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PALYNOLOGY OF A PORTION OF THE EL RENO GROUP (PERMIAN)

SOUTHWEST OKLAHOMA

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PALYNOLOGY OF A PORTION OF THE EL RENO GROUP (PERMIAN) SOUTHWEST OKLAHOMA

INTRODUCTION

A detailed palynologic investigation of the El Reno Group of southwestern Oklahoma was conducted with the following objectives: (1) to identify, describe and illustrate the acid-insoluble microfossils from the shale, claystone and siltstone facies; (2) to compare the palynological assemblages laterally and vertically within the El Reno Group; (3) to investigate the use of palynomorphs as a tool for local and regional correlation within the redbed sequence of southwestern Oklahoma.

The Permian redbed sequence in western Oklahoma generally has been considered non-fossiliferous except for certain plant megafossils and vertebrate remains (Dunbar, 1960). The geologist has had to rely upon sparse fossils and gross lithologic trends where mapping the redbed units. Fossil spores and pollen were first described from the Flowerpot Formation in the El Reno Group of Greer County by Wilson (1962a); these provided a datable assemblage of Permian age from within these redbed units in Oklahoma. The investigation by Wilson was of invaluable assistance and furnished the background for this further study of the Flowerpot Shale and the overlying Blaine and Dog Creek Formations.

An intensive investigation of cores in the El Reno Group from three widely spaced localities in Blaine, Harmon and Greer counties disclosed large, diverse and well-preserved palynomorph assemblages in the Flowerpot, Blaine and Dog Creek Formations. Fourteen assemblages were recorded of which one (OPC 1072-138) is considered to be stratigraphically equivalent to the assemblage reported from Greer County by Wilson (1962a). The remaining assemblages are considered new and previously undescribed.

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REVIEW OF PERMIAN LITERATURE

The number of investigations of Permian palynomorphs from throughout the world within the last five years has been impressive. Major contributions have been made in Russia (Zauer, 1965), England (Clarke, 1965), India (Bharadwaj, 1962), Austria (Klaus, 1963, 1964), Africa (Hart, 1960, 1966), Canada (Jansonius, 1962) and the United States (Wilson, 1962a). Current emphasis is based on the use of palynology as a means of correlation in Permian stratigraphy which began nearly three decades ago.

The first bisaccate Permian palynomorph to be described was a striate-type of conifer pollen, *Pityosporites sewardii* Virkki, from Australia (Virkki, 1937). Subsequent studies of Australian Permian palynology were published by Dulhunty (1945), De Jersey (1946), Balme (1952, 1959, 1963), Balme and Hennelly (1955, 1956a, 1956b) and Hennelly (1958). Pant (1955) designated *Pityosporites sewardii* Virkki as the type species of a new genus *Striatites*. From this beginning the striate-type pollen became the focal point of many extensive investigations.

Russian palynologic studies were published after Virkki's report (Luber, 1938; Luber and Waltz, 1938, 1941) and following the end of the second world war, numerous investigations of stratigraphic and taxonomic importance appeared (Zoritscheva and Sedova, 1954; Isonova and Nesterenko, 1955; Andreeva, 1956; Sedova, 1956; Naumova, 1959; Zauer, 1960; Samoilovich, 1961). Russian publications first described many of the striate bisaccate pollen and essentially formed the background for subsequent studies. Hart (1964, 1965) reviewed the Russian and other Permian palynologic literature and emended numerous Permian genera. V. V. Zauer (1965) reported a Permian assemblage which contains many species of Vittatina recognized in this study (See Table 1). There are other similarities noted but these are of a generic level and are not used in comparison of the two assemblages.

Palynology has been employed in India to correlate coal seams and has led to publications by Mehta (1944), Ghosh and Sen (1948) and later papers dealing with taxonomy and morphology of pollen and spores by Bharadwaj (1954, 1955b, 1955c, 1962a, 1962b, 1964) and his coworkers (Bharadwaj and Venkatachala, 1957; Bharadwaj and Salujha, 1963; Bharadwaj and Tiwari, 1963, 1964; Sukh Dev, 1961; Lele, 1963; Lele and Maithy, 1965; Tiwari, 1963).

Palynomorphs reported from the Permian of India by Bharadwaj (1962), although quite diverse and well represented by twenty-eight named species, contain only one which was recognized as occurring in El Reno assemblages.

The European portion of the Permian received attention in the publications of Klaus (1953a, b, c; 1955, 1963, 1964), Grebe (1957) and Leschik (1956, 1958, 1959). Their studies of the

Permian are of importance in delineating the spore and pollen assemblages associated with evaporite sequences.

Klaus (1965) investigated the palynomorphs of the German Zechstein section. Forty-nine species were described of which fifteen are conspecific with Oklahoma fossils. The assemblage reported by Klaus resembles closely Permian assemblages of the El Reno Group in Oklahoma.

A small spore flora was studied in England by Butterworth and Williams (1954) and later a comprehensive and detailed study of Upper Permian and Triassic palynology of England was published by Clarke (1965a, b). Contributions to the study of marine Permian palynomorphs have been made by Downie (1958), Wall and Downie (1962), Downie, Evitt and Sarjeant (1963) and Norris and Sarjeant (1965).

Upper Permian and Triassic rocks of the Peace River area in Canada contain assemblages of spores and pollen that have proved useful in dating that sequence of strata (Jansonius, 1962). The Upper Permian Peace River assemblage contains eight species in common with El Reno assemblages.

The first major published palynologic study of the Permian in the United States was by Wilson (1962a) on the Flowerpot Shale from Greer County, Oklahoma. A rich spore and pollen assemblage was reported from a seven-inch-thick bed of gray shale in a redbed sequence. Within the same year, Permian spores and pollen were reported from the Mid-Continent region of the United States by

Jizba (1962), Brush (1962) and Wilson (1962b). Marine palynomorphs have been reported by Wilson (1960) and Tasch (1963). More recent studies have revealed assemblages of spores and pollen in the Wellington Formation of Kansas (Shaffer, 1964) and Oklahoma (Hedlund, 1964).

The microfossils of the Flowerpot investigation by Wilson (1962a) bear the closest palynological resemblance to the El Reno assemblage of all published material. The reported spore and pollen complex from Greer County is equivalent to level OPC 1072-138. The difference in relative percentages (see Table 2) is because all species reported by Wilson were not recognized or encountered.

Hedlund (1964) reported a Lower Permian assemblage from the Wellington Formation which contained five species that are present in the El Reno Group assemblages. A paucity of well-developed striate grains was observed in the assemblage.

Tshudy and Kosanke (1966) described a Lower Permian Wolfcampian assemblage from the subsurface of northwest Texas. Recognized in their assemblage are three species congeneric with members of the El Reno assemblages. Certain species in the Wolfcampian assemblage have been observed in the Wellington Formation of Oklahoma and Kansas such as *Schizaeoisporites microrugosus* and *Costapollenites ellipticus*. These forms are absent from El Reno assemblages.

STRATIGRAPHY

The El Reno Group of Oklahoma comprises, in ascending order, the Flowerpot Shale, Blaine Formation and the Dog Creek Shale and is assigned to the Guadalupean Stage of the Upper Permian (Dunbar, et al, 1960). The areal extent of the El Reno Group is from south-central Kansas, southwestward through Oklahoma into northern Texas. El Reno was first proposed as a formation name by Becker (1930, p. 55) and later given group status by Schweer (1937, p. 1553).

The name "Flower-pot shale" was applied by Cragin (1896, p. 24) to reddish-brown gypsiferous shales below the Medicine Lodge Gypsum and above the sandstones of the Cedar Hills Formation as exposed at Flowerpot Mound, Barber County, Kansas. Norton (1939, p. 1792) redefined the formation as, "the rocks between the dolomite at the base of Medicine Lodge Gypsum and the white sandstone at the top of the Cedar Hills Sandstone." The name was changed to Flowerpot Shale (Swineford, 1955, Moore and others, 1959, p. 39). The Flowerpot Shale ranges in thickness in Oklahoma from 450 feet in Blaine County to 180 feet in Harmon and Greer Counties (Fay, 1964).

The Blaine Formation with its numerous gypsum beds and interbedded shales was first defined by Gould (Gould, 1905) from the previously named "Blaine division" (Gould, 1902, p. 47).

