Pecakipollis*
 - OO. Diameter of endogerminal openings much less than diameter of vestibulum; exogerminals annulate, swollen; interloculum usually present ----- *Trudopollis*
 - NN. No vestibulum, no interloculum, mesogerminal consisting of a basketlike filter. ----- *Nudopollis*
 - CC. Exogerminals circular pores, or at most slightly oval.
 - P. Outline of pollen grains circular or nearly so.
 - Q. Platea and interloculum present ----- *Pompeckjoidaepollenites*
 - QQ. No development of platea.
 - R. Endexine reflexed inward around endopores ----- *Thomsonipollis*
 - RR. Endexine not reflexed inward, endexine of two prominent layers ----- *Kyandopollenites*
 - PP. Outline of pollen grains triangular, concave triangular or convex triangular.
 - S. With prominent plicae.
 - T. Plicae terminating in a triangular flap within the vestibulum ----- *Pseudoplicapollis*
 - TT. Plicae terminating at base of vestibulum, no pointed flap present ----- *Plicapollis*
 - SS. Without prominent plicae.
 - U. Platea and interloculum present ----- *Pompeckjoidaepollenites*
 - UU. No platea present.
 - V. Inner part of ektexine thickened or swollen in interapertural areas. ----- *Pseudovacuoipollis*
 - VV. Ektexine almost the same thickness throughout.
 - W. Interloculum present ----- *Osculapollis*
 - WW. No interloculum.
 - X. Prominent reticulate tectum present ----- *Pseudatlantopollis*
 - XX. Without reticulate tectum.
 - Y. Endexine annulate or split into several lamellae adjacent to endogerminal.
 - Z. Wall thin, vestibulum very shallow; baculate area of exogerminals poorly developed; successive atria formed by splitting of endexine ----- *Praecursipollis*
 - ZZ. Wall thicker, vestibulum deep, roomy; baculate area of exogerminals well developed ----- *Pecakipollis*
 - YY. Endexine not annulate nor split into several lamellae adjacent to endogerminal.
 - a. Endexine strongly reflexed inward below vestibulum, terminating in a small pore ----- *Endoinfundibulapollis*
 - aa. Endexine not reflexed inward; small forms less than 16μ in diameter ----- *Minorpollis*

STRATIGRAPHIC DISTRIBUTION OF NORMAPOLLES GENERA

Genera assignable to the Normapolles group are limited in Europe to the Late Cretaceous and early Tertiary. They first appear in the basal part of the Cenomanian, attain their greatest development during the Santonian and Maestrichtian Stages and gradually decrease in number during the early Tertiary. Only one genus, *Plicapollis*, persists beyond the Eocene into the early Oligocene, all others have become extinct by the end of Eocene time. A chart showing the stratigraphic distribution of the European Normapolles genera is provided by Góczán and others (1967, p. 540). Although a few Normapolles genera, notably *Thomsonipollis*, were known from the North American continent in 1967, data concerning these genera were largely omitted from that treatise.

Normapolles genera first appear in Mississippi embayment rocks during the Cenomanian. *Complexiopollis* is the lone Normapolles genus to appear in the Tuscaloosa Formation sample. In the Coniacian, four genera were recognized; one of these, however, new genus A, was represented by but a single specimen — an insufficient number to permit assigning generic and specific epithets. The Campanian is represented by 15 genera and the Maestrichtian by 18 genera. A decline in numbers of genera begins in the Paleocene which is represented by only 8 genera. The lower Eocene Wilcox Group yielded specimens of 10 genera; by the middle Eocene (Claiborne time) this number had abruptly decreased to 1 (*Nudopollis*). The upper Eocene formations examined failed to yield any specimens assignable to Normapolles genera, although Fairchild and Elsik (1969) stated that they had seen several specimens of *Nudopollis terminalis* in the late Eocene Jackson Group.

In Europe, the greatest number of Normapolles genera is attained during the Santonian, followed by a second peak of abundance during the Maestrichtian and two minor peaks in the early Tertiary (Góczán and others, 1967). In the Mississippi embayment the greatest number of genera was observed in the Campanian-Maestrichtian interval. Thus, the development of Normapolles genera in the Mississippi embayment approximately parallels the development of those genera in Europe. As the sampling interval in the lower part of the Campanian and older stages was very sparse in the Mississippi embayment, it is pointless to try to compare in detail the European and Mississippi embayment maxima.

Fifty-seven genera are included in the European Normapolles complex by Góczán, Groot, Krutzsch, and Pacltová (1967). Forty-seven of these genera were from boreal middle Europe and 10 were confined to western Hungary with but four Normapolles genera common to

the two European regions. Only 18 of these 57 genera are recorded from Mississippi embayment samples. To this number must be added the two genera erected by Stover (in Stover and others, 1966) *Kyandopollenites* and *Choanopollenites*, and the genera established as a result of the present work, *Osculapollis*, *Praecursipollis*, *Pseudatlantopollis*, and *Endoinfundibulapollis*. This makes a total of 24 Normapolles genera from Mississippi embayment rocks, exclusive of the four possible new genera that were not named because of insufficient numbers of specimens.

Figure 43 compares the stratigraphic distribution of these genera in Europe and in the Mississippi embayment.

Of the genera common to Europe and the Mississippi embayment, several show remarkably similar stratigraphic ranges in the two areas, notably *Complexiopollis*, *Trudopollis*, *Pseudoplicapollis*, *Nudopollis*, *Interpollis*, and *Thomsonipollis*. The sample coverage from the early Campanian through the Cenomanian is poor in the Mississippi embayment. As more samples are examined from this interval, undoubtedly additional Normapolles genera will be identified and the stratigraphic ranges of others will be extended.

The ranges of several genera are distinctly different in Europe and in the Mississippi embayment. *Plicapollis* and *Vacuopollis* have ranges in Europe extending from the Turonian or Coniacian into the Eocene, and *Plicapollis* even into the basal Oligocene. In the Mississippi embayment their known ranges are limited to the Campanian and Maestrichtian. This discrepancy is difficult to explain. These genera apparently died out earlier in the Mississippi embayment than in Europe. A similar pattern is observed for the genus *Minorpollis*. However, this genus is considered by European workers as a collection genus for small pollen grains that may be difficult to diagnose. (See Góczán and others, 1967, p. 478.) Consequently, several genera may be included in the European range of this form genus.

Genera such as *Megatriopollis* and *Pecakipollis* may be as rare in European rocks as they are in rocks from the Mississippi embayment; consequently, although, at present, their stratigraphic ranges do not coincide, further work may extend the ranges in one or both areas and so greater coincidence may be forthcoming.

Pompeckjoidaepollenites has a range in Europe extending from the Coniacian into the late Eocene. In Mississippi embayment samples specimens of this genus were observed only in the upper part of the lower Eocene. This apparent discrepancy may be due to the rarity of specimens of this genus in this area. This genus very clearly is derived from the *Trudopollis* stock. Parallel evolution taking place later in the Mississippi embayment than in Europe or later immigration from Europe could explain the later first appearance of the genus in the Mississippi embayment.

NORMAPOLLES POLLEN FROM THE MISSISSIPPI EMBAYMENT

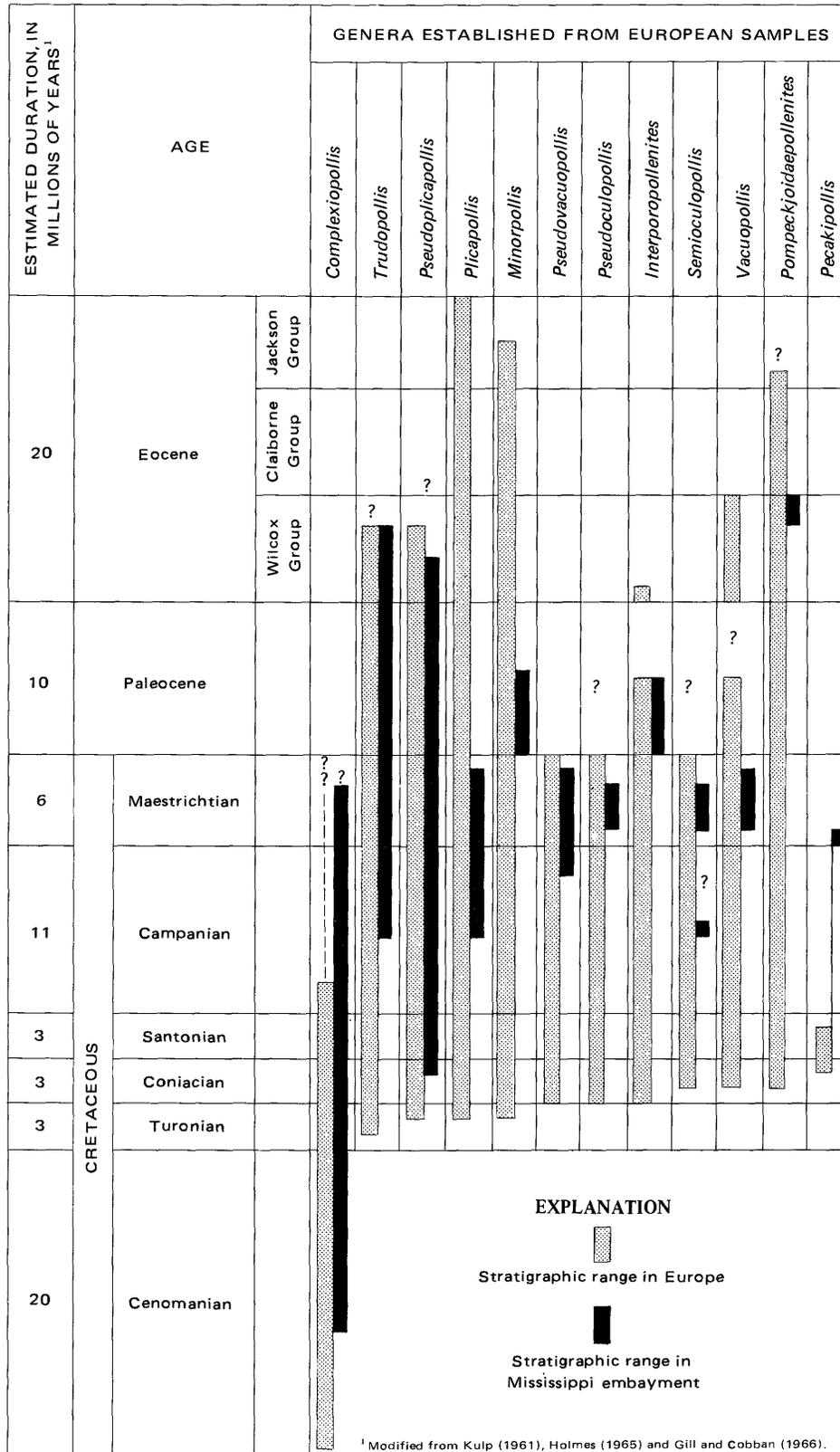
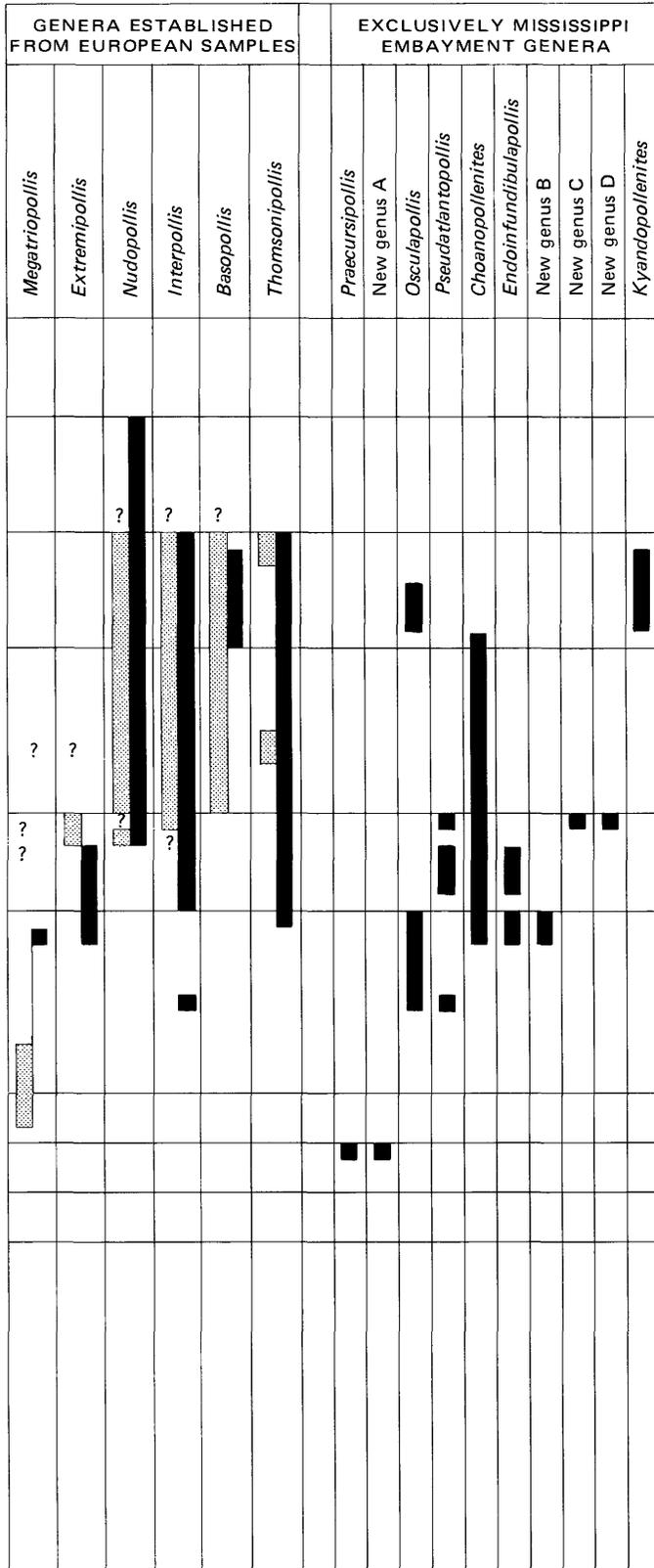


FIGURE 43. — Comparison of stratigraphic distribution of Normapollis



The genera *Thomsonipollis*, *Interpollis*, and *Extremipollis* appear earlier in the stratigraphic column in the Mississippi embayment than in Europe. This fact would seem to contradict the suggestion of Góczán, Groot, Krutzsch, and Pacltová (1967) that central Europe is the center of development of the Normapolles group. Certainly, so far as genera are concerned, many more Normapolles genera are known from Europe than from the Mississippi embayment. However, certain genera, because of their rarity may not yet have been found in rocks as old in Europe as in North America. An alternative hypothesis is one that would allow for the origin of certain Normapolles genera in Europe and others in North America. It must be remembered that the Normapolles group is a group of convenience. No one has implied genetic relationship of all the genera included. Quite the contrary, it is evident on a morphologic basis that such genera as *Interpollis* and *Nudopollis* have little in common and probably originated from widely divergent plant stems. If the continents were at one time close enough to permit plant migration from east to west, there could as well have been migration from west to east. A further argument for independent origin in North America of genera now assigned to the Normapolles group is seen in the fact that the genera *Choanopollenites*, *Kyandopollenites*, *Osculapollis*, *Praecursipollis*, *Pseudatlantopollis*, *Endoinfundibulapollis*, and four new unnamed genera have been found in Mississippi embayment rocks. None of these genera has been reported from Europe.