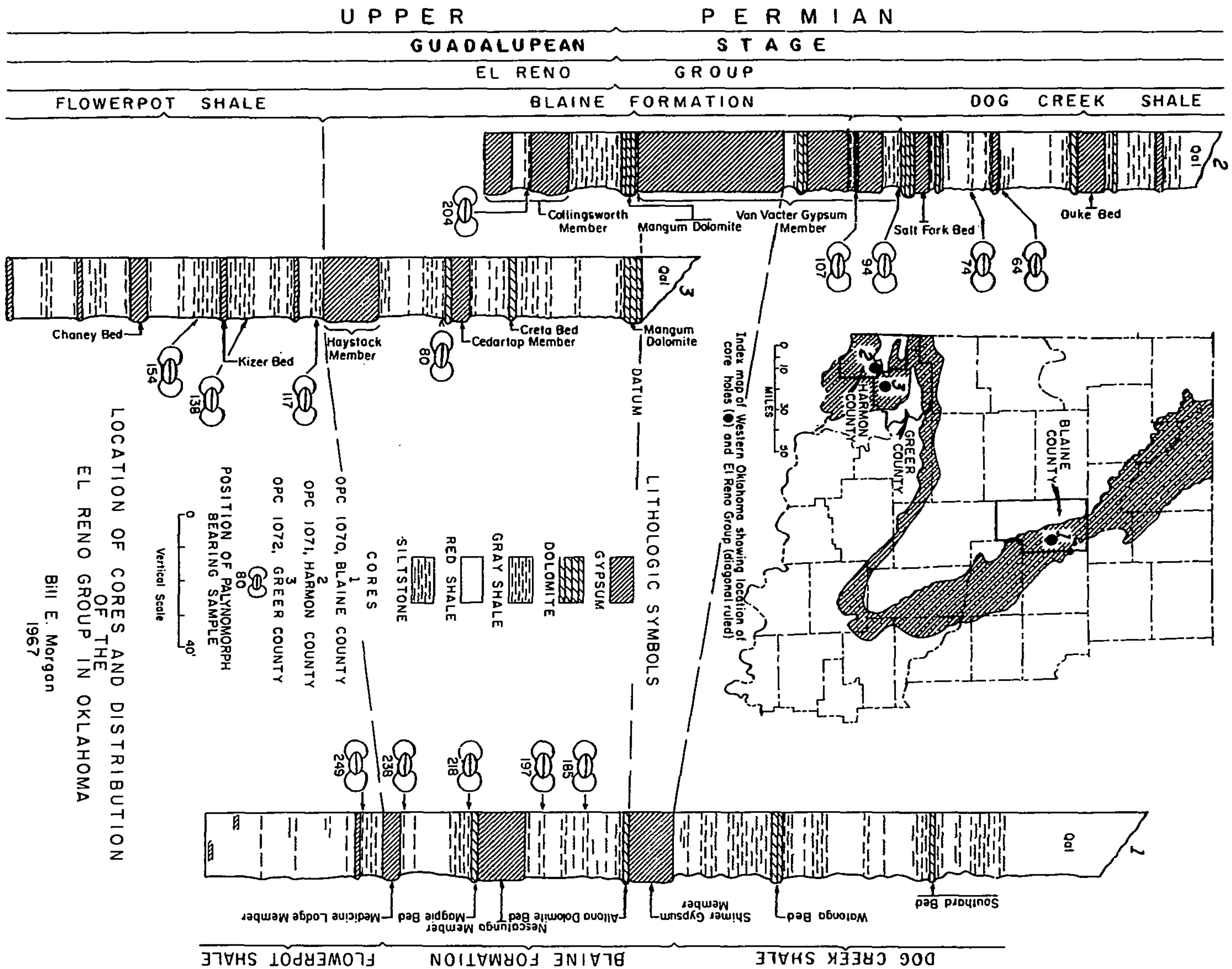
The gypsum units of the Blaine Formation in Blaine County in ascending order are the Medicine Lodge, Nescatunga and the Shimer Members. The Altona dolomite bed is at the base of the Shimer Gypsum. In Harmon and Greer Counties the gypsum units are the Haystack, Cedartop, Collingsworth (Creta of Greer County) and the Van Vacter Members. The Mangum Dolomite Member underlies the Van Vacter Gypsum. The formation ranges in thickness from 85 feet in Blaine County to 185 feet in Harmon and Greer Counties in southwestern Oklahoma. The additional thickness in this area is due, apparently, to the increased deposition of gypsum above the Mangum Dolomite.

The Dog Creek Shale was named by Cragin (1896, p. 39-40) for a sequence of shales, thin dolomites and siltstones between the top of the Blaine Formation and the bottom of the overlying Marlow Formation. The Altona Dolomite or the Shimer Gypsum marks the upper limits of the Blaine Formation in Blaine County whereas the Van Vacter Member forms the top in Harmon and Greer Counties. The Dog Creek Shale conformably overlies these units. The thickness of the Dog Creek Shale ranges from 30 feet in Kansas to 195 feet in Blaine County (Fay, 1964) and to 80 feet in Beckham County, Oklahoma (Scott, 1957).

In the southern part of Blaine County a deltaic sandstone facies replaces the Flowerpot and Blaine Formations. This includes the Chickasha Formation and the underlying Duncan Sandstone. According to Fay (1964, p. 27),

> "The central basin area extends from northern Blaine County to northern Grady County, Oklahoma, the area of change into the deltaic facies being in central Blaine County for the middle part of the Flowerpot Shale, in southern Blaine and northern Canadian Counties for the upper portions of this formation, and in central Canadian County for the uppermost part. Dolomite Unit G and the siltstone Units C and E of the northern platform are absent in the central basin facies where they grade into reddish-brown gypsiferous clay shale. The only recognizable beds in the basin facies are Units K, J, I and basal B. All units are thicker in the basin than on the northern platform and therefore it is probable that the bottom of the sea was subsiding in the basin and that more sediment was being received in this area. As will be discussed later, the same is true of the southern delta facies farther south. This entire facies, several hundred feet thicker in northern Grady County than in southern Grady County adjacent Stephens County, Oklahoma, indicates that a marginal shelf was present not far away and that the source area was nearby, probably in the Ouachita and Arbuckle Mountains region.
>
> The southern delta area received deposits of fine silt and mud that were locally hardened and covered by water again after exposure to the air. A general increase in the amount of sand southward and southeastward indicates that this entire complex of sediments probably was derived by erosion of the Arbuckle Mountains area. That the siltstones in the upper part of the Flowerpot Shale on the northern platform are unrelated to those of the southern delta area clearly indicates at least two separate source areas for these sediments. Most of the clay and iron minerals may have been derived from the Ouachita Mountains, but some, no doubt, came from the Ozark dome. The evaporites and units of the central basin facies are absent in the deltaic facies, where influx of fresh water would have lowered the salinity."

The sandstone facies of the El Reno Group is not represented in the three cores that were investigated. Figure 1 shows generalized lithologic columns and the position of spore and pollen bearing samples. Stratigraphic terminology used for Harmon and Greer County cores is taken from Scott and Ham (1957) whereas the Blaine County terminology is taken from Fay (1962). Datum level for Figure 1 is the Mangum Dolomite of Greer and Harmon Counties and the Altona Dolomite of Blaine County.



LOCATION OF CORES AND DISTRIBUTION OF THE EL RENO GROUP IN OKLAHOMA

Bill E. Morgan
1967

CORE OPC 1070, BLAINE COUNTY

The core site for OPC 1070 is located in the SE¼, Sec. 21, T. 18 N., R. 12 W., and is approximately five miles southeast of the town of Southard (see Fig. 1). The core recovered two hundred and ninety-five feet of Permian and Quaternary sediments. Sixty-two feet of Quaternary material was penetrated above the Permian contact. One hundred ten feet of Dog Creek Shale was recovered but proved barren of microfossils. Below this section, eighty-four feet of gypsum, red and green shales and silty shales were collected from the Blaine Formation.

Four productive horizons were found to bear spores and pollen within the Blaine Formation (see Table 1 for lithologic descriptions and the position of the fossiliferous beds). The first fossiliferous sample was recovered at a depth of 185 feet, being eleven feet below the base of the Shimer Gypsum Bed and the Altona Dolomite Bed. The second productive zone was identified at a depth of 197 feet and four feet above the Nescatunga Gypsum. Immediately below the Magpie Dolomite, basal unit of the Nescatunga Gypsum Member, the third fossiliferous sample was collected 218 feet below ground level. The fourth palynomorph bearing horizon occurred at 238 feet in depth and was situated immediately above the Medicine Lodge Gypsum, basal member of the Blaine Formation.

Fifty-one feet of Flowerpot Shale was recovered and contained but a single recognizable spore and pollen bearing horizon. This fossiliferous zone was collected at a depth of 249 feet, six feet below the base of the Blaine. Samples below this zone proved to be barren.

CORE OPC 1071, HARMON COUNTY

The site of core OPC 1071 is in the SW¼, Sec. 33, T. 3N., R. 25W., Harmon County. The core was drilled to a depth of 221 feet and bottomed in the Collingsworth Gypsum. The core consists of Dog Creek and Blaine Formations and yielded five productive spore and pollen zones. Fossiliferous Dog Creek samples at 64 and 74 feet in depth are seventeen and seven feet respectively above the Van Vacter Gypsum. Sample 94 immediately underlies the Salt Fork Bed of the Dog Creek Formation. Sample 107 occurs within the Van Vacter Gypsum as a two-foot gray shale parting between massive gypsum beds. The lower-most sample is in a shale parting within the Collingsworth Gypsum at a depth of 204 feet. This lies 173 feet below the top of the Van Vacter Gypsum and twenty-eight feet below the Mangum Dolomite.