STRATIGRAPHIC DISTRIBUTION OF NORMAPOLLES SPECIES

Normapolles species have proved to be excellent index fossils in Europe. They have the same stratigraphic utility in the Mississippi embayment. Individual specimens often can provide preliminary information concerning the stratigraphic placement of a sample. When used in conjunction with assemblages of other Normapolles species and other pollen and spore species, their stratigraphic value is enhanced remarkably.

Fifty-nine Normapolles species have been recognized from Mississippi embayment rocks. Of this number, 43 species have been found in sufficient numbers for specific names to be assigned. The remainder are referred to by generic designation only. It is notable that the greater proportion of species recognized could not be equated with European species. The great proportion of new species suggests that the Mississippi embayment genera and species were at least somewhat isolated from their European counterparts.

Mississippi embayment species have been plotted in

genera in Europe and Mississippi embayment.

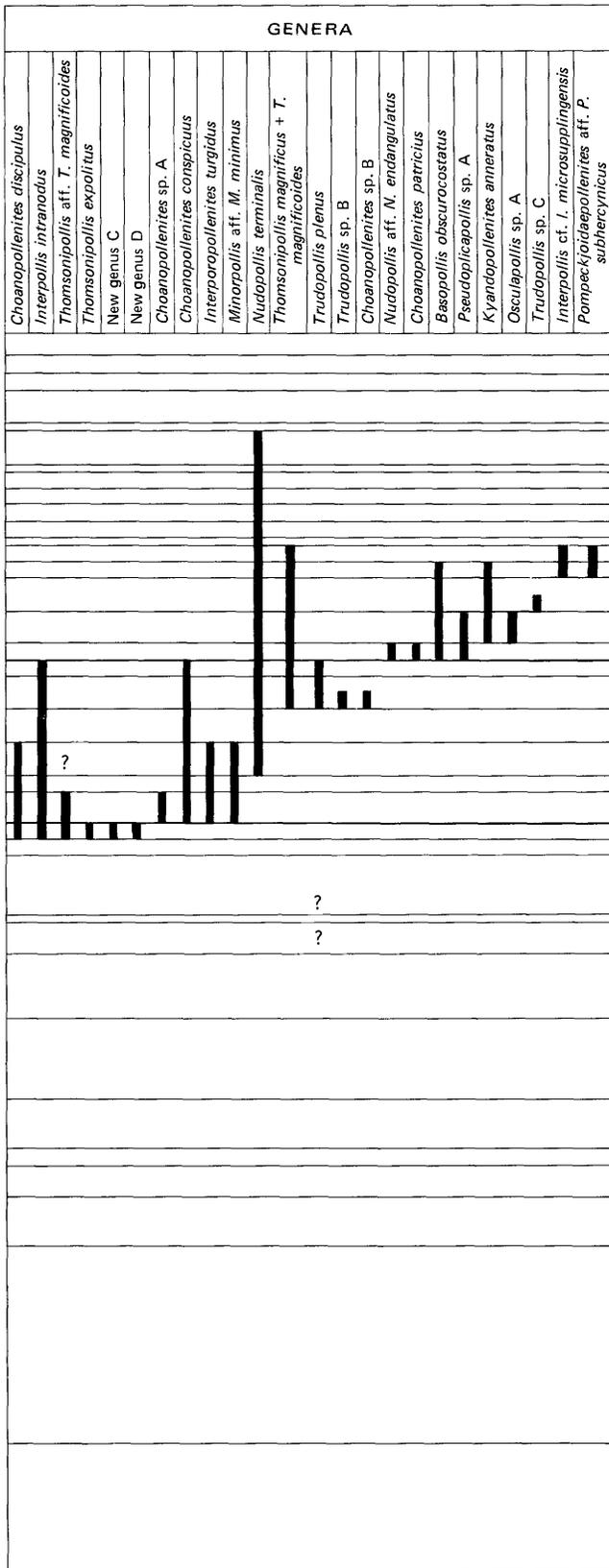


FIGURE 44. — Continued.

stratigraphic sequence in figure 44. This figure portrays the sequential development of Normapollis species in Mississippi embayment rocks. Beginning in the Cenomanian three species were recognized, all belonging to the genus *Complexiopollis*. In succeeding younger samples, development continues to be expressed in the form of increased numbers of species. In the Coniacian, 7 species were found; in the Campanian, 22; and in the Maestrichtian, 28. This species peak in the Maestrichtian is followed by a decline in the Paleocene to 16 species, then to 12 species in the early Eocene, and to only 2 in the middle Eocene. In the Mississippi embayment rocks examined, no Normapollis genus or species originates in rocks younger than those of the upper part of the Wilcox. Concurrently, all Normapollis species apparently became extinct in North America by the end of middle Eocene time.

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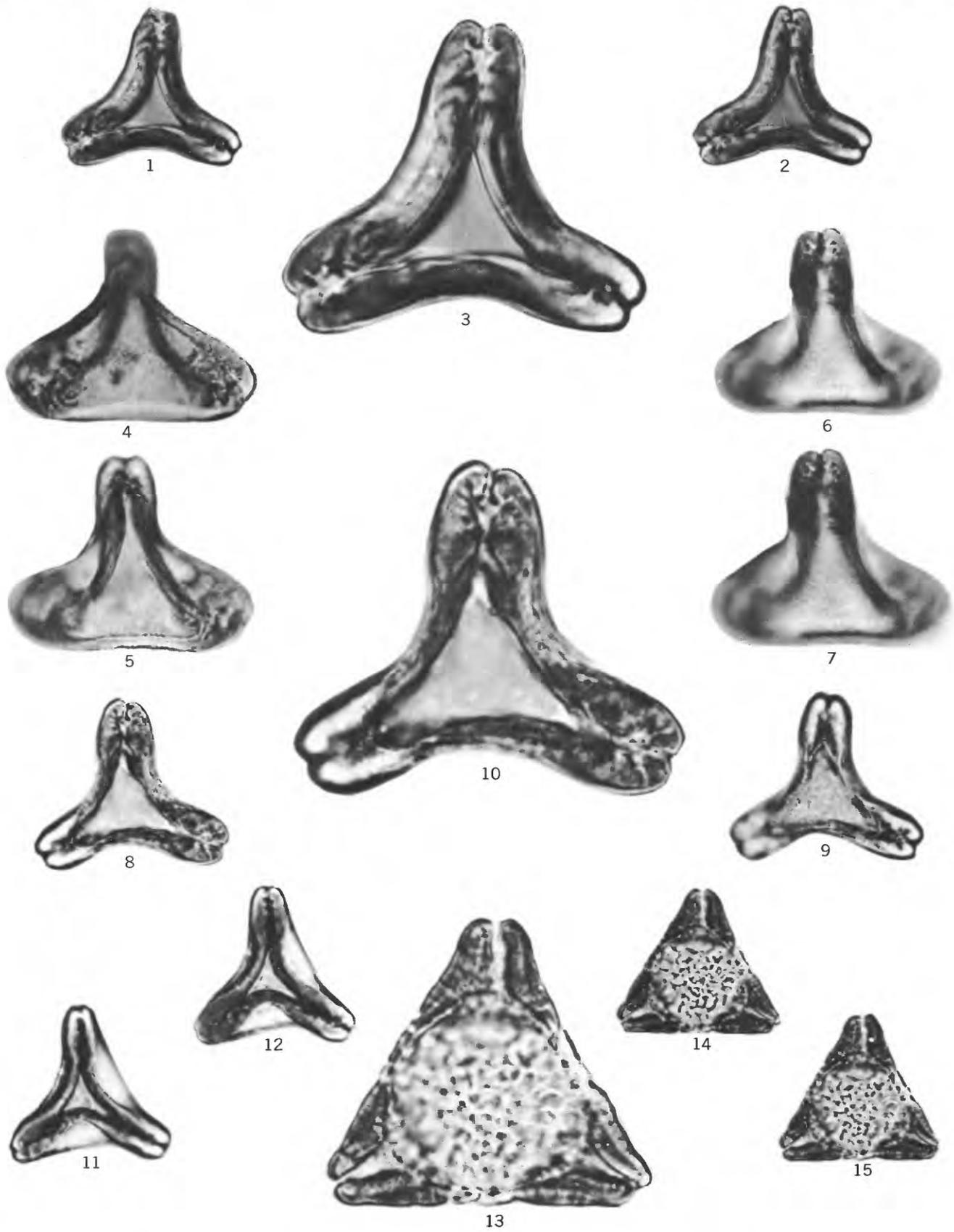
PLATES 1-20

[Contact photographs of the plates in this report are available, at cost, from the U.S. Geological Survey Photographic Library,
Federal Center, Denver, Colorado 80225]

PLATE 1

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-12. *Basopollis obscurocostatus*, n. sp.
- 1-3. Holotype, sample D1862, slide 3, preparation 2, coordinates 95.7×3.9 , diameter 29μ .
 - 3. Holotype \times 2,000.
 - 4-7. Paratype, sample D1862, slide 3, preparation 2, coordinates 92.6×16.1 , diameter 42μ .
 - 8-10. Sample D1851, slide 3, coordinates 107.0×4.4 , diameter 29μ .
 - 10. Same \times 2,000.
 - 11-12. Sample D1862, slide 3, preparation 2, coordinates 105.6×13.3 , diameter 29μ .
- 13-15. Cf. *Choanopollenites* sp.
- 13. Sample D3138, slide 4, coordinates 88.5×13.2 , diameter 26μ , \times 2,000.
 - 14-15. Same \times 1,000.

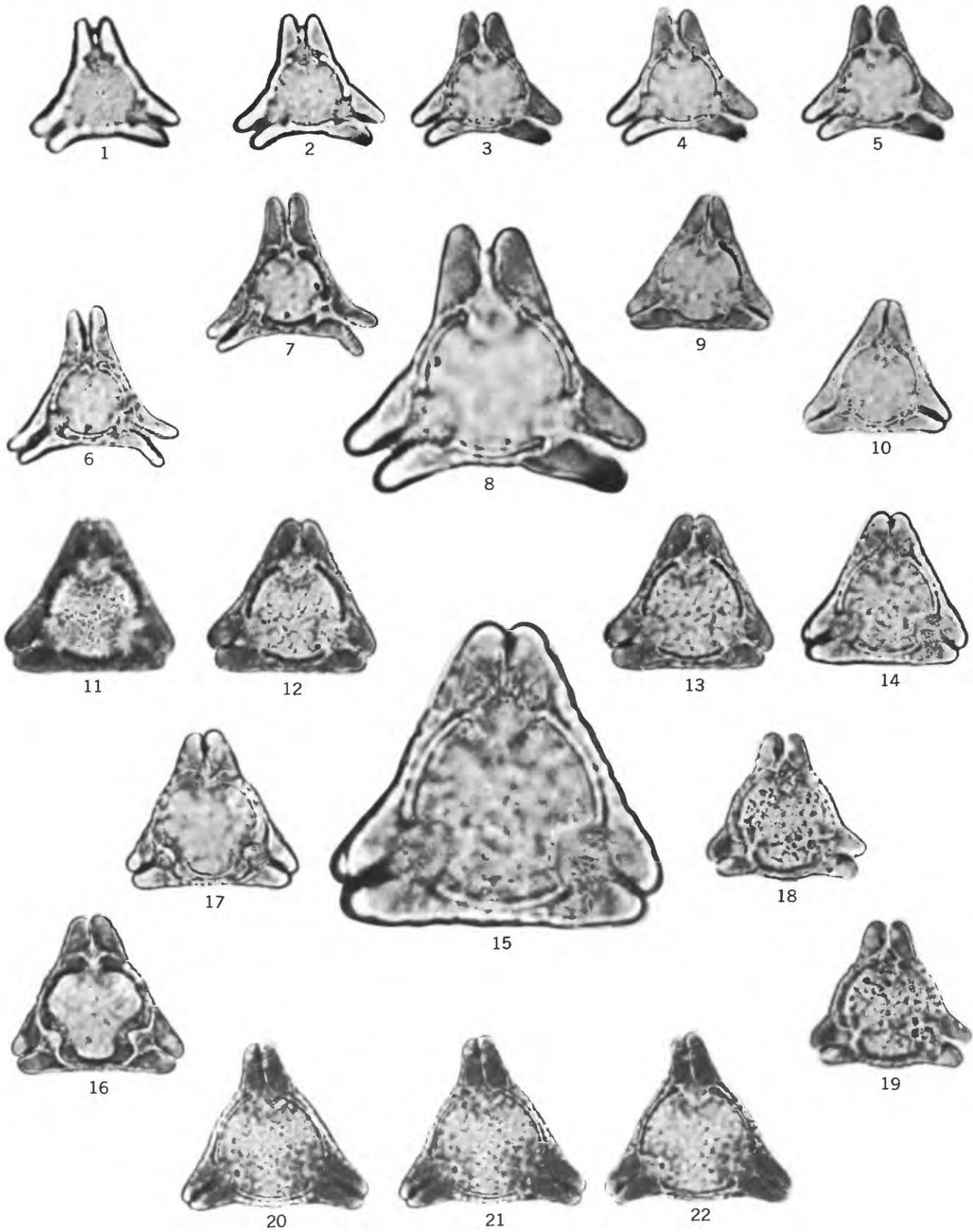


BASOPOLLIS *OBSCUROCOSTATUS* AND CF. *CHOANOPOLLENITES* SP.