CORE OPC 1072, GREER COUNTY

The site of core OPC 1072 is in the SW¼, Sec. 14, T. 4N., R. 23W, Greer County. The core consists of 25 feet of alluvium, 81 feet of Blaine Formation, 73 feet of Flowerpot Formation and was drilled to a total depth of 209 feet. This core was found to contain four fossil bearing levels, one in the

Blaine and three in the Flowerpot Formation. The first of the palynomorph-bearing beds was encountered at eighty feet which is fifty feet below the Mangum and immediately beneath the Cedartop Gypsum. The Haystack Gypsum at one hundred and sixteen feet marks the base of the Blaine Formation. The gray-green shale of the Flowerpot Formation immediately beneath this gypsum unit contains a good spore and pollen assemblage. Another good suite of palynomorphs was recovered at 138 feet. The gray-green silty shale at 154 feet in depth was the lowest productive zone recognized in the core.

TABLE 1

STRATIGRAPHIC SECTIONS OF THE EL RENO GROUP

AND POSITION OF PALYNOLOGIC MATERIAL

OPC 1070 Southard Core Hole 1, 3 miles west, 100 feet north of southeast corner of Section 21, T. 18 N., R. 12 W., Blaine County, Oklahoma

	FEET
QUATERNARY COVER -	62.5
DOG CREEK SHALE (lower part)	
Unnamed beds:	
Siltstone, red, red-brown and green-gray - - - - - - -	20.3
Southard Bed:	
Dolomite, laminated, pale yellow, microgranular - - -	0.4
Unnamed beds:	
Siltstone and shale, red, red-brown and green-gray, some veins of spar gypsum - - - - - - - - - - - - - - - - -	45.7
Watonga Bed:	
Dolomite, pale yellow, laminae of green-gray shale - - -	1.8
Unnamed beds:	
Shale and siltstone, variegated - - - - - - - - - - - - -	29.7
BLAINE FORMATION	
Shimer Member:	

Anhydrite, medium gray, finely crystalline - - - - - - 12.4

Altona Bed:

Pellet dolomite, pale yellow-brown - - - - - - - - - - 1.0

Unnamed beds:

Siltstone, green-gray and red shale - - - - - - - - - - 11.3

Shale, green-gray, silty, salty, SPORES AND POLLEN (185)-1.2

Shale and siltstone, red and green-gray - - - - - - - - 11.4

Shale, green-gray, silty, salty, some satin spar gypsum, SPORES AND POLLEN (197)- - - - - - - - - - - - - - 1.1

Shale, red-brown silty, salty - - - - - - - - - - - - - 4.4

Nescatunga Member:

Anhydrite, green-gray, finely crystalline; gypsum, medium gray, finely crystalline, salty - - - - - - - - 14.3

Magpie Bed:

Pellet dolomite, pale yellow-brown, salty - - - - - - - 1.0

Unnamed beds:

Shale, green-gray, silty, salty, SPORES AND POLLEN (218) - 0.8

Shale and silty shale, red-brown and green-gray bands - 18.7

Shale, green-gray, silty, salty, SPORES AND POLLEN (238) - 0.9

Medicine Lodge Member:

Gypsum and anhydrite, impure, medium gray to brown, brown shale in veinlets - - - - - - - - - - - - - - - - - 4.5

FLOWERPOT SHALE

Unnamed beds:

Shale, red-brown, silty, no taste of salt - - - - - - -	1.6
Shale, green-gray, some argillaceous siltstone, SPORE AND POLLEN in lower part (249) - - - - - - - - -	5.0
Shale, red-brown -	0.3
Gypsum, impure, medium green-gray, medium granular - -	0.8
Siltstone and silty shale, red-brown, green-gray, gypsiferous in part - - - - - - - - - - - - - - - - -	44.5
TOTAL	295.6

OPC 1071 Hollis #1 Core; 1,200 feet east, 1,200 feet north of southwest corner section 33, T. 3 N., R. 25 W., Harmon County, Oklahoma.

	FEET
QUATERNARY DEPOSIT -	11.5
DOG CREEK SHALE	
Unnamed beds:	
Siltstone, red-brown - - - - - - - - - - - - - - - - - - -	4.2
Gypsum, medium gray, granular, well-layered - - - - - -	2.6
Siltstone and shale, red-brown, green-gray - - - - - -	17.0
Duke Bed:	
Gypsum, medium gray, medium granular - - - - - - - - -	7.9
Unnamed beds:	
Dolomite, yellow-gray, microgranular - - - - - - - - -	2.4
Shale, green-gray, silty, gypsum nodules - - - - - - -	1.9
Shale, red-brown, some green-gray, silty - - - - - - -	16.8
Shale, green-gray, blocky, SPORES AND POLLEN (64) - -	1.9
Gypsum, medium gray, medium granular - - - - - - - - -	2.1
Shale, medium green-gray, silty, satin spar gypsum - -	3.5
Shale, red-brown, silty, gypsiferous - - - - - - - - -	2.0
Shale, green-gray, silty, in part dolomitic, SPORES AND POLLEN (74) - - - - - - - - - - - - - - - - -	4.5
Shale, red-brown, mottled green-gray, silty, gypsiferous -	4.3

<u>Salt Fork Bed</u>:

Gypsum, medium gray, medium granular - - - - - - - - - 7.1

Dolomite, yellowish gray, microgranular - - - - - - - 4.4

BLAINE FORMATION

<u>Van Vacter Member</u>:

Shale, medium gray, silty, few veins of satin spar gypsum, SPORES AND POLLEN (94) - - - - - - - - - - - - - 0.9

Siltstone, light gray and red-brown - - - - - - - - - 3.3

Gypsum, light gray, finely granular - - - - - - - - - 2.2

Anhydrite, light gray, finely crystalline - - - - - - 6.6

Shale, green-gray, tastes of salt, red-brown in lower part, upper part contains SPORES AND POLLEN (107) - - 1.5

Anhydrite, light gray-and white-banded, finely crystalline - 1.0

Shale, medium gray to brown, silty, gypsiferous - - - - 2.1

Gypsum, red-brown, medium granular, red-brown shale - - 0.9

Anhydrite, light gray, finely crystalline - - - - - - - 8.2

Gypsum, medium gray, coarsely granular - - - - - - - - 3.5

Dolomite, pale yellowish-gray, microgranular - - - - - 2.3

Shale, green-gray, lower part red-brown, silty - - - - 4.3

Gypsum and anhydrite interbedded, light gray to brownish-red - 52.9

<u>Mangum Bed</u>:

Dolomite, pale yellowish gray, microgranular - - - - - 4.0

<u>Unnamed bed</u>:

Siltstone and shale, green-gray and red-brown - - - -	15.8

<u>Collingsworth Member</u>:

Gypsum and red-brown shale interbedded - - - - - - - - -	13.1
Shale, green-gray, silty, SPORES AND POLLEN (204) - - -	0.8
Shale, red-brown, slightly silty - - - - - - - - - - - -	2.5
Gypsum, light gray, coarsely crystalline - - - - - - -	2.0
Anhydrite and gypsum, medium gray, very finely crystalline -	10.0
Gypsum, medium gray, medium granular - - - - - - - - - -	1.0
TOTAL	221.0

OPC 1072 Russell Core; 1,400 feet north, 1,700 east of southwest corner of section 14, T. 4 N., R. 23 W., Greer County, Oklahoma.

	FEET
QUATERNARY DEPOSIT -	23.8
BLAINE FORMATION	
Mangum Bed:	
Limestone, pale yellowish-brown, finely crystalline - -	5.2
Unnamed beds:	
Shale, green-gray and red-brown bands, silty - - - - -	31.5
Dolomite, pale yellowish-brown, oolitic in part - - - -	2.0
Shale, mottled green-gray and red-brown, silty - - - -	10.8
Cedartop Member:	
Gypsum, brownish-white to medium gray, medium granular -	6.5
Dolomite, medium gray, oolitic - - - - - - - - - - - - - -	0.5
Unnamed beds:	
Shale, green-gray, fissile, silty, SPORES AND POLLEN (80) -	7.0
Shale red-brown, some grayish-brown, satin spar - - - -	10.2
Siltstone, green-gray and red brown, few veins of satin spar gypsum -	2.9
Haystack Member:	
Gypsum, light to medium gray, fine to medium granular, some green-gray and brown shale stringers - - - - - - -	5.9
Anhydrite, light grayish-white, finely crystalline - - -	4.2
Gypsum, medium gray, medium granular, banded - - - - -	6.1

FLOWERPOT SHALE

Unnamed beds:

Shale, green-gray, silty and slightly dolomitic, contains SPORES AND POLLEN (117) - - - - - - - - - - - - 3.7

Shale, red-brown and green-gray interbedded - - - - - - 4.7

Gypsum, light gray, finely granular - - - - - - - - - - 0.5

Shale, red-brown and green-gray layers, silty - - - - - 11.6

Gypsum nodules, white, finely crystalline, irregular - - 0.4

Shale, red-brown, silty, selenite crystals - - - - - - 0.7

Shale, green-gray, siltstone in lower part, upper part contains SPORES AND POLLEN (138) - - - - - - - - - - - 4.5

Shale, red-brown, green-gray, silty - - - - - - - - - - 3.6

Gypsum, light gray, finely granular - - - - - - - - - - 0.4

Shale, green-gray, gypsiferous - - - - - - - - - - - - 0.5

Shale, red-brown, satin spar gypsum veins - - - - - - - 0.4

Kizer Member:

Gypsum, pale green-gray, very finely granular - - - - - 1.0

Unnamed beds:

Shale, green-gray, silty - - - - - - - - - - - - - - - - 2.4

Shale, red-brown, slightly silty - - - - - - - - - - - - 1.1

Shale, green-gray, red-brown in middle - - - - - - - - - 2.1

Shale, green-gray, slightly silty, SPORES AND POLLEN (154) - 1.4

Shale, red-brown, green-gray bands - - - - - - - - - - 8.2

Gypsum, pale green-gray, finely granular - - - - - - - 0.2

Shale, green-gray, mottled red-brown, silty - - - - - -	5.1
Chaney Member:	
Gypsum, light to medium gray, finely granular - - - - -	4.2
Unnamed beds:	
Siltstone and sandstone, green-gray, taste of salt - -	2.0
Gypsum, colorless to pale yellowish-gray, finely granular -	0.6
Shale, alternating beds of green-gray and red-brown, silty with satin spar veins and salty taste - - - - -	33.2
Anhydrite, light gray, microcrystalline, thin irregular masses of green-gray shale - - - - - - - - -	0.2
TOTAL	209.3

COLLECTIONS

Sixty-nine channel samples were collected from three cores used in this investigation. The gypsum, dolomite and anhydrite layers were not collected because palynomorphs found in these sediments are extremely hard to extract and generally not well preserved.

The color of the rocks sampled varied from dark brick-red, to brown, to light pink; from dark olive green to gray and gray-green to a light green. Each sample, regardless of color, was processed for acid-resistant microfossils. Thirty-four barren samples of brown, red and green shale were processed before encountering the first productive gray-green shale sample. Spores and pollen were recovered from fourteen of thirty-eight samples of gray-green silty shales and siltstones. Other gray-colored samples contained a large amount of dark organic debris but no spores and pollen. All red, brown, pink and green and red colored lithologies were found to be barren.

SAMPLE PREPARATION AND STUDY PROCEDURE

Sample Preparation

The techniques employed in the preparation of Permian shales are, in part, standard procedures for processing shale. Twenty gram samples of the material were placed in polyethelene beakers, covered with concentrated hydrochloric acid. These were neutralized after all reaction ceased. Each sample was then covered with 52% hydroflouric (HF) acid for eight hours, then neutralized. The sparse nature of palynologic material in the samples processed required concentration. In order to concentrate the material, several short centrifuge cycles were employed (Funkhouser, S. W. and Evitt, W. R., 1959). The residue containing the palynologic material was washed in repeated Alcojet baths (Bond, 1964) in thirty-second short centrifuge cycles until clear, then washed with additional distilled water to remove the Alcojet.

Final concentration of the residue was accomplished by heavy liquid-flotation techniques employing zinc bromide (Staplin, F. L., Pocock, S. J., Jansonius, Jan and Oliphant, E. M., 1960). The zinc bromide was removed from the sample by adding dilute hydrochloric acid and distilled water and centrifuging for three minutes. The sample after removal from the zinc bromide and hydrochloric acid was clean, concentrated and ready to make into slides. Slides were made as outlined by Wilson (1959b). Ten microscope slides were made of each productive interval.

STUDY PROCEDURE

Microscope slides were observed under an American Optical Microstar compound microscope, using 10X W. F. oculars and 10X, 43X and 97X objectives. Each microscope slide was examined by systematic traverses. Selected microfossils were ringed with glass marking ink and photographed with a Leitz Ortholux microscope using Adox KB-14 film.

The coding system used to designate the individual palynomorph is as follows: Each core was assigned an Oklahoma Palynologic Collection number and its location registered on OPC file cards. Fossiliferous horizons were numbered according to their depth in the core and ten slides, consecutively numbered, were prepared of each level. Individual specimens were ringed with china marking ink.

The slides used in this study for statistical counts and for photographing representative specimens and the unprocessed portions of the samples collected for the dissertation are in the collection of the Oklahoma Geological Survey. The cores are on file in the University of Oklahoma Core Library, Norman, Oklahoma.

The frequency of species encountered on each microscope slide is designated according to the following scale:

Rare - - - - - - -	1-3 individuals
Uncommon - - - - -	4-6 individuals
Common - - - - - -	7-9 individuals
Abundant - - - - -	10 or more

PALEONTOLOGY

The palynomorphs recovered and identified from the El Reno Group consist of fifty-six genera of fossil spores and pollen and one acritarch genus. Ten genera of the fossil spore and pollen are considered new and undescribed. The fifty-six genera of spores and pollen are represented by one hundred and seven species, of which seventy species are considered new and undescribed. The acritarch genus is represented by a single species which is herein reported as occurring in the Permian for the first time.

The classification of the fossil spores and pollen grains into supra-generic categories of the Sporae Dispersae is based essentially upon the "Morphographic Classification" as outlined by Potonie and Kremp (1954, 1955, 1956) and later supplemented by Potonie (1956, 1958, 1960) and further modifications by other authors.

SPORAE DISPERSAE

Anteturma Sporites H. Potonie, 1893

FUNGI IMPERFECTAE

Order Moniliales

Genus REDUVIASPORONITES Wilson, 1962

Type Species: Reduviasporonites catenulatus Wilson, 1962, p. 91, pl. 1, fig. 1.

REDUVIASPORONITES CATENULATUS Wilson, 1962

Plate 1, figure 1

Occurring throughout the El Reno Group *Reduviasporonites catenulatus* is common in the Flowerpot Formation and Dog Creek Shale but is less common in the Blaine Formation.

Figured specimen: OPC 1071-74-8-5.

Turma Triletes (Rheinsch, 1881) Potonie and Kremp, 1954

Subturma Azonotriletes Luber, 1935

Infraturma Laevigati (Bennie and Kidston, 1886) Potonie, 1956

Genus LEIOTRILETES (Naumova) Potonie and Kremp, 1954

Type Species: *Leiotriletes sphaerotriangulus* (Loose) Potonie and Kremp, 1954.

LEIOTRILETES Sp. A

Plate 1, figure 2

Spore radial; trilete; trilete mark distinct, extends to slightly thickened periphery; trilete 25 microns long with lips thickened; spore wall concave between trilete apices. Four micron thick wall evident on spore body; overall diameter 51 microns.

Rare in upper portion of Flowerpot Formation. Leiotriletes Sp. A differs from L. parvus Guennel in having a somewhat thicker wall and possessing slightly thickened lips of the laesura.

Figured specimen: OPC 1070-249-5-1.

Genus CALAMOSPORA Schopf, Wilson and Bentall, 1944

Type Species: Calamospora hartungiana Schopf, 1944 in Schopf, Wilson and Bentall (p. 51-52, fig. 1).

CALAMOSPORA cf. C. BREVIRADIATA Kosanke, 1950

Plate 1, figure 3

Previously reported in Oklahoma from the Crowberg coal of mid-Pennsylvanian age (Wilson and Hoffmeister, 1956) and the Flowerpot Shale of Permian age (Wilson, 1962), specimens identified as Calamospora cf. C. breviradiata Kosanke were rare in the lower portion of the Dog Creek Shale and not recognized in other El Reno units.

Figured specimen: OPC 1071-74-3-4.

Genus PUNCTATISPORITES (Ibrahim, 1932) Ibrahim, 1933

emend. S., W., and B., * 1944

Type species: Punctatisporites punctatus (Ibrahim, 1932) Ibrahim, 1933.

* for Schopf, Wilson and Bentall, 1944

PUNCTATISPORITES Sp. A

Plate 1, figure 4

Spores radial; trilete; circular in outline; trilete mark distinct, extending three-quarters of spore radius; interareas between rays minutely punctate. Total dimensions 29 by 28 microns.

Specimens of Punctatisporites are extremely rare and recognized only in the Lower Blaine from the Hollis Core (1071-204). P. Sp. A differs from P. obliquus Kosanke in its larger size (8 microns) and the punctate interarea between the trilete apices.

Figured specimen: OPC 1071-204-7-5.

Infraturma Muronati Potonie and Kremp, 1954

Genus PHYLLOTHECOTRILETES Luber, 1955

Type Species: Phyllothecotriletes nigritellus (Luber) Luber, 1955

PHYLLOTHECOTRILETES Sp. A

Plate 1, figure 5

Spore radial; trilete; sub-circular and oblate in outline; trilete mark distinct, wavy and unequal in length, two-thirds diameter of spore body, not reaching the thickened rim. Dimensions: 31 microns in diameter.

This small distinctive spore was rare and did not appear on the assemblage count. Recognized only in the Flowerpot Formation.

Figured specimen: OPC 1072-117-2-3.