PLATE 2

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-10. *Extremipollis vivus*, n. sp.
- 1-5, 8. Holotype, sample D3420, slide 2, coordinates 95.2×21.0 , diameter 23μ .
 - 8. Holotype \times 2,000.
 - 6-7. Paratype, sample D3420, slide 4, coordinates 94.4×21.0 , diameter 27μ .
 - 9-10. Sample D3420, slide 2, coordinates 94.8×7.8 , diameter 23μ . A specimen with somewhat shorter annuli and more equilateral triangular shape.
- 11-22. *Extremipollis versatilis*, n. sp.
- 11-15. Holotype, sample D3420, slide 3, coordinates 97.6×11.5 , diameter 27μ .
 - 15. Holotype \times 2,000.
 - 16-17. Paratype, sample D3420, slide 3, coordinates 108.2×5.3 , diameter 27μ .
 - 18-19. Sample D3420, slide 2, coordinates 99.0×10.0 , diameter 26μ .
 - 20-22. Sample D4268-A, slide 1, coordinates 88.1×15.3 , diameter 30μ . May be a variety or different species with thinner ektexine, provisionally including it here.



EXTREMIPOLLIS VIVUS AND *E. VERSATILIS*

PLATE 3

[Magnification \times 1,000 unless otherwise indicated]

FIGURES 1-18. *Extremipollis caminus*, n. sp.

- 1-5. Holotype, sample D3420, slide 4, coordinates 79.7×4.5 , diameter 36μ .
5. Holotype \times 2,000.
- 6-7. Paratype, sample D3420, slide 2, coordinates 84.3×14.8 , diameter 32μ .
- 8-9. Sample D3413, slide 3, coordinates 104.0×12.0 , diameter 41μ .
10. Sample D3420, slide 3, coordinates 82.0×13.4 , diameter 31μ .
- 11-12. Sample D3420, slide 5, coordinates 112.1×10.2 , diameter 36μ .
13. Sample D3420, slide 3, coordinates 79.5×20.7 , diameter 32μ .
- 14-18. Sample D3420, slide 2, coordinates 104.2×14.5 , diameter 25μ .

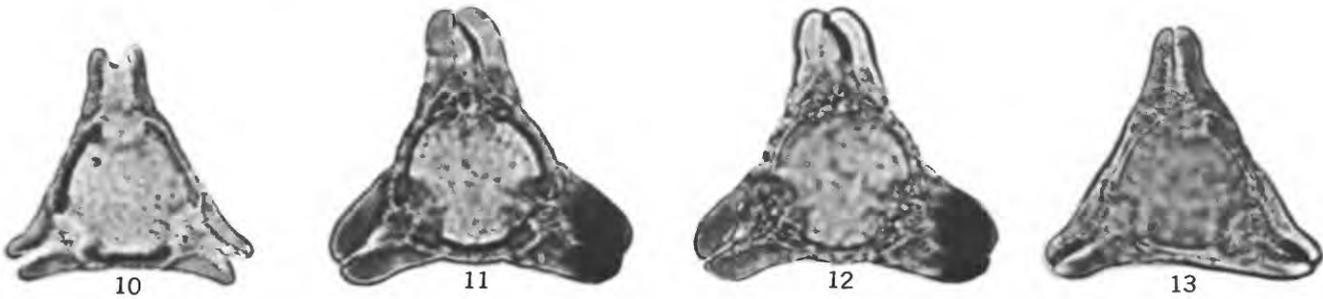
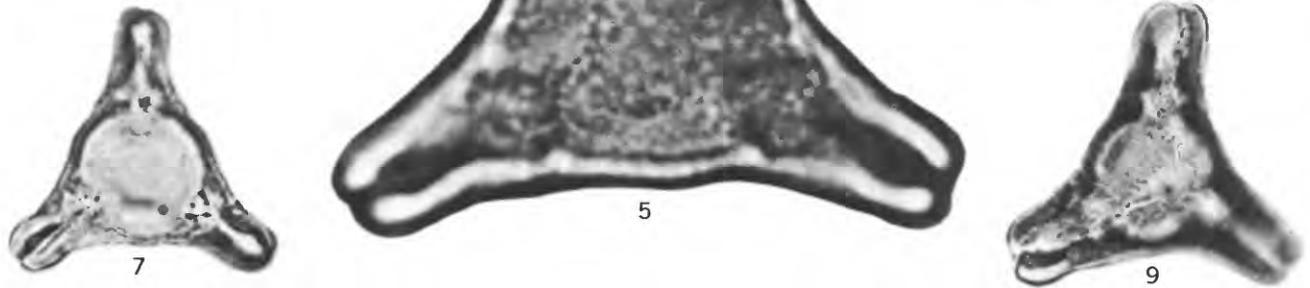


PLATE 4

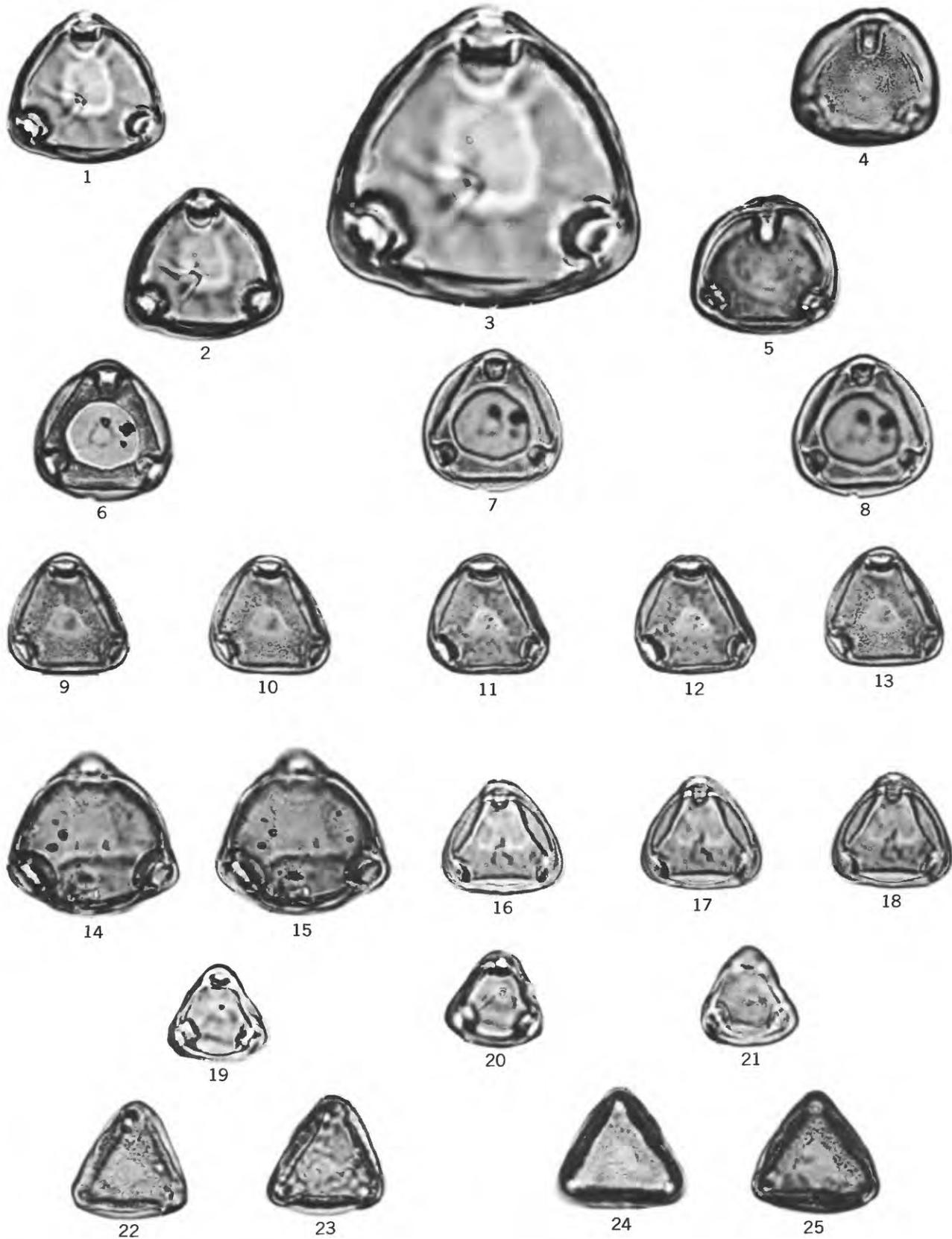
[Magnification \times 1,000 unless otherwise indicated]

FIGURES 1-21. *Interpollis cf I supplingensis*

- 1-3. Sample D3410-C, slide 4, coordinates 76.4×21.1 , diameter 28μ .
3. Same \times 2,000.
- 4-5. Sample D3410-C, slide 3, coordinates 101.9×4.4 , diameter 26μ .
4. One external pore (at top) subequatorial; another, equatorial. Bacula below ektexine gives appearance of rough surface.
- 6-8. Sample D3410-C, slide 5, preparation 3, coordinates 106.5×22.6 , diameter 25μ . Equatorial constriction shows clearly, as well as absence of bacula in polar regions.
- 9-13. Sample 1967-A, slide 1, coordinates 81.9×13.5 , diameter 23μ .
- 14-15. Sample D3413, slide 2, coordinates 93.3×3.5 , diameter 28μ . A variant with prominent thickening around endogerminal and slightly larger size.
- 16-18. Sample D1967-A, slide 1, coordinates 93.3×2.2 , diameter 20μ . Equatorial constriction shows well.
- 19-21. Sample D3260, slide 8, coordinates 80.4×14.5 , diameter 16μ , a smaller variety.

22-25. *Interpollis microsupplingensis*.

- 22-23. Sample D1855, slide 6, preparation 2, coordinates 82.3×12.9 , diameter 20μ .
- 24-25. Sample D1848, slide 3, coordinates 88.1×13.4 , diameter 20μ .



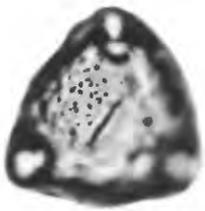
INTERPOLLIS CF. *I. SUPPLINGENSIS* AND *I. MICROSUPPLINGENSIS*

PLATE 5

[Magnification $\times 1,000$ unless otherwise indicated]

FIGURES 1-15. *Interpollis intranodus*, n. sp.

- 1-5. Holotype, sample D3285, slide 1, coordinates 90.3×15.3 , diameter 25μ .
 1. Shows nodelike gemmae between ektexine and endexine appearing as black dots.
 5. Holotype $\times 2,000$.
- 6-7. Paratype, sample D3285, slide 2, coordinates 97.7×21.7 , diameter 25μ .
- 8-9. Sample D1966-C, slide 2, coordinates 103.8×11.6 , diameter 28μ .
 10. Same $\times 2,000$. Note circular subequatorial pore in upper aperture.
- 11-12. Sample D1966-F, slide 14, coordinates 80.5×22.5 , diameter 25μ .
- 13-14. Sample D3413, slide 3, coordinates 94.7×7.6 , diameter 36μ . A slightly larger variety.
 15. Same $\times 2,000$. Interloculum shows well on this specimen.



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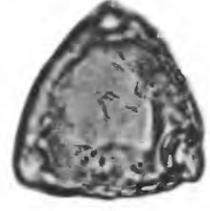
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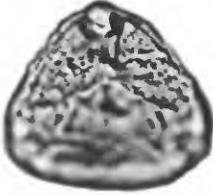
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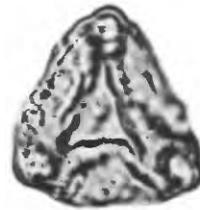
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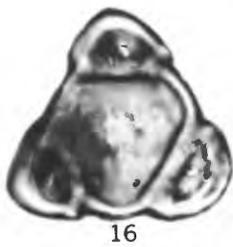
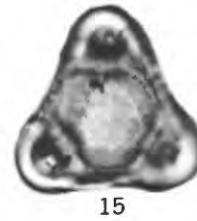
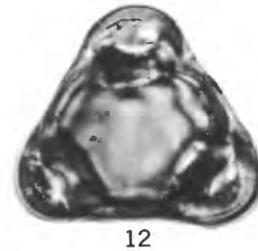
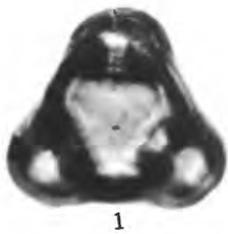
14

INTERPOLLIS INTRANODUS

PLATE 6

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-18. *Interporopollenites turgidus*, n. sp.
- 1-6. Holotype, sample D3548-A, slide 1, coordinates 77.5×11.8 , diameter 26μ . Photographs at different focal levels.
 6. \times 2,000.
 - 7-8. Sample D3285, slide 2, coordinates 92.1×3.9 , diameter 24μ .
 - 9-12. Paratype, sample D3548-A, slide 2, coordinates 78.4×6.5 , diameter 29μ .
 - 13-15. Sample D3285, slide 1, coordinates 83.6×14.9 , diameter 25μ . Note thin polar spots on this and succeeding specimens.
 - 16-18. Sample D3548-A, slide 2, coordinates 84.1×11.0 , diameter 26μ .



INTERPOROPOLLENITES TURGIDUS

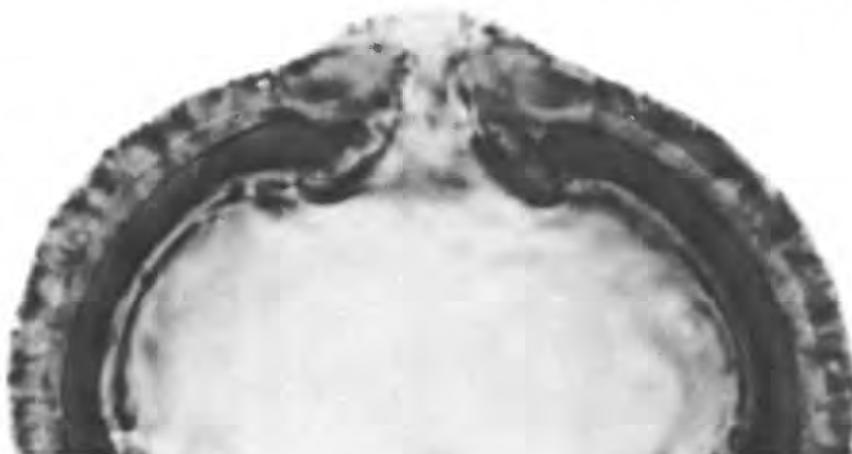
PLATE 7

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-5. *Kyandopollenites anneratus* Stover
1. Sample D1862, slide 6, preparation 2, coordinates 101.8 \times 7.1, diameter 55 μ .
 2. Same \times 2,000, showing wall layers and pores.
- 3-5. Sample D1846, slide 1, coordinates 102.4 \times 11.8, diameter 55 μ .
3. Surface ornamentation.
 4. Intermediate focus.
 5. Showing wall layers.
- 6-10. *Megatriopollis?* sp.
- 6-9. Sample D3285, slide 2, coordinates 100.1 \times 7.9, diameter 29 μ .
 10. Same \times 2,000.



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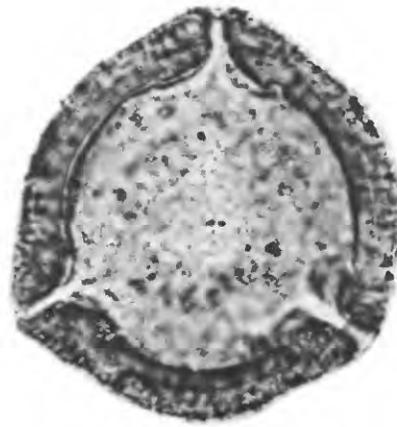
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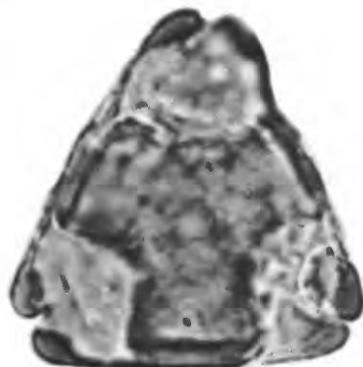
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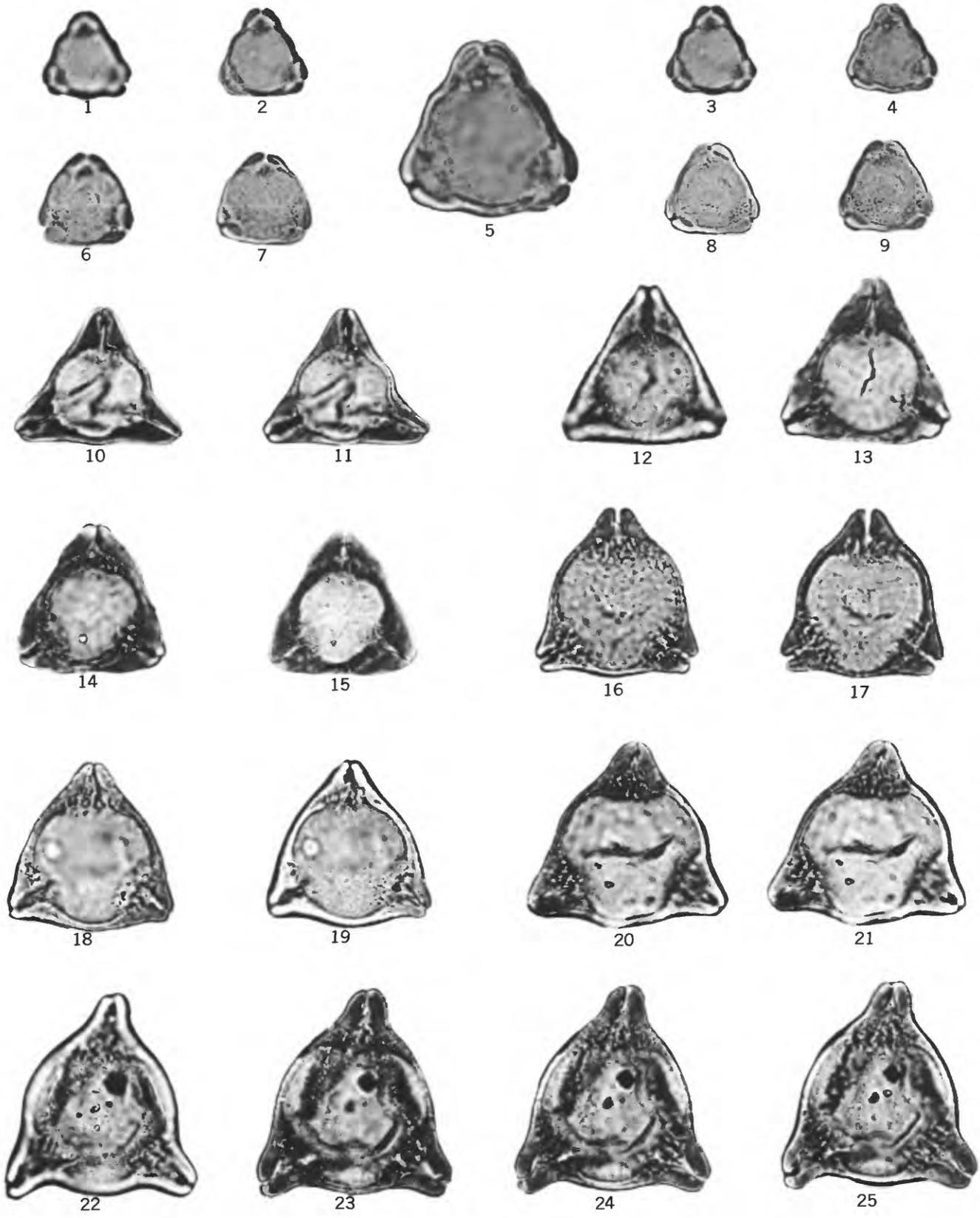
9

KYANDOPOLLENITES ANNERATUS AND *MEGATRIOPOLLIS?* SP.

PLATE 8

[Magnification $\times 1,000$ unless otherwise indicated]

- FIGURES 1-9. *Minorpollis* aff. *M. minimus*
1-5. Sample D3285, slide 1, coordinates 82.3×6.7 , diameter 15μ .
5. Same $\times 2,000$.
6-7. Sample D1966-F, slide 6, coordinates 76.4×6.9 , diameter 15μ .
8-9. Sample D1966-F, slide 7, coordinates 104.2×4.6 , diameter 16μ .
- 10-25. *Nudopollis*
10-11. *Nudopollis* aff. *N. endangulatus*
Sample D3222, slide 1, coordinates 107.5×15.3 , diameter 25μ .
- 12-15. *Nudopollis* aff. *N. thiergartii*
12-13. Sample D3416, slide 1, coordinates 103.3×13.7 , diameter 28μ .
14-15. Sample D3416, slide 2, coordinates 90.3×5.0 , diameter 25μ .
- 16-25. *Nudopollis* aff. *N. terminalis*
16-17. Sample D3222, slide 1, coordinates 79.3×21.0 , diameter 29μ .
18-19. Sample D3548-A, slide 2, coordinates 80.7×9.2 , diameter 28μ .
20-21. Sample D1848, slide 3, coordinates 83.1×13.0 , diameter 33μ .
22-25. Sample D1848, slide 3, coordinates 85.7×18.2 , diameter 36μ .

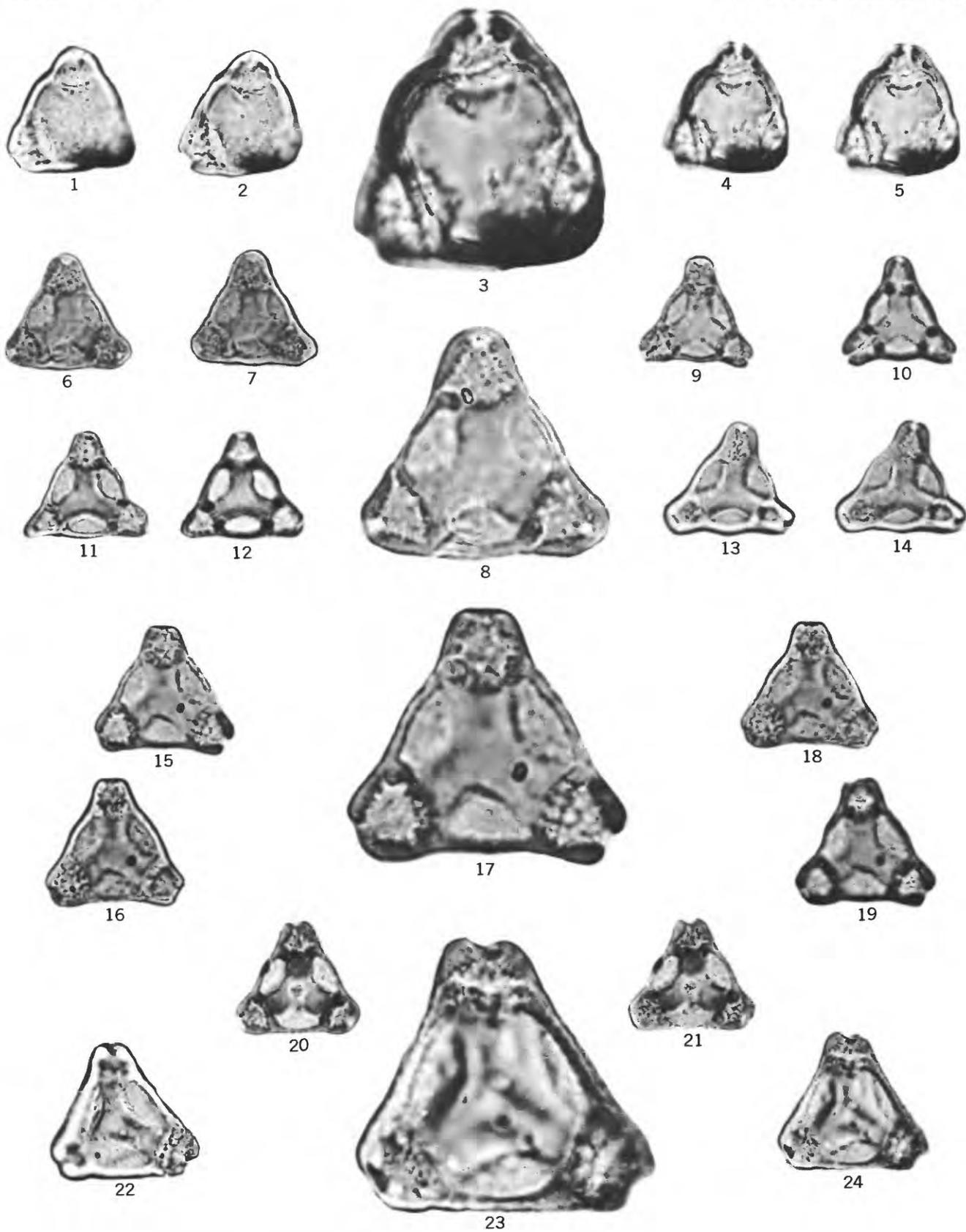


MINORPOLLIS AFF. *M. MINIMUS*, *NUDOPOLLIS* AFF. *N. ENDANGULATUS*,
N. AFF. N. THIERGARTII, AND *N. AFF. N. TERMINALIS*

PLATE 9

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-5. Cf. *Pecakipollis* sp.
Sample D3413, slide 1, coordinates 90.7×10.1 , diameter 23μ .
1-2. 4-5. Different focal levels.
3. \times 2,000.
- 6-14. *Plicapollis usitatus*, n. sp.
6-8. Holotype, sample D3260, slide 2, coordinates 89.8×10.3 , diameter 20μ .
8. Same \times 2,000.
9-10. Paratype, sample D3260, slide 1, coordinates 110.8×17.7 , diameter 19μ . Note torn lower left aperture. Although exogerminals are clearly pores, this tear provides the appearance of a vertical slit shaped aperture.
11-12. Sample D3413, slide 1, coordinates 111.2×11.4 , diameter 19.5μ .
13-14. Sample D3260, slide 3, coordinates 92.7×18.0 , diameter 20μ .
- 15-24. *Plicapollis retusus*, n. sp.
15-19. Holotype, sample D3412, slide 3, coordinates 112.5×2.4 , diameter 26μ .
17. Holotype \times 2,000.
20-21. Sample D3413, slide 1, coordinates 82.4×17.7 , diameter 20μ .
22-24. Paratype, sample D3412, slide 4, coordinates 106.0×19.9 , diameter 23μ .
23. Paratype \times 2,000.