Turma Zonales (Bennie and Kidston, 1886) Potonie, 1956

Subturma Zonotriletes Waltz, 1935

Infraturma Cingulati R. Potonie and Klaus, 1954

Genus ANGUISPORITES Potonie and Klaus, 1954

Type Species: *Anguisporites anguinus* Potonie and Klaus, 1954, p. 525, pl. 10, fig. 4.

ANGUISPORITES INTONSUS Wilson, 1962

Plate 1, figure 6

Spores assigned to *Anguisporites intonsus* are rare in the Flowerpot and Blaine Formations. The average diameter of *A. intonsus* was found to be 40 to 44 microns, somewhat smaller than the type species but resemble it in other characters.

Figured specimen: OPC 1070-238-4-1.

ANGUISPORITES CONTORTUS Wilson, 1962

Plate 1, figure 7

Originally described and illustrated from the Flowerpot Formation, *A. contortus* was found to be rare in the Blaine Formation. Overall dimension somewhat smaller than the Flowerpot specimens.

Figured specimen: OPC 1070-197-9-5.

Genus LYCOSPORA (S., W., and B., 1944) Potonie and Kremp, 1954

Type Species: *Lycospora micropapillatus* (Wilson and Coe) S., W., and B., 1944, p. 54, pl. 3, figures 19-195.

LYCOSPORA IMPERIALIS Jansonius, 1962

Plate 1, figure 10

Reported from Permian sediments of the Peace River Area, Canada, this small trilete spore is rare in the El Reno Group of the Oklahoma Permian.

Figured specimen: 1072-138-3-2 (pl. 2, fig. 4).

Infraturma Zonat: Potonie and Kremp, 1954

Genus ZONALASPORITES Ibrahim, 1933

Type Species: Zonalasporites ulughbeki Ibrahim, 1933 (pl. 14, fig. 11; photograph in Potonie and Kremp, 1956, II, pl. 18, fig. 410, not from original specimen).

ZONALASPORITES Sp. A

Plate 1, figure 12

Spores radial; alete; spherical to subspherical; outer wall translucent, loose convolute folds, 2 to 3 microns high, 2 to 3 microns wide.

Zonalasporites Sp. A differs from Z. punctatus Wilson in being smaller and nonpunctate. It is rare in the Flowerpot Shale.

Figured specimen: OPC 1072-154-4-8.

ZONALASPORITES Sp. B

Plate 1, figure 11

Radial; alete; spherical to subspherical; diameter 28 to 31 microns; outer wall translucent, loose convolute folds, 1 to 2 microns high, 1 to 2 wide.

Zonalasporites Sp. B differs from Z. Sp. A in its less dense and tight fold, more translucent outer wall and 13 microns smaller size. It occurs in the same level as Z. Sp. A and is a rare member of the assemblage.

Figured specimen: 1072-154-1-1.

Genus KRAEUSELISPORITES Leschik, 1955, emend. Jansonius, 1962

Type Species: Kraeuselisporites dentatus Leschik, 1955, p. 37, pl. 4, fig. 21.

KRAEUSELISPORITES Sp. A

Plate 1, figure 13
and
Plate 2, figure 1

Spore radial, trilete, spherical to subspherical; distal body granular with numerous short, broad based spines; outer flange of spore wall micrograpular and with few spines; trilete mark extending to near edge of flange.

Kraeuselisporites Sp. A is uncommon in the Flowerpot Shale and not encountered in the other El Reno members. Reported by Jansonius from the Triassic of the Peace River Area, Western Canada, K. Sp. A differs from K. apiculatus Jansonius in having a distinctively thickened trilete mark that extends to near the outer edge of the flange.

Figured specimens: OPC 1072-138-3-1 and OPC 1072-138-5-5.

Genus LUNDBLADISPORA Balme, 1963

Type Species: Lundbladispora willmotti Balme, 1963, p. 22, pl. 5, fig. 12.

LUNDBLADISPORA Sp. A

Plate 2, figures 2 and 3

Spores radial; trilete; circular to subcircular in outline; spore wall finely reticulate, distally a circular thickened ring is developed; cingulum flattened at trilete apices and slightly inflated between apices showing gap between the central body and cingulum.

Represented only by one specimen but reported because of its distinctive diagnostic features. The genus has been previously reported from Lower Triassic sediments of Australia by Balme, 1963.

Figured specimen: OPC 1071-204-1-2.

Genus ACUELISPORITES Artuz, 1957

Type Species: Aculeisporites aculeus Artuz, 1957, pl. 7, fig. 53.

ACULEISPORITES Sp. A

Plate 2, figure 4

Spore radial; trilete; circular in outline, central body subtriangular; trilete extends beyond the central body; overall diameter 76 microns, central body 57 microns; exine ornamented with moderately coarse coni. Size range from 70 to 82 microns in diameter.

Aculeisporites Sp. A is generally larger than A. variabilis Jansonius by about 10 or more microns and the trilete is less distinct. It is rare in the Flowerpot Formation.

Figured specimen: OPC 1072-138-6-1.

Anteturma Pollenites R. Potonie, 1931

Turma Saccites Erdtman, 1947

Subturma Monosaccites (Chitaley, 1951) Potonie and Kremp, 1954

Infraturma Triletesaccites Leschik, 1955

Genus NUSKOISPORITES (Potonie and Klaus) Klaus, 1963

Type Species: Nuskoisporites dulhuntyi Potonie and Klaus, 1954, p. 528, pl. 10, fig. 5.

NUSKOISPORITES Sp. A

Plate 2, figure 8

Spores radial; monolete; broadly circular in outline; saccus attached near aperture on proximal face; distal saccus free; aperture modified, not distinctly trilete but a broad gaping laesura; laesura bounded by polygonal raised ornamentation; saccus finely inframicroreticulate. Dimensions: 76 to 80 microns; central body 46 to 48 microns wide.

Nuskoisporites Sp. A differs from N. crenulatus Wilson in its much smaller size (20 microns smaller) and modified aperture. Rare in the Blaine Formation.

Figured specimen: OPC 1070-238-3-1.

Genus PARASACCITES Bharadwaj and Tiwari, 1964

Type Species: *Parasaccites korbaensis* Bharadwaj and Tiwari, 1964, p. 143.

PARASACCITES Sp. A

Plate 2, figure 9

Spores radial; spherical to oblate; saccus attached evenly subequatorially both proximally and distally; trilete mark distinct, short, less than one-third diameter of central body; central body laevigate; saccus with radially oriented reticulation. Ranges in size from 64 to 73 microns.

Distinct in the mode of saccus attachment, *Parasaccites* Sp. A can be differentiated from *P*. Sp. B on the basis of the plain smooth saccus of *P*. Sp. A. *Parasaccites* Sp. A is common in the Dog Creek Shale and Flowerpot Shale but uncommon in the Blaine.

Figured specimen: OPC 1071-74-3-2.

PARASACCITES Sp. B

Plate 2, figure 10

Pollen with radial symmetry; distinct trilete; circular in outline; saccus attached subequatorially both proximally and distally to central body; trilete mark thickened and extending almost to saccus attachment zone which is distinctly darker than the central body and saccus; central body slightly granular; saccus with radial folds giving a crenulate appearance to the outer circumference of the grain. Ranges in size from 48 to 56 microns in overall diameter.

Parasaccites Sp. B differs from P. Sp. A in its large thickened trilete and crenulate saccus. Common in the Blaine Formation, P. Sp. B is found throughout the stratigraphic section investigated.

Figured specimen: OPC-1070-197-5-1.

PARASACCITES Sp. C

Plate 2, figure 11

Radially symmetrical trilete pollen grain; generally circular in outline; simple trilete extends one-half diameter of central body; strongly folded saccus attached subequatorially and is strongly serrate in appearance around outside equator. Overall size range from 40 to 44 microns in diameter.

Parasaccites Sp. C differs from P. Sp. A in having a larger simple trilete mark and much folded saccus; it differs from P. Sp. B in not having a thickened trilete and dark zone of saccus attachment. Uncommon in the Flowerpot Formation.

Figured specimen: OPC 1072-154-4-2.

Genus BARAKARITES Bharadwaj and Tiwari, 1964

Type Species: Barakarites indicus Bharadwaj and Tiwari, 1962, p. 13.

BARAKARITES Sp. A

Plate 2, figure 12

Spore radial; trilete; circular in outline; oblate; saccus attached to equator proximally but distally inclined and attached subequatorially; proximal face of central body divided into roughly polygonal shaped areas between trilete rays; area immediately surrounding trilete mark laevagate; saccus finely infrareticulate. Overall diameter 66 to 68 microns in size.

Barakarites Sp. A differs from Parasaccites Sp. A in having a distally inclined saccus and polygonal ornamentation of interarea between the trilete mark and zone of saccus attachment.

Figured specimen: OPC 1072-30-4-1.

Infraturma Vesiculomonoraditi (Pant, 1954) Bhardwaj, 1956

Genus POTONIEISPORITES Bhardwaj, 1954, emend. Bhardwaj, 1964.

Type Species: Potonieisporites novicus Bhardwaj, 1954 (p. 520-521, fig. 10).