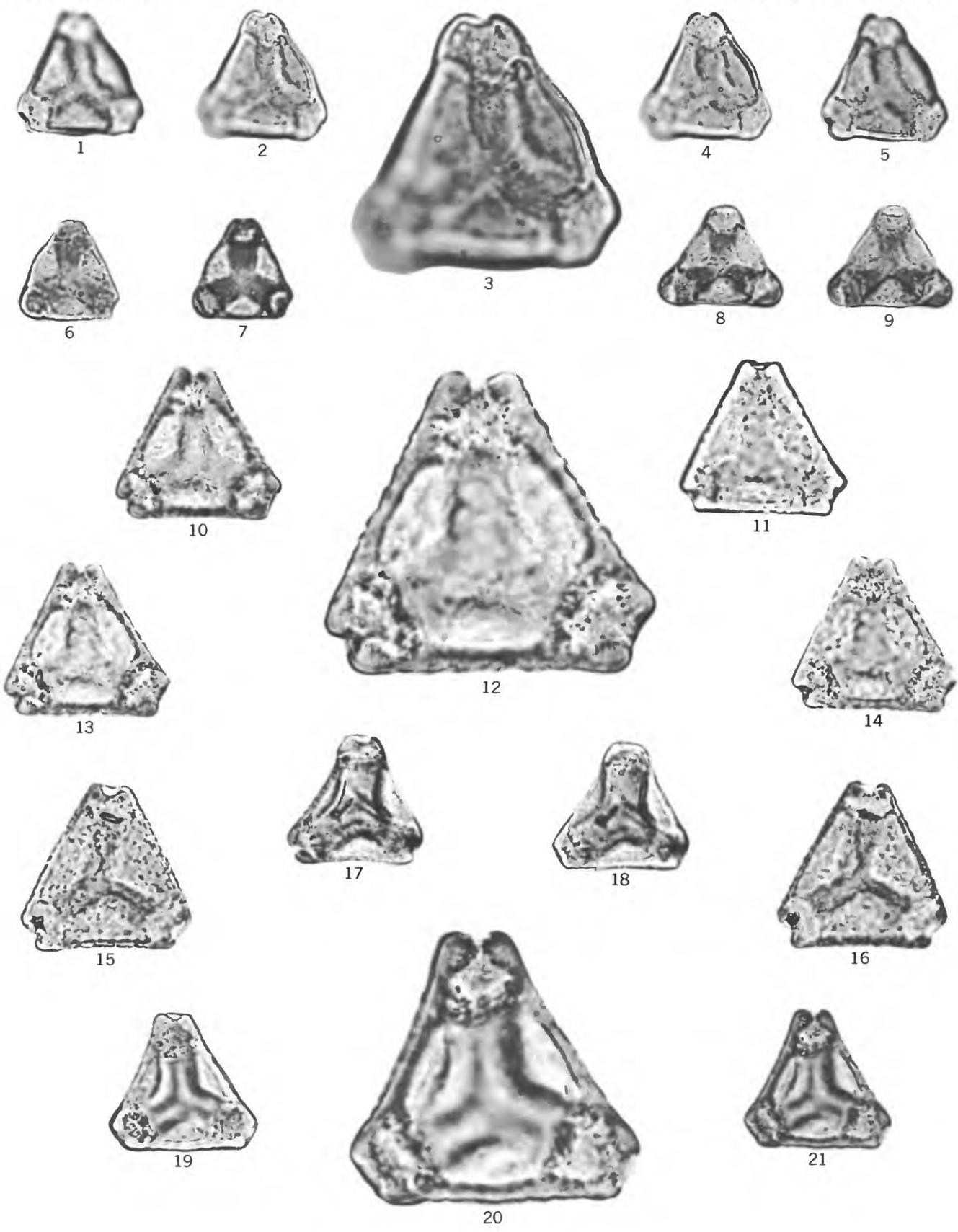


CF. *PECAKIPOLLIS* SP., *PLICAPOLLIS* *USITATUS*, AND *PLICAPOLLIS* *RETUSUS*

PLATE 10

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-9. *Plicapollis vacuus*, n. sp.
- 1-5. Holotype, sample D3412, slide 4, coordinates 87.0 \times 3.1, diameter 21 μ .
 - 3. Holotype \times 2,000.
 - 6-7. Paratype, sample D3412, slide 1, coordinates 78.9 \times 17.7, diameter 18 μ .
 - 8-9. Sample D3416, slide 1, coordinates 108.9 \times 6.9, diameter 17 μ .
- 10-21. *Plicapollis rusticus*, n. sp.
- 10-14. Holotype, sample D3412, slide 4, coordinates 110.9 \times 9.4, diameter 28 μ .
 - 12. Holotype \times 2,000.
 - 15-16. Paratype, sample D3412, slide 1, coordinates 108.0 \times 11.8, diameter 29 μ .
 - 17-18. Sample D3412, slide 3, coordinates 112.0 \times 5.7, diameter 23 μ .
 - 19-21. Sample D3412, slide 3, coordinates 111.7 \times 2.5, diameter 25 μ .
 - 20. Same \times 2,000.

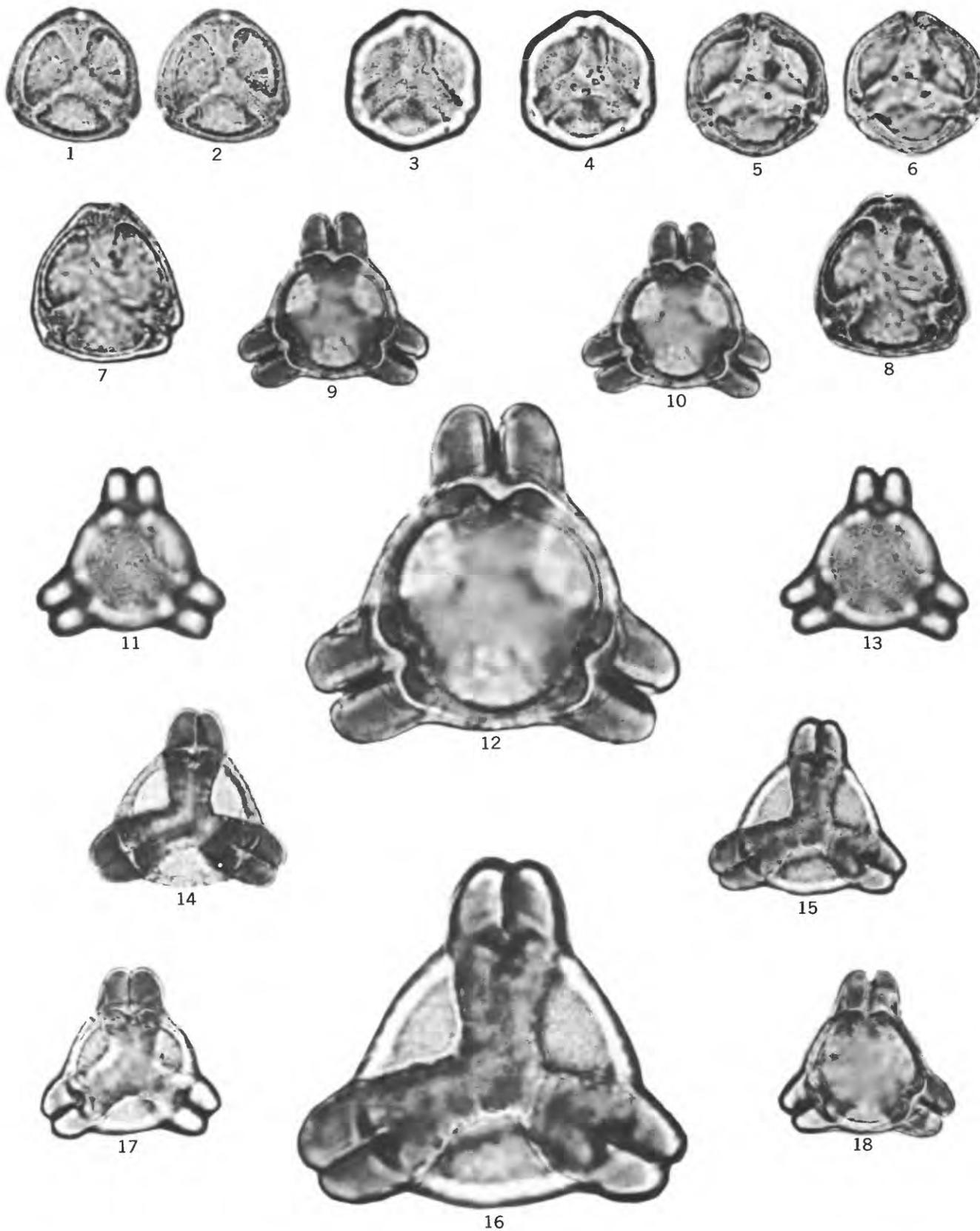


PLICAPOLLIS VACUUS AND *P. RUSTICUS*

PLATE 11

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-8. *Pompeckjoidaepollenites* aff. *P. subhercynicus*
- 1-2. Sample D1848, slide 3, coordinates 82.6 \times 18.4, diameter 24 μ . Note pore and shifted platea.
 - 3-6. Sample D1848, slide 2, coordinates 90.6 \times 2.1, diameter 23 μ . Interloculum visible on figures 5 and 6.
 - 7-8. Sample D1848, slide 2, coordinates 93.9 \times 7.2, diameter 26 μ .
- 9-18. *Pseudoculopollis admirabilis*, n. sp.
- 9-13. Holotype, sample D3420, slide 5, coordinates 81.5 \times 9.8, diameter 31 μ . Extension of ocular swellings over one pole are on the obverse side of this specimen. Surface ornamentation shown on figures 11, 13.
 - 12. Holotype \times 2,000.
 - 14-16. Paratype, sample D3420, slide 1, coordinates 102.3 \times 14.4, diameter 29 μ . Extensions of ocular swelling over pole present on upper surface of this specimen.
 - 17. Sample D3420, slide 1, coordinates 83.0 \times 3.7, diameter 27 μ .
 - 18. Sample D3420, slide 4, coordinates 89.3 \times 16.0, diameter 30 μ . Extensions of ocular swellings present on obverse side of this specimen.



POMPECKJOIDAEPOLLENITES AFF. *P. SUBHERCYNICUS* AND *PSEUDOCULOPOLLIS ADMIRABILIS*

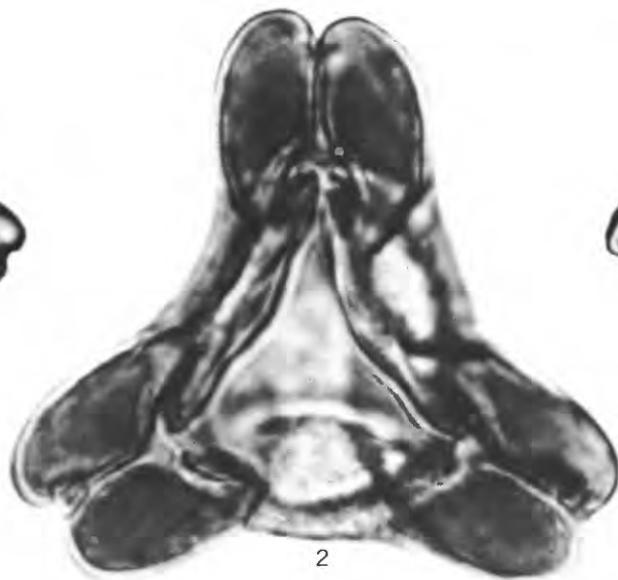
PLATE 12

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-6. *Pseudoculopollis* sp. A
Sample D3002, slide 3, coordinates 82.6 \times 2.8, diameter 36 μ .
2. Same \times 2,000.
- 7-13. *Semioculopollis* sp. A
7-9. Sample D3260, slide 2, coordinates 108.0 \times 4.4, diameter 25 μ .
8. Same \times 2,000.
- 10-13. Sample D3420, slide 5, coordinates 82.8 \times 11.0, diameter 23 μ .



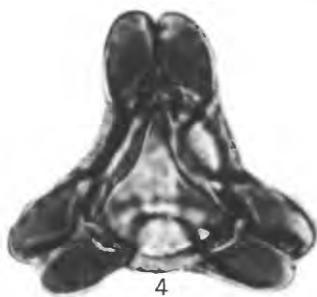
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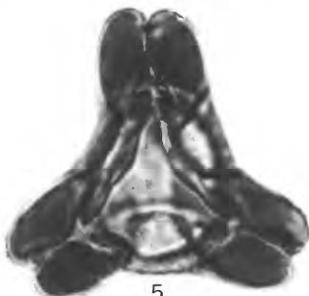
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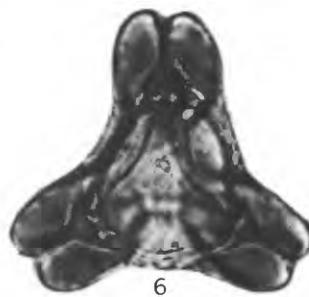
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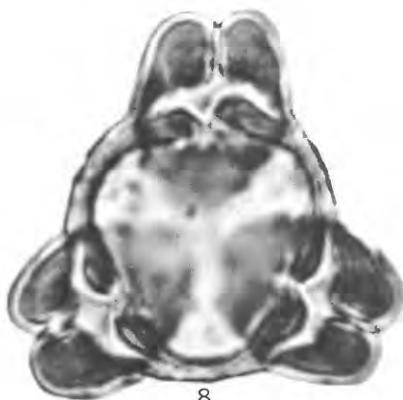
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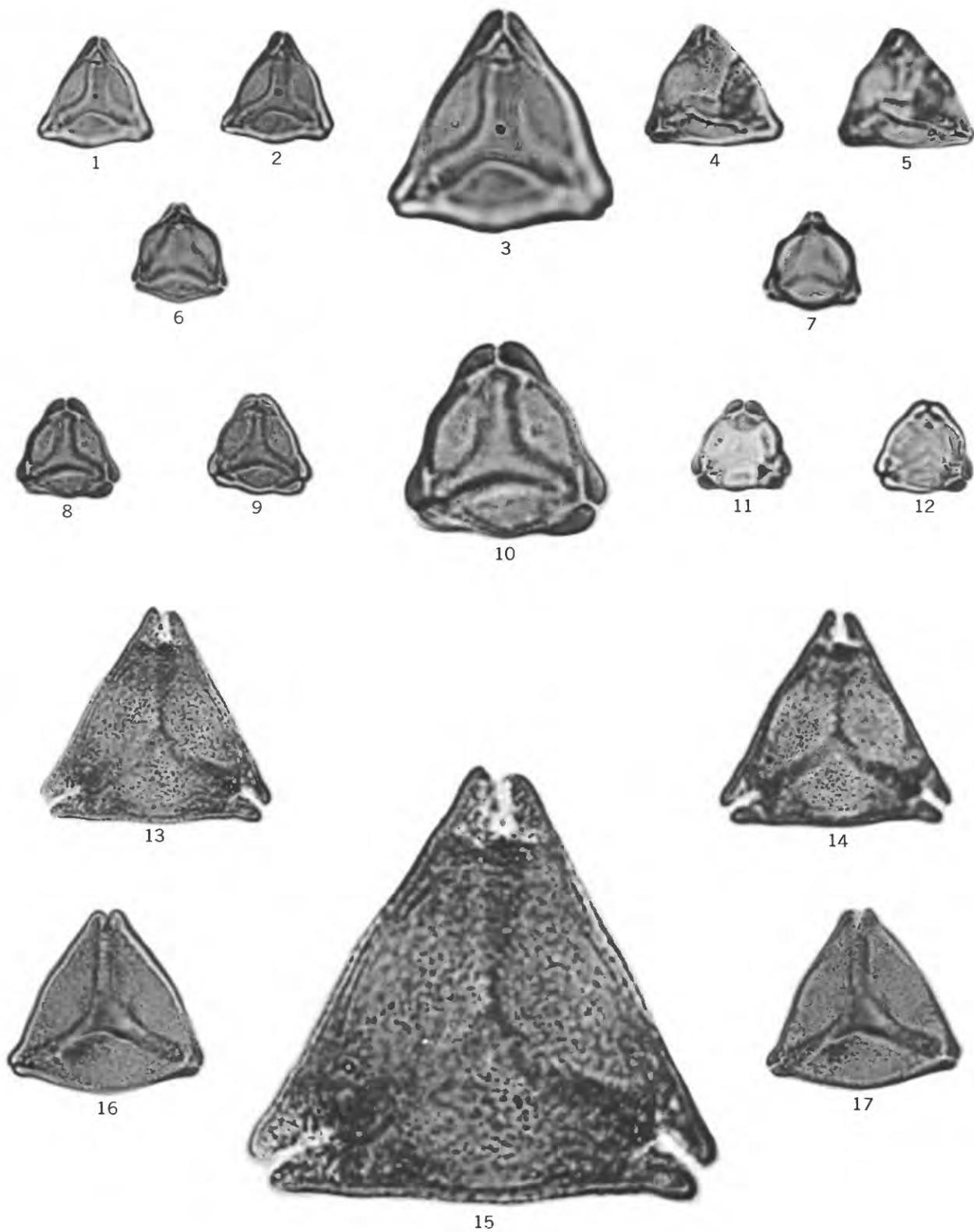


13

PLATE 13

[Magnification $\times 1,000$ unless otherwise indicated]

- FIGURES 1-7. *Pseudoplicapollis endocuspis*, n. sp.
1-3. Holotype, sample D3265, slide 1, coordinates 101.2 \times 6.7, diameter 18 μ .
3. Holotype $\times 2,000$.
4-5. Paratype, sample D3265, slide 3, coordinates 107.5 \times 9.2, diameter 22 μ .
6-7. Sample D3412, slide 1, coordinates 104.1 \times 17.3, diameter 16 μ .
- 8-12. *Pseudoplicapollis serenus*, n. sp.
8-10. Holotype, sample D3412, slide 2, coordinates 84.7 \times 13.0, diameter 16 μ .
10. Holotype $\times 2,000$.
11-12. Paratype, sample D3412, slide 4, coordinates 87.7 \times 6.5, diameter 16 μ .
- 13-17. *Pseudoplicapollis* sp. A
13-15. Sample D3222, slide 1, coordinates 101.0 \times 15.7, diameter 34 μ .
15. Same $\times 2,000$.
16-17. Sample D1854, slide 3, preparation 2, coordinates 96.1 \times 8.1, diameter 31 μ .

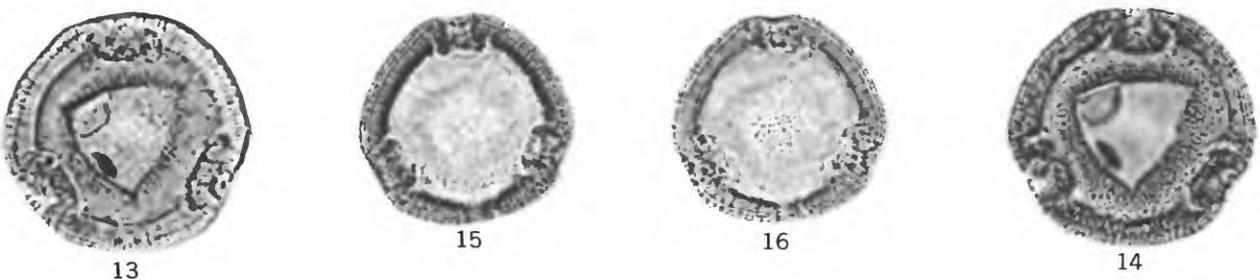
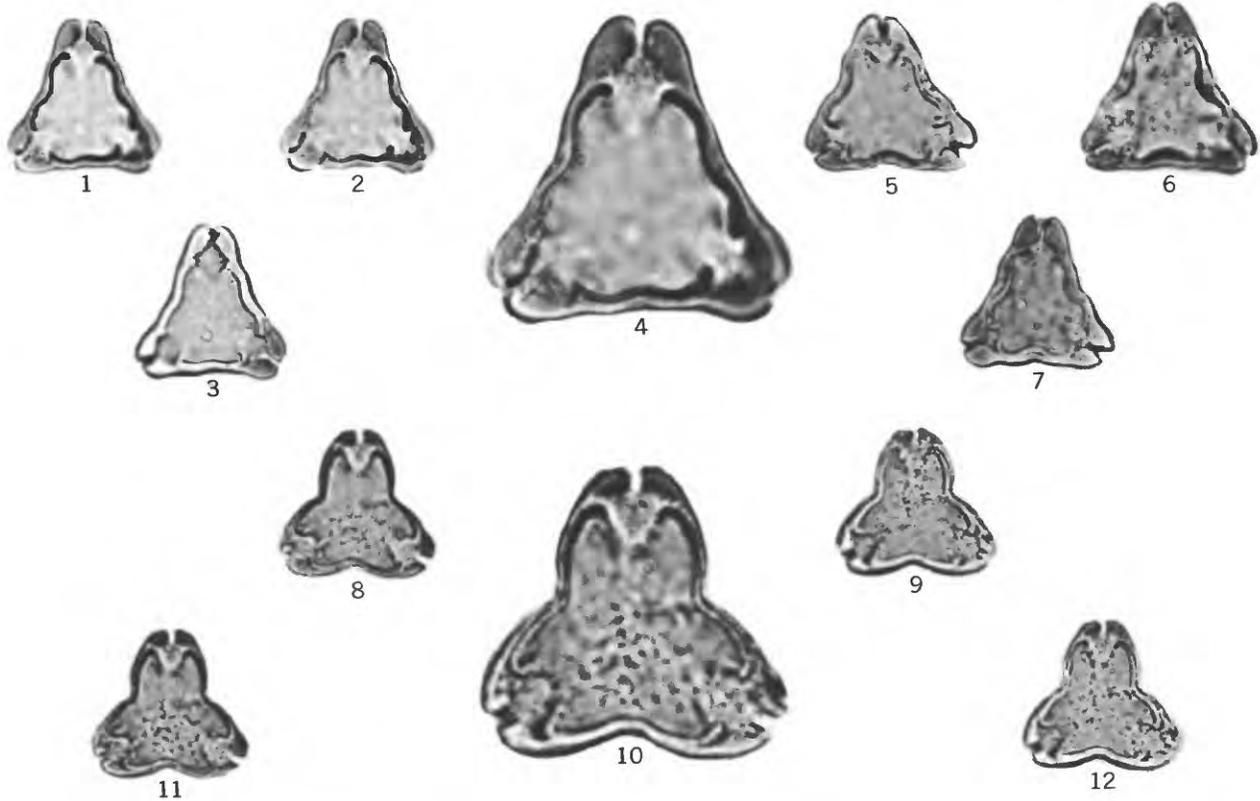


PSEUDOPlicapollis endocuspis, *P. serenus*, and *P. sp. A*

PLATE 14

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-12. *Pseudovacuopollis involutus*, n. sp.
- 1-4. Holotype, sample D3416, slide 2, coordinates 92.9×6.4 , diameter 21μ .
 4. Holotype \times 2,000.
 5. Sample D4268-A, slide 1, coordinates 104.0×2.4 , diameter 20μ .
 6. Sample D1967-C, slide 1, coordinates 103.7×5.0 , diameter 21μ .
 7. Sample D4268-A, slide 2, coordinates 74.8×10.3 , diameter 20μ .
 - 8-12. Paratype, sample D3416, slide 2, coordinates 104.7×10.7 , diameter 18μ . The granulate appearance is due to granulation of endexine, ectexine is psilate.
 10. Paratype \times 2,000.
- FIGURES 13-20. *Thomsonipollis magnificus* Krutzsch
- 13-14. Sample D1855, slide 3, preparation 2, coordinates 109.9×5.3 , diameter 31μ .
 - 15-16. Sample D1855, slide 6, preparation 2, coordinates 108.5×18.6 , diameter 26μ .
 - 17-20. Sample D1851, slide 3, coordinates 92.4×18.5 , diameter 26μ . Specimen with somewhat thinner endexine somewhat intermediate between *Thomsonipollis magnificus* and *T. magnificoides*.

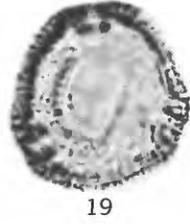
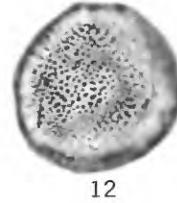
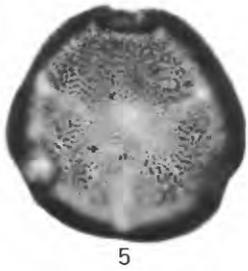


PSEUDOVACUOPOLLIS INVOLUTUS AND *THOMSONIPOLLIS MAGNIFICUS*

PLATE 15

[Magnification $\times 1,000$ unless otherwise indicated]

- FIGURES 1-8. *Thomsonipollis magnificoides*
- 1-2. Sample D1854, slide 3, preparation 2, coordinates 81.5×19.5 , diameter 31μ .
 - 3-4. Sample D1849, slide 1, coordinates 114.7×14.1 , diameter 28μ .
 - 5-6. Sample D1849, slide 3, coordinates 105.8×18.0 , diameter 31μ .
 - 7-8. Sample D1851, slide 3, coordinates 104.8×6.7 , diameter 29μ .
- 9-20. *Thomsonipollis* aff. *T. magnificoides*
- 9-12. Sample D3548-A, slide 2, coordinates 77.6×17.8 , diameter 21μ .
 - 13-14. Sample D3548-A, slide 2, coordinates 104.5×17.3 , diameter 23μ .
 - 15-16. Sample D3548-A, slide 1, coordinates 88.7×19.1 , diameter 27μ .
 - 17-20. Sample D3548-A, slide 2, coordinates 75.1×17.5 , diameter 23μ .