POTONIEISPORITES SIMPLEX Wilson, 1962

Plate 2, figure 5

This round to oval pollen grain was found to be rare in the Flowerpot and not recognized in the superjacent El Reno Group. Wilson (1962a), however, records the species as common at that locality.

Figured specimen: OPC 1070-249-9-1.

POTONIEISPORITES MICRODENS (Wilson)

Wilson and Venkatachala, 196? in manuscript

Syn: Hoffmeisterites microdens Wilson, 1962

Plate 2, figure 6

Rare in the Dog Creek and Blaine Formations, Potonieisporites microdens is uncommon in the Flowerpot Formation. The species was reported as uncommon by Wilson (1962a).

Figured specimen: OPC 1072-117-7-1.

POTONIEISPORITES Sp. A

Plate 2, figure 7

Pollen monosaccate, bilateral; equatorial outline elongate oval; central body dark, distinct with strong monolete mark extending one-half of the central body; distal folds touching and extending transversely across the middle of the central body; bladder finely infrareticulate appearing radial around central body. Size ranges from 84 to 91 microns in length and 50 to 55 microns in width.

Rare in the Blaine Formation, Potonieisporites Sp. A has been observed in the Wellington Formation of Kansas (Shaffer, 1964). P. Sp. A is common in the Kansas Wellington. P. Sp. A differs from P. microdens in the darker color of the central body and the median position of the distal folds and its 40 microns smaller size.

Figured specimen: OPC 1071-949-2.

Subturma Disaccites Cookson, 1947

Infraturma Disaccitriletes Leschik, 1955

Genus LIMITISPORITES Leschik, 1956 emend. R. Potonie, 1958

Type Species: Limitisporites delasaucei (R. Potonie and Klaus) Schaarschmidt - Pityosporites delasaucei R. Potonie and Klaus, 1954, p. 536, pl. 10, fig. 6.

LIMITISPORITES DELASAUCEI (R. Potonie and Klaus) Schaarschmidt, 1963

Plate 3, figure 1, 2

Occurring as an uncommon sporomorph in the Flowerpot Formation, *Limitisporites delasaucei* is easily recognized due to the crescent shaped fold on the body and the finely infrareticulate bladders.

The presence or absence of tetrad scars on the proximal surface of bisaccate pollen and the shape of that scar has been considered a prime diagnostic feature by some (Klaus, 1963; Madler, 1965) while others do not consider it as important. Schaarschmidt, 1963, and Grebe and Schweitzer, 1964, have illustrated that the tetrad scar may vary within a given species from monolete to trilete. The scar itself reflects the tetrad arrangement which, within conifers, seems to vary. Figure 1, plate 3, shows a grain with a "roof shaped" mark as seen in the genus *Jugasporites* and figure 2, plate 3, illustrates a monolete mark as seen in the genus *Limitisporites*. Certain other forms are seen to be trilete and were previously assigned to *Illinites* (Clarke, 1965b) which now is considered to be a striate genus (Freudenthal, 1965). These forms are therefore considered to be of the same genus and are assigned to the senior genus, *Limitisporites*, with *Jugasporites* and part of *Illinites* becoming junior synonyms. Until properly published, the suggested new combination must not be considered valid.

Figured specimens: OPC 1070-249-6-2 and OPC 1070-249-7-1.

LIMITISPORITES PERSPICUUS (Leschik) comb. nov.

Plate 3, figure 4

Rare in the Blaine Formation, Limitisporites perspicuus differs from L. delasaucei in having coarser radial ribbing of the bladders which overlap onto the circular central body more so than do the bladders of L. delasaucei. The area of overlap is not a darkened arci in L. perspicuus as it is in L. delasaucei.

Figured specimen: OPC 1071-107-1-2.

LIMITISPORITES Sp. A

Plate 3, figure 3

Bisaccate pollen; central body circular, somewhat thickened possessing monolete to dock-formic tetrad scar; sacci slightly diploxylonoid, reticulate. Averages 65 to 76 microns in length.

Limitisporites Sp. A differs from L. perspicuus (Leschik) comb. nov. in possessing a more distinct central body and less reticulate sacci. Rare in the El Reno Group, Limitisporites Sp. A was recognized as occurring only in the Flowerpot Formation.

Figured specimen: OPC 1072-117-3-3.

Genus GIGANTOSPORITES Klaus, 1963

Type Species: Gigantosporites heisseli Klaus, 1963, p. 283.

GIGANTOSPORITES ALETOIDES Klaus, 1963

Plate 3, figures 7, 8

Several grains here assigned to Gigantosporites aletoides Klaus were recovered from samples of Dog Creek and Blaine shale.

Though rare, the pollen is easily recognized and may prove to be of stratigraphic importance.

Figured specimen: OPC 1071-74-6-1.

Infraturma Pinosacciti Erdtman, 1947 emend. Potonie, 1958

Genus ALISPORITES Daugherty, 1941 emend. Potonie and Kremp, 1956.

Type Species: Alisporites opii Daugherty, 1941 (p. 98, pl. 34, fig. 2).

ALISPORITES AEQUUS Wilson, 1962

Plate 4, figure 1

Bilateral bisaccate non-striate pollen grains are common in occurrence throughout the section studied. Alisporites aequus is common in the assemblages recovered. It lacks the well defined sulcus of Paravesicaspora and is easily differentiated from it.

Figured specimen: OPC 1072-154-6-2.

Genus VESICASPORA Schemel, 1959, emend. Wilson and Venkatachala, 1963.

Type Species: Vesicaspora wilsonii Schemel, 1951, p. 748, fig. 3.

VESICASPORA Sp. A

Plate 4, figure 2

Grains mono-to bisaccate; bilateral; oval in outline; central body oval, without distinct sulcus, proximal surface reticulate and continuous with sacci reticulations; bladders semicircular and completely embracing the central body. Size average 30-34 by 24-25 microns.

Vesicaspora Sp. A compares with the emended description of the genus and can be differentiated from other species of *Vesicaspora* by its small size (32 microns) and the reticulate nature of the central body which is not radially disposed as in *V. schemeli* Klaus, and is coarser than the reticulations of *V. wilsonii* Schemel. *Vesicaspora* Sp. A is common in the Blaine Formation and uncommon elsewhere in the section.

Figured specimen: OPC 1070-218-1-1.

Genus FALCISPORITES Leschik emend. Klaus, 1963

Type Species: *Falcisporites* (al. *Pityosporites*) *zapfei* (R. Potonie and Klaus) Leschik, 1956; in R. Potonie and Klaus, 1954, plate 10, figure 9.

FALCISPORITES ZAPFEI (R. Potonie and Klaus) Leschik, 1956

Plate 4, figure 4

The uppermost part of the Blaine Formation has yielded specimens assignable to *Falcisporites zapfei*. Though uncommon in occurrence, the forms are easily recognized and fit the description by both Leschik and Klaus. This species has been reported from the Upper Permian of the Southern Alps by Klaus, 1963, and from the Zechstein of Germany by Grebe, 1957, and from the Peace River Area of Canada by Jansonius, 1962.

Figured specimen: OPC 1070-197-10-6.

Genus PARAVESICASPORA Klaus, 1963

Type Species: Paravesicaspora (al. Sulcatisporites) splendens Leschik, 1956, pl. 22, fig. 10.

PARAVESICASPORA SPLENDENS (Leschik) Klaus, 1963

Plate 4, figures 3, 7, 8, 9

One of the most abundant non-striate genera, Paravesicaspora splendens occurs in abundance throughout the studied section. The forms of P. splendens vary in size and definition of the central body as well as having more distinct radial ornamentation of the distal surface adjacent to the sulcus than the type species but is so similar as to be separated only with difficulty. Paravesicaspora splendens has been reported from the Upper Permian of the Alps and from the Zechstein of Germany.

Figured specimens: OPC 1070-249-1-3, 1070-249-1-1, 1070-249-2-1, 1071-204-2-1.

PARAVESICASPORA Sp. A

Plate 4, figures 5, 6

Bilateral bisaccate grains; overall outline somewhat rectangular; central body elongate transversely, sulcus distinct, central body generally dark in color; bladder attachment shorter than width of central body; finely reticulate near distal sulcus and increasing in coarseness of reticulation on sacci.

Restricted to the Flowerpot Formation, this species is uncommon in its occurrence. Paravesicaspora Sp. A is easily differentiated from *P. splendens* by the attachment of its sacci, smaller size and the non-radial ornamentation of the central body.

Figured specimen: OPC 1070-249-3-1.

Additional figured specimen: OPC 1070-249-8-2.

Genus KLAUSIPOLLENITES Jansonius, 1962

Type Species: *Pityosporites schaubergeri* Potonie and Klaus, 1954, p. 536, pl. 10, fig. 7.

KLAUSIPOLLENITES Sp. A

Plate 4, figures 10, 11

Bisaccate bilateral grain without noticeable germinal structure; central body circular; sacci attached proximally at equator and distally inclined; area of attachment shorter than the diameter of the central body; bladders slightly infrareticulate.