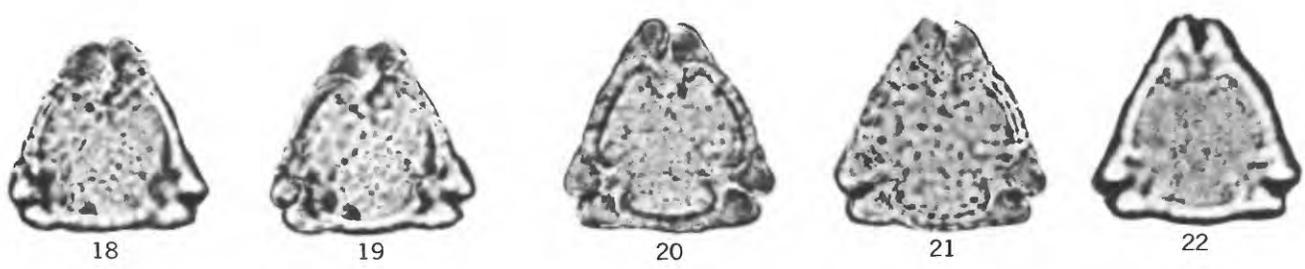
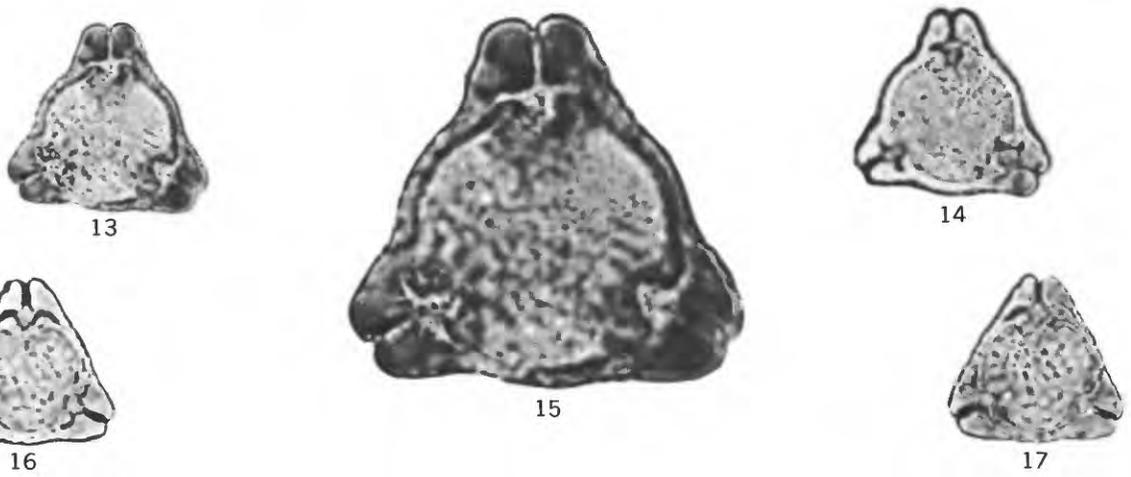
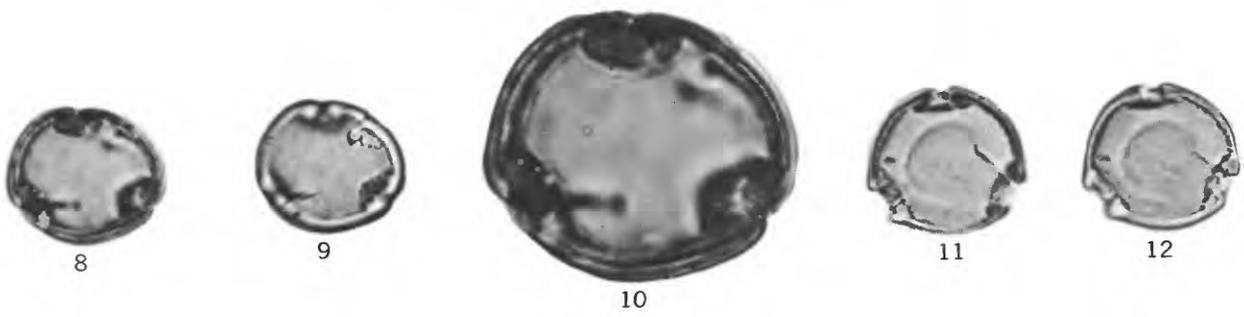
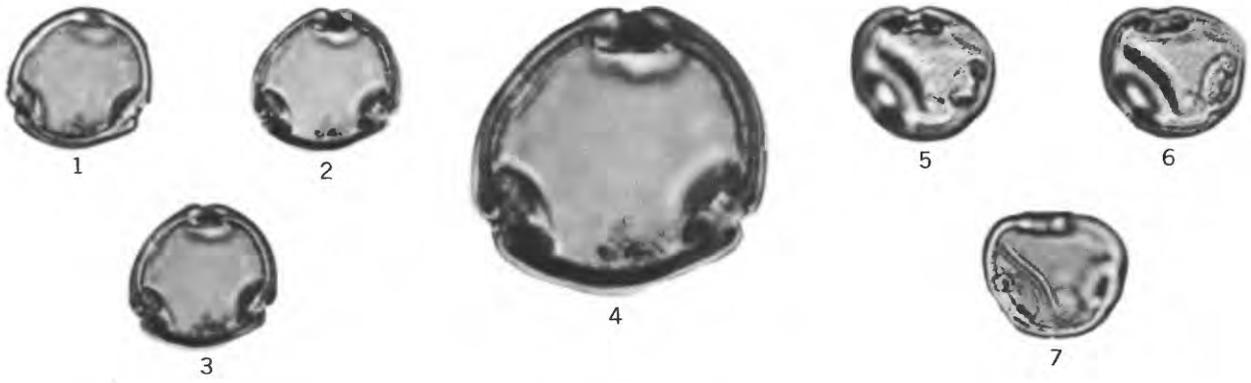


THOMSONIPOLLIS MAGNIFICOIDES AND *T. AFF. T. MAGNIFICOIDES*

PLATE 16

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-12. *Thomsonipollis expolitus*, n. sp.
- 1-4. Holotype, sample D3410-C, slide 4, coordinates 74.5 \times 11.5, diameter 18 μ .
 - 4. Holotype \times 2,000.
 - 5-7. Sample D3410-C, slide 2, coordinates 107.4 \times 21.0, diameter 18 μ .
 - 8-10. Paratype, sample D3410-C, slide 1, coordinates 104.6 \times 21.4, diameter 20 μ .
 - 10. Paratype \times 2,000,
 - 11-12. Sample D3410-C, slide 4, coordinates 74.5 \times 4.5, diameter 20 μ .
- 13-22. *Trudopollis variabilis*, n. sp.
- 13-15. Holotype, sample D3412, slide 2, coordinates 109.7 \times 14.1, diameter 26 μ .
 - 15. Holotype \times 2,000.
 - 16-17. Sample D3412, slide 4, coordinates 107.8 \times 11.6, diameter 22 μ .
 - 18-19. Paratype, sample D3412, slide 2, coordinates 99.5 \times 14.8, diameter 24.5 μ .
 - 20-22. Sample D3260, slide 6, coordinates 113.9 \times 6.1, diameter 28 μ .

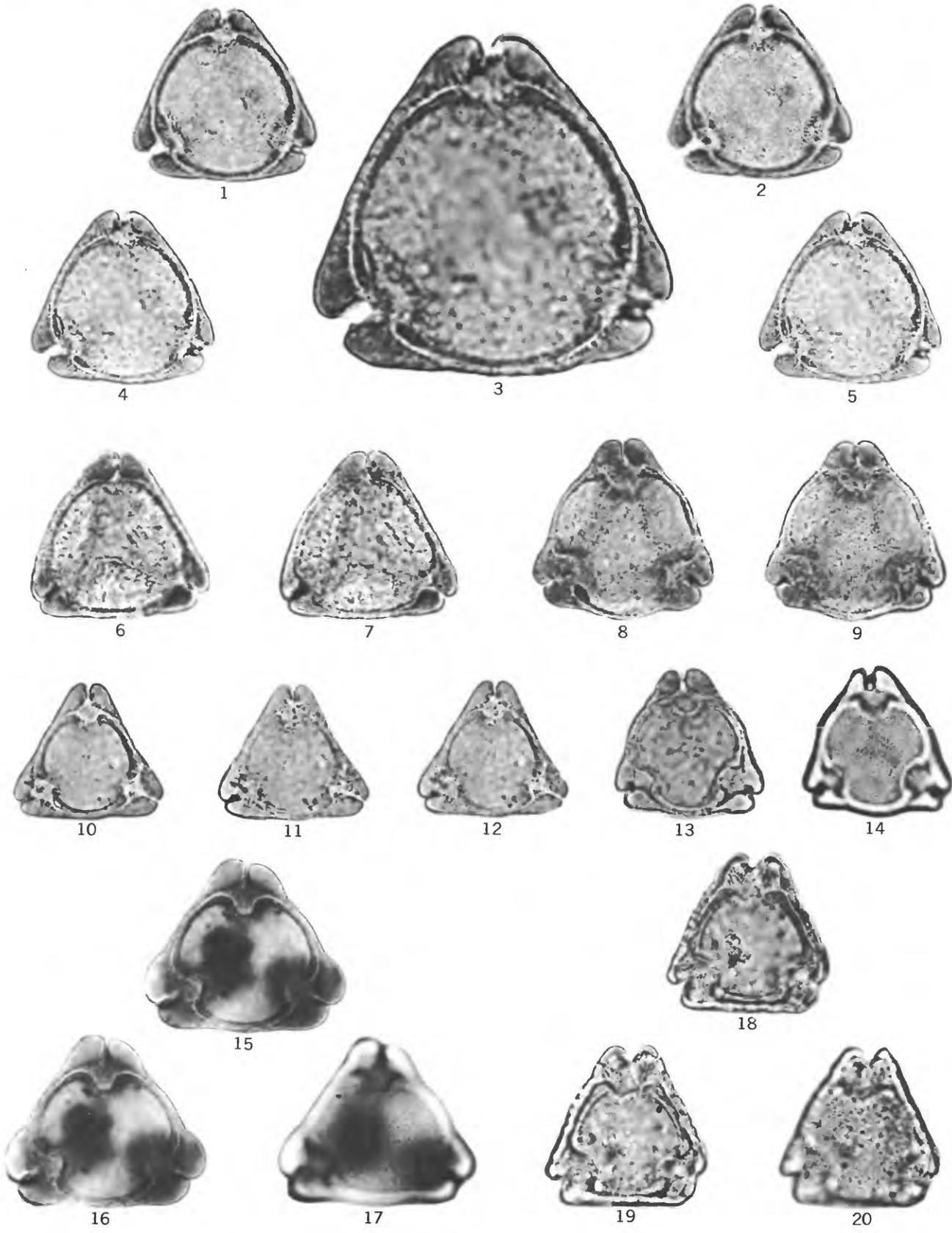


THOMSONIPOLLIS EXPOLITUS AND *TRUDOPOLLIS VARIABILIS*

PLATE 17

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-9. *Trudopollis plenus*, n. sp.
- 1-5. Holotype, sample D3138, slide 4, coordinates 113.6 \times 10.0, diameter 29 μ .
 - 3. Holotype \times 2,000. Interloculum shows particularly well.
 - 6-7. Paratype, sample D3138, slide 1, coordinates 91.3 \times 16.7, diameter 29 μ .
Faint arci present.
 - 8-9. Sample D3138, slide 3, coordinates 111.8 \times 7.1, diameter 30 μ . Annuli on this specimen larger and slightly protruding.
- 10-12. *Trudopollis* sp. A
Sample D3412, slide 1, coordinates 111.5 \times 5.7, diameter 23 μ .
- 13-14. *Trudopollis* sp. B
Sample D1849, slide 2, coordinates 89.3 \times 21.5, diameter 26 μ .
- 15-17. *Trudopollis* sp. C
Sample D1846, slide 2, coordinates 106.5 \times 7.9, diameter 31 μ .
- 18-20. *Trudopollis* cf. *T. artifex* Wey. and Krg., 1953
Sample D3413, slide 3, coordinates 105.6 \times 6.6, diameter 28 μ .

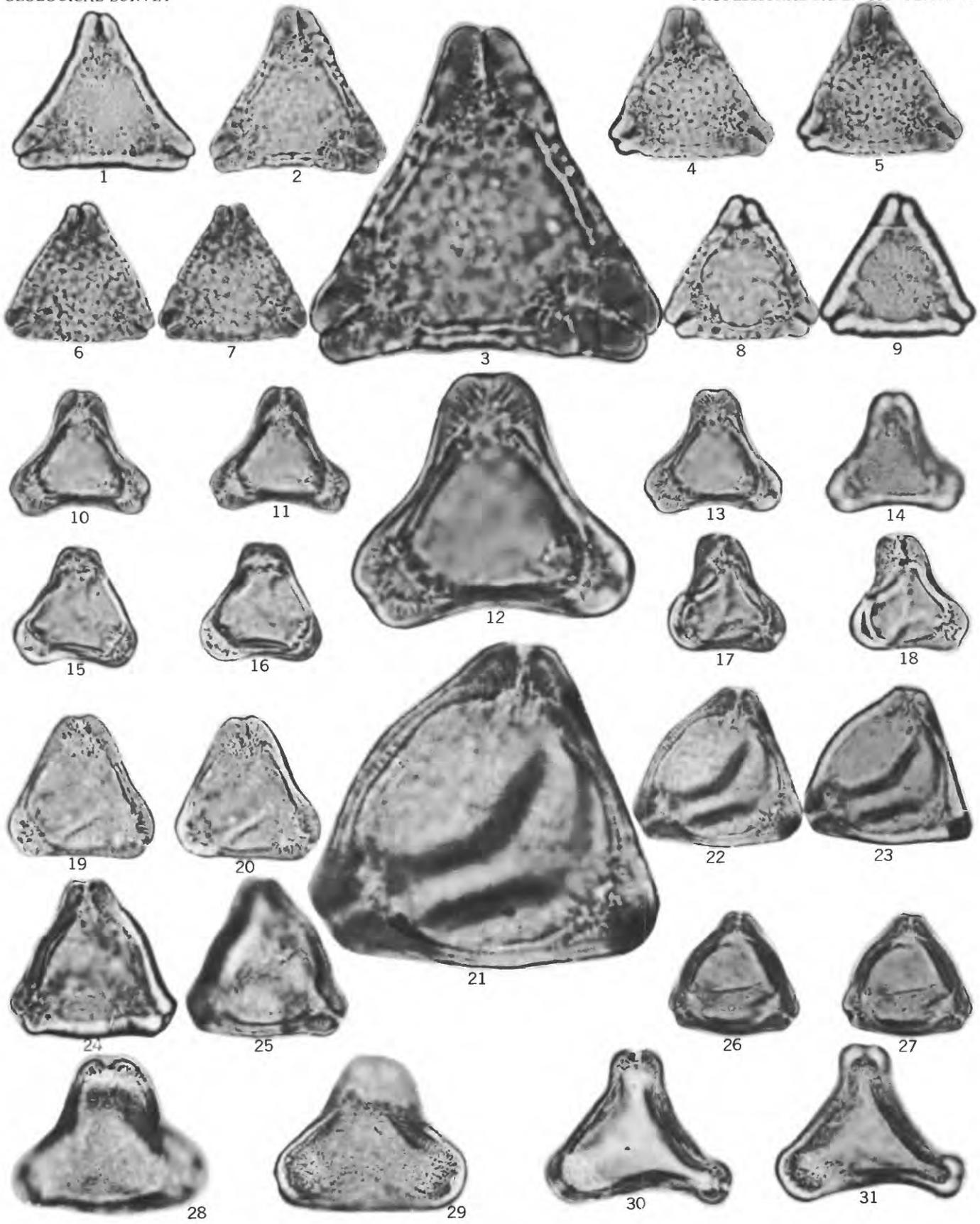


TRUDOPOLLIS PLENUS, T. CF. *T. ARTIFEX*, AND *T. SP. A, B, AND C*

PLATE 18

[Magnification $\times 1,000$ unless otherwise indicated]

- FIGURES 1-9. *Vacuopollis munitus*, n. sp.
- 1-3. Holotype, sample D3416, slide 1, coordinates 74.1 \times 11.8, diameter 28 μ .
 - 3. Holotype $\times 2,000$.
 - 4-5. Paratype, sample D3416, slide 1, coordinates 82.7 \times 18.7, diameter 26 μ .
 - 6-7. Sample D3416, slide 2, coordinates 82.3 \times 5.3, diameter 26 μ .
 - 8-9. Sample D1967-B, slide 1, coordinates 97.8 \times 6.7, diameter 26 μ . This specimen displays a somewhat thicker ektexine.
- 10-20. *Osculapollis aequalis*, n. gen., n. sp.
- 10-14. Holotype, sample D3412, slide 4, coordinates 102.6 \times 3.2, diameter 23 μ .
 - 12. Holotype $\times 2,000$.
 - 15-16. Paratype, sample D3412, slide 3, coordinates 98.5 \times 2.5, diameter 21 μ .
 - 17-18. Sample D3260, slide 5, coordinates 108.8 \times 3.5, diameter 21.5 μ .
 - 19-20. Sample D3412, slide 3, coordinates 100.9 \times 21.7, diameter 25 μ .
- 21-27. *Osculapollis perspectus*, n. sp.
- 21-23. Holotype, sample D3412, slide 3, coordinates 104.1 \times 16.3, diameter 29 μ .
 - 21. Holotype $\times 2,000$.
 - 24-25. Paratype, sample D3412, slide 3, coordinates 105.7 \times 13.7, diameter 28 μ .
 - 26-27. Sample D3412, slide 3, coordinates 95.0 \times 12.9, diameter 23 μ .
- 28-31. *Osculapollis* sp. A
- 28-29. Sample D1862, slide 3, preparation 2, coordinates 97.0 \times 10.0, diameter 34 μ .
 - 30-31. Sample D1862, slide 3, preparation 2, coordinates 93.4 \times 17.3, diameter 29 μ .

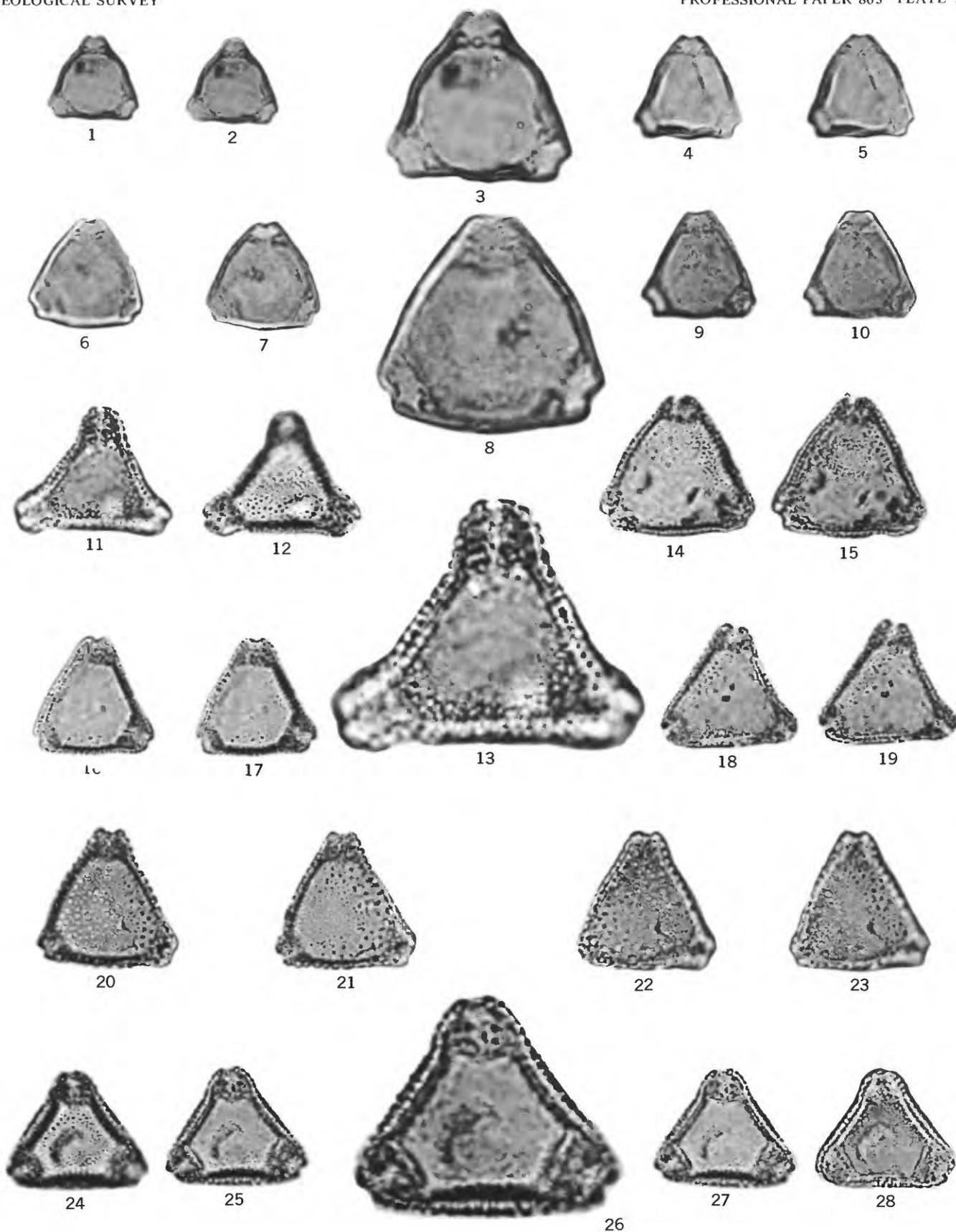


VACUOPOLLIS MUNITUS, *OSCU LAPOLLIS AEQUALIS*, *O. PERSPECTUS*, AND *O. SP. A*

PLATE 19

[Magnification \times 1,000 unless otherwise indicated]

- FIGURES 1-10. *Praecursipollis plebius*, n. gen. n. sp.
- 1-3. Holotype, sample D3265, slide 3, coordinates 87.0×5.5 , diameter 16μ .
 - 3. Holotype \times 2,000.
 - 4-5. Sample D3265, slide 1, coordinates 102.3×5.4 , diameter 19μ .
 - 6-8. Paratype, sample D3265, slide 4, coordinates 78.4×7.1 , diameter 20μ .
 - 8. Paratype \times 2,000.
 - 9-10. Sample D3265, slide 1, coordinates 114.4×18.1 , diameter 19.5μ .
- 11-28. *Pseudatlantopollis simulatus*, n. gen., n. sp.
- 11-13. Holotype, sample D1967-B, slide 10, coordinates 100.0×18.9 , diameter 23μ .
 - 13. Holotype \times 2,000.
 - 14-15. Sample D1967-B, slide 8, coordinates 86.6×10.0 , diameter 26μ .
 - 16-17. Sample D1967-A, preparation 2, slide 6, coordinates 106.2×7.2 , diameter 21μ .
 - 18-19. Sample D1967-B, slide 5, coordinates 88.4×4.4 , diameter 23μ .
 - 20-23. Paratype, sample D1967-B, slide 9, coordinates 111.9×18.9 , diameter 25μ . The nature of the reticulum shows well on this specimen.
 - 24-28. Sample D3260, slide 8, coordinates 112.8×3.4 , diameter 21μ .
 - 26. Same \times 2,000.

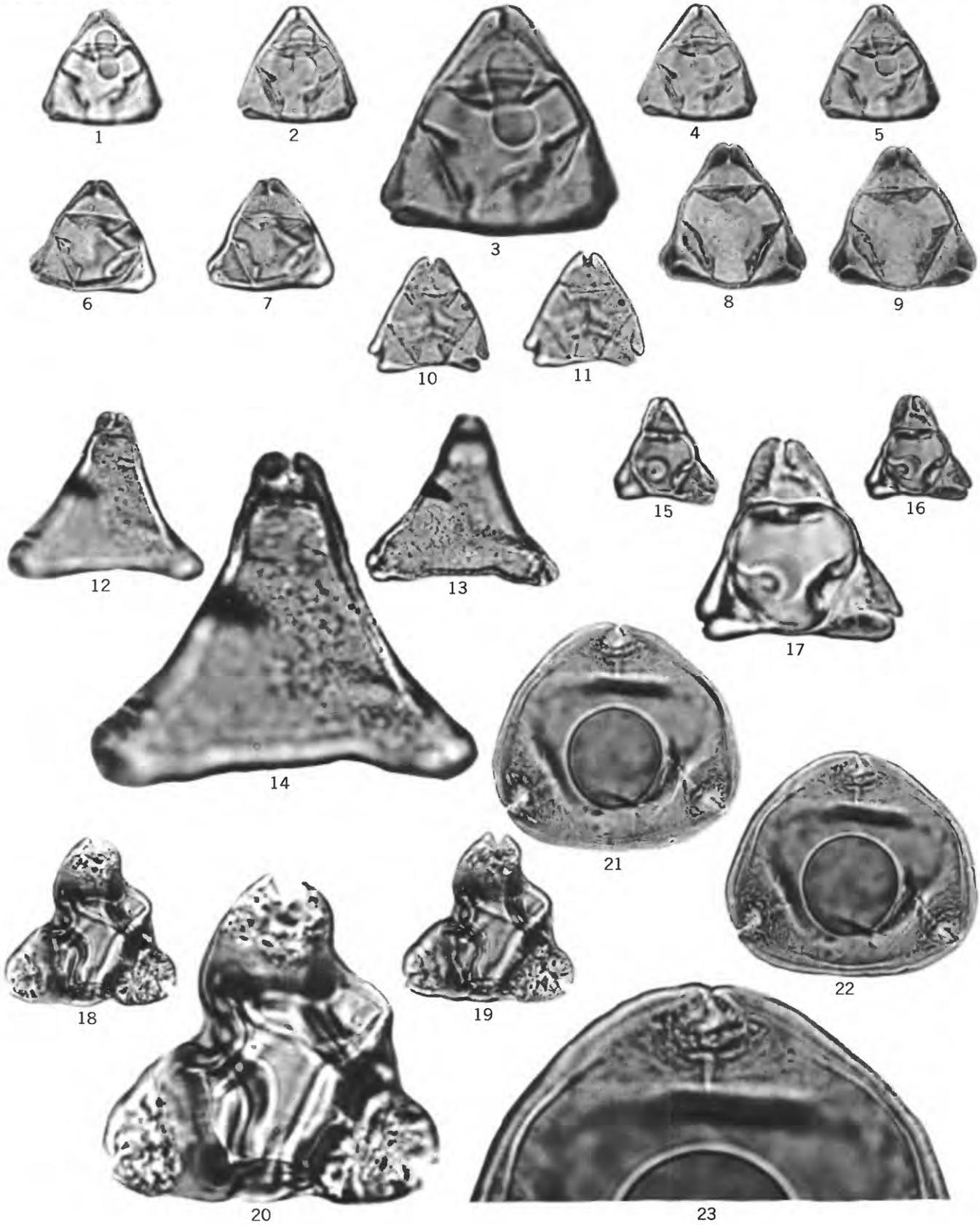


PRAECURSIPOLLIS PLEBIUS AND *PSEUDATLANTOPOLLIS SIMULATUS*

PLATE 20

[Magnification $\times 1,000$ unless otherwise indicated]

- FIGURES 1-11. *Endoinfundibulapollis distinctus*, n. gen., n. sp.
- 1-5. Holotype, sample D4268-B, slide 1, coordinates 78.5×21.9 , diameter 20μ .
 - 3. Holotype $\times 2,000$.
 - 6-7. Paratype, sample D4268-B, slide 2, coordinates 79.2×15.1 , diameter 21μ .
 - 8-9. Sample D3412, slide 4, coordinates 87.7×18 , diameter 20μ .
 - 10-11. Sample D4268-A, slide 1, coordinates 103.0×1.6 , diameter 25μ .
- 12-14. New Genus A.
- 12-13. Sample D3265, slide 3, coordinates 81.9×2.1 , diameter 31μ .
 - 14. Same $\times 2,000$.
- 15-17. New Genus B.
- 15-16. Sample D3412, slide 1, coordinates 90.9×13.6 , diameter 18.5μ .
 - 17. Same $\times 2,000$.
- 18-20. New Genus C.
- 18-19. Sample D3410-C, slide 2, coordinates 102.3×19.3 , diameter 28μ .
 - 20. Same $\times 2,000$.
- 21-23. New Genus D.
- 21-22. Sample D3410-B, slide 2, coordinates 101.1×19.0 , diameter 44μ .
 - 23. Same $\times 2,000$, one aperture only.



ENDOINFUNDIBULAPOLLIS DISTINCTUS AND NEW GENERA A, B, C, AND D