These very small grains (usually less than 30 microns in length) occur in the Flowerpot and Blaine Formations as an uncommon member of the assemblage. *Klausipollenites* Sp. A is 25 microns in length shorter than *K. vestidus* Jansonius and may be differentiated by the size.

Figured specimen: OPC 1070-197-1-5.

Additional figured specimen: OPC 1072-154-1-4.

Genus VITREISPORITES Leschik, 1955, emend. Jansonius, 1962.

Type Species: *Vitreisporites signatus* Leschik, 1955, p. 53, pl. 8, fig. 10.

VITREISPORITES Sp. A

Plate 4, figure 12

Grains bilateral bisaccate; oval in outline; central body indistinct and generally lighter in color than bladders; bladders clasping the central body; bladders are inframicroreticulate; overall dimensions, length 24 microns, width 18 microns, gap between bladder attachment areas from 8 to 10 microns.

These minute bisaccate grains are common to abundant in the El Reno Group. They resemble somewhat, Paravesicaspora but differ in their small size and indistinct central body. Vitreisporites Sp. A may be differentiated from V. koenigswaldii Jansonius by its smaller relative size (20 microns).

Figured specimen: OPC 1071-204-3-3.

Infraturma Striatiti Pant, 1954

Genus LUECKISPORITES Potonie and Klaus, 1954 emended Klaus, 1963

Type Species: Lueckisporites virkkiae R. Potonie and Klaus, 1954, plate 10, item 3.

Undoubtedly the most abundant single genus in the Permian El Reno Group of southwestern Oklahoma, Lueckisporites constitutes from 16 to nearly 70% of the fossils recovered in an assemblage. The conditions during this period of Oklahoma's past were perhaps the most favorable for the parent plant of Lueckisporites. The low-lying, warm, deltaic conditions and possibly slight saline soil condition seems to have supported this abundant vegetation due to the content of *Lueckisporites* in the studied samples.

Clark, 1965, chose, rather than speciate, to distinguish variants of *L. virkkiae*. Klaus, 1963, shows several distinctly recognizable species of *Lueckisporites*. In this study, several of the species established by Klaus were recognized as distinct and different from *L. virkkiae*. Due to their variation in abundance and possible stratigraphic significance, it was decided to follow Klaus in his interpretation of the genus.

LUECKISPORITES VIRKKIAE Potonie and Klaus, 1954

Plate 5, figure 1, 4

Consistently abundant throughout the El Reno Group, *Lueckisporites virkkiae* constitutes a major portion of all grains identified. *L. virkkiae* differs from *L. microgranulatus* in its coarsely granulate exoexine strips and close appressed semicircular sacci.

Figured specimen: OPC 1070-218-2-1.

LUECKISPORITES MICROGRANULATUS Klaus, 1963

Plate 5, figure 2

Recognized as occurring in abundance in the Flowerpot Shale, *Lueckisporites microgranulatus* decreases sharply in abundance in the overlying El Reno Group. *L. microgranulatus* is easily differentiated from other species of *Lueckisporites* by the finely infrapunctate to infrareticulate exoexinal strips and large, inflated, radially reticulate sacci.

Figured specimen: OPC 1072-154-4-9.

LUECKISPORITES GLOBOSUS Klaus, 1963

Plate 5, figure 3

Grains recognized as belonging to *Lueckisporites globosus* were encountered in the Blaine Formation where they were common. According to Klaus' description of having the exoexinal lamella detached from the outer edge of the central body, the Blaine species are differentiated from *L. virkkiae* due to this characteristic.

Figured specimen: OPC 1070-185-7-2.

LUECKISPORITES PARVUS Klaus, 1963

Plate 5, figure 5

Uncommon in the Flowerpot Shale, *Lueckisporites parvus* is common in the Blaine Formation and Dog Creek Shale.

Figured specimen: OPC 1070-218-8-3.

Genus TAENIAEPOLLENITES Visscher, 1966

Type Species: *Taeniaepollenites jonkeri* Visscher, 1966, p. 360, pl. XVIII, figs. 1A, B, C.

TAENIAEPOLLENITES Sp. A

Plate 5, figure 6

Bilateral striatiti; disaccate; central body with exinous thickenings dorsally that divide into four taeniae; central taeniae tend to bifurcate; outer taeniae continuous; taeniae form a distinct cap-like structure; central body itself light in color; sacci haploxylonoid with moderate size infrareticulation.

Members of the genus *Taeniaepollenites* were recognized in each formation in the El Reno Group. However, found to be rare in the Blaine Formation, Taeniaepollenites Sp. A is absent from the Flowerpot and Dog Creek Shale. T. Sp. A differs from T. Sp. B by its thick continuous outer taeniae.

Figured specimen: OPC 1070-218-4-4.

TAENIAEPOLLENITES Sp. B

Plate 5, figure 7

Bilateral disaccate striatiti; central body with three to four broad, thin strips on proximal surface; central body light in color and larger than the sacci; sacci infrareticulate.

Rare in the Flowerpot Shale, Taeniaepollenites Sp. B differs from T. Sp. A in the thinness of the dorsal bands in T. Sp. A and the much smaller size of the sacci.

Figured specimen: OPC 1072-117-6-1.

TAENIAEPOLLENITES Sp. C

Plate 5, figure 8

Bilateral bisaccate striatiti; proximal cap divided into approximately four taeniae which appear to have a slight reticulate pattern; central body light in color; sacci clasping central body and possess strong infrareticulation that has a radial orientation.

Rare in the Dog Creek Shale, Taeniaepollenites Sp. C was not recorded from the lower studied strata. T. Sp. C differs from T. Sp. B in having infrareticulate taeniae and strong radial infrareticulations of the sacci.

Figured specimen: OPC 1071-74-3-3.

TAENIAEPOLLENITES Sp. D

Plate 5, figure 9

Disaccate striatiti; central body circular; proximal cap with four ribs that may bifurcate; ribs broad and appearing reticulate; sacci semicircular in size and showing radial infrareticulation.

Uncommon in the Flowerpot Shale, *Taeniaepollenites* Sp. D is rare in the Blaine Formation and uncommon in samples from the Dog Creek Shale. *T.* Sp. D differs from *T.* Sp. A by lacking the thickened, bordered cap and by the reticulate nature of the ribs.

Figured specimen: OPC 1072-117-5-7.

Genus LUNATISPORITES (Leschik) Bharadwaj, 1962

Type Species: *Lunatisporites acutus* Leschik, 1955

Recognized as being a different and distinct entity from *Taeniaepollenites* Visscher, 1966, *Lunatisporites* is here used in the manner proposed by Bharadwaj, 1962, only restricting it to diploxylonoid forms with five or more taeniae.

LUNATISPORITES Sp. A

Plate 5, figure 10

Disaccate diploxylonoid striatiti; central body circular and grooved on dorsal cap to form seven to eight occasionally bifurcating broad taeniae; sacci larger than central body, attachment area equal to greatest diameter of central body; sacci coarsely infrareticulate.

Members of this genus with large infrareticulate sacci are rare in the Blaine Formation. Lunatisporites Sp. A is distinguished by its greater size from T. Sp. D, and also by the large inflated nature of the sacci.

Figured specimen: OPC 1070-185-1-8.

LUNATISPORITES cf. L. SULCATUS (Pautsch, 1959) comb. nov.

Plate 5, figure 11

Palynomorphs strongly resembling Pautsch's description and illustration of Lunatisporites (Pollenites) sulcatus were recognized in the Flowerpot Shale. Klaus' emendation of Taeniaesporites excludes diploxylonoid forms and therefore a new combination in names is considered necessary. Described from the Triassic of Poland originally, the Flowerpot specimens, due to being rare and too few specimens observed, are thought to be morphologically similar and therefore assigned to L. sulcatus. L cf. L. sulcatus differs from L. Sp. A in the broad, flat nature of its punctate taeniae.

Figured specimen: 1070-249-9-3.

LUNATISPORITES Sp. B

Plate 5, figure 12

Diploxylonoid bisaccate striatiti; central body circular, only slightly darker than sacci; proximal cap with approximately eight intramicroreticulate ribs. sacci large; inframicroreticulate, greater than semicircular in size; distal area of attachment near mid-line leaving a distinct, narrow sac-free portion of central body exposed.

Rare in the Blaine Formation, Lunatisporites Sp. B does not have the coarse bladder reticulation of L. Sp. A and has less distinctive ribbing and much greater size.

Figured specimen: OPC 1071-107-2-3.

LUNATISPORITES Sp. C

Plate 6, figure 1

Bilateral, disaccate striatiti; central body transversely oblong; cap differentiated into numerous ribs; sacci attachment two dark crescent marks across the distal surface of the central body, roughly parallel to central body wall; bladders infrareticulate.

Resembling Lunatisporites fuscus Bharadwaj, L. Sp. C differs in the more numerous narrow ribs and larger central body and sacci.

Figured specimen: OPC 1072-154-5-7.

Genus PROTOHAPLOXYPINUS Samoilovich, 1953 emend. Hart, 1964

Type Species: Protohaploxypinus latissimus (Luber and Walts, 1941) Samoilovich, 1953, p. 36.

PROTOHAPLOXYPINUS Sp. A

Plate 6, figure 2

Bisaccate bilateral haploxylonoid striatiti; central body divided into ten or more lightly punctate taeniae; sacci smaller than central body and clasping it; sacci lightly infrareticulate.

Occurring throughout the El Reno Group as uncommon fossils, Protohaploxypinus Sp. A differs from P. Sp. B in having darker, punctate taeniae and somewhat larger, infrareticulate sacci.

Figured specimens: OPC 1072-154-6-1; 1071-94-3-3.

PROTOHAPLOXYPINUS Sp. B

Plate 6, figure 3

Disaccate bilateral haploxylonoid striatiti; central body with eight or more proximal taeniae; taeniae narrow, close spaced and reticulate; central body larger than sacci; sacci infrareticulate and area of attachment darker than bladders.

Uncommon in the Blaine Formation, Protohaploxypinus Sp. B differs from P. Sp. A in the nature of the taeniae ornamentation.

Figured specimen: OPC 1070-197-10-7.

PROTOHAPLOXYPINUS Sp. C

Plate 6, figure 4

Bilateral bisaccate haploxylonoid striatiti; central body oval and proximally divided into eight to ten broad occasionally bifurcating taeniae; taeniae with very light infrareticulation; sacci smaller than central body and clasping nearly the full width of the central body; sacci with distinct fine infrareticulations.

Uncommon in the Flowerpot Shale, Protohaploxypinus Sp. C possess broader taeniae and sacci that are more semicircular than P. Sp. B.

Figured specimen: OPC 1072-117-5-7.

Genus STRIATOABIETITES Sedova, 1956 emend. Hart, 1964

Type Species: _Striatoabietites_ _bricki_ Sedova, 1956, plate XLI, figure 5.

STRIATOABIETITES Sp. A

Plate 6, figure 5

Bilateral disaccate striatiti; diploxylonoid in outline; central body longitudinally elongated; proximal cap with from 10 to 16 ribs; sacci semicircular in shape, zone of distal attachment of sacci broad, well defined.

Observed in the Dog Creek Shale, this rare to uncommon occurring species was not recognized in the underlying units. _Striatoabietites_ Sp. A differs from other striatiti in the length and shape of the central body.

Figured specimen: OPC 1071-74-2-5.

Genus STRIATITES Pant, 1955 emend. Jansonius, 1962

Type Species: _Pityosporites_ _sewardii_ Virkki, 1938, p. 429, fig. 2a.

Until properly published, the suggested new combination must not be considered valid.

STRIATITES PHYSEMA comb. nov.

Plate 6, figure 6

Bilateral diploxylonoid disaccate striate pollen; central body circular to oblate, proximal cap thin with numerous indistinct ribs, longitudinal peripheral folds reflected by dark arci; arci parallel ribs on sides of central body; no distinct sulcus; sacci diploxylonoid, reniform inflated and slightly larger in size than the central body; distal sac-free area broad, distinct.

Striatites physema comb. nov. differs from *S. rugosus* Jansonius in being larger in size (100-107 by 58-63 microns) and have a more broad well defined sac-free distal area. *Striatites physema* comb. nov. has a lighter central body with more ribs than *S. triassicus* Schulz, 1965.

Abundant in the Van Vacter Member of the Blaine Formation, *Striatites physema* comb. nov. is common in the Dog Creek Shale and rare in the Flowerpot Shale.

Figured specimen: OPC 1071-107-5-2.

Genus STROTERSPORITES Wilson, 1962, emend. Klaus, 1964

Type Species: *Strotersporites communis* Wilson, 1962, pl. II, fig. 1.

STROTERSPORITES COMMUNIS Wilson, 1962

Plate 6, figure 7

Strotersporites communis is common in the Flowerpot Shale from which it was originally described and is rare in the overlying Blaine and Dog Creek Formations.

Figured specimen: OPC 1071-117-1-2.

STROTERSPORITES Sp. A

Plate 6, figure 8

Disaccate bilateral striatiti; central body longitudinally oblong; proximal cap with 10 to 12 ribs; proximal slit distinct and somewhat thickened on each side; central body with several peripheral folds; body measures 47 by 36 microns, overall length 75 microns; bladders slightly diploxylonoid and infrareticulate.

Resembling Strotersporites communis, S. Sp. A is one-half the size of the designated type and therefore can be differentiated by its much smaller relative size. Uncommon in the Blaine Formation and Flowerpot Shale, S. Sp. A is rare in the Dog Creek Shale.

Figured specimen: OPC 1070-238-9-4.

STROTERSPORITES RICHTERI (Klaus, 1952) Wilson, 1962

Plate 7, figure 9

Diagnosis of the bounded laesura as a distinct characteristic of Strotersporites by Klaus has made it possible to accept this species as a distinct member of that genus. Uncommon in the Blaine Formation, S. richteri differs from other species of Strotersporites in the indistinctly granular nature of the ribs and somewhat coarse infra-reticulation of the sacci.

Figured specimen: OPC 1070-218-1-2.

Genus TUBANTIAPOLLENITES Visscher, 1966

Type Species: Tubantiapollenites striatoides Visscher, 1966, plate XIX, fig. 3.

TUBANTIAPOLLENITES Sp. A

Plate 6, figure 12

Bisaccate diploxylonoid striatiti; proximal cap with 16 to 22 ribs separated by narrow striae; proximal intexine with monolete to roof shaped tetrad scar; wide germinal area set off by folds at sacci bases; sacci reticulate; size ranges 68 to 78 microns in length and 40 to 52 microns in width.

Tubantiapollenites Sp. A is approximately 20 microns larger in overall size than T. schultzii Visscher, 1966. The sacci bases of T. Sp. A are darker, more distinct and the distal germinal area is not as wide as T. balmei Visscher, 1966, and the sacci are smaller in T. striatiodes Visscher, 1966, than in T. Sp. A. The genus Tubantiapollenites Visscher possesses a circular rather than elongate oblong body as in Strotersporites Wilson. Sacci vary from haploxylonoid to diploxylonoid in Tubantiapollenites while Strotersporites is a diploxylonoid genus. Rare in the Flowerpot Formation.

Figured specimen: OPC 1072-138-7-2.

TUBANTIAPOLLENITES Sp. B

Plate 6, figure 11

Diploxylonoid bisaccate striatiti, central body oblong transverse to ribbing, dark in color, with 10 to 14 ribs parallel to distinct proximal monolete slit; ribs adjacent to the slit thickened, other ribs less distinct; sacci crescent shaped, larger than the long diameter of the central body; area of sac-insertion darker than the rest of the central body; overall size of the grain 58 by 51 microns; central body 33 by 41 microns.

This small distinct species was uncommon in the Flowerpot Shale. One of the smallest _Tubantiapollenites_ encountered, _T_. Sp. B can be differentiated from _T_. Sp. A by its smaller size (16 microns shorter in length), vertically oval central body and more crescentic shaped sacci.

Figured specimen: OPC 1070-249-7-2.

TUBANTIAPOLLENITES Sp. C

Plate 6, figure 10

Disaccate diploxylonoid striatiti; central body transversely oval to circular in outline; proximal cap split by distinct modified monolete scar; ribs parallel to the slit, broad, bifurcating, microreticulate, eight to twelve in number; sacci reniform, inflated, coarsely infrereticulate; somewhat greater in size than the central body.

Uncommon in the Blaine Formation, _Tubantiapollenites_ Sp. C was not recognized elsewhere in the studied section. _Tubantiapollenites_ Sp. C differs from _T_. Sp. B in the more round shape of the central body, the much larger and more coarsely infrareticulate sacci and larger overall size.

Figured specimen: OPC 1071-107-5-1.

Genus STRIATOPODOCARPITES Sedova, 1956, emended Hart, 1964

Type Species: _Striatopodc arpites tojmensis_ Sedova, 1956, pl. XLI, fig. 8.

STRIATOPODOCARPITES Sp. A

Plate 7, figure 1

Disaccate diploxylonoid striatiti; central body circular and dark brown in color; proximal cap divided into six inflated, strongly punctate ribs; median proximal slit distinct, one-third length of central body; sacci strongly diploxylonoid; greater in size than the central body, near circular in shape; distal area of sacci attachment near mid-line and sacci almost touching each other; sacci distinctly reticulate.

Distinctive in the large circular inflated sacci and small dark oval striated central body, Striatopodocarpites Sp. A is rare in the El Reno Group. Striatopodocarpites Sp. A differs from Striatopodocarpites Sp. B in having six strongly punctate ribs and distinct proximal slit.

Figured specimen: OPC 1072-138-3-7.

STRIATOPOCARPITES Sp. B

Plate 7, figure 2

Bilateral, disaccate striatiti; circular dark central body dorsally divided into four to six broad, inflated, slightly punctate to granular ribs; sacci strongly inflated; sacs much larger than the central body, attached tightly around the equator; distally the area of attachment parallels and leaves a small sac-free area transversely across the central body; sacci finely infrareticulate.

Striatopodocarpites Sp. B is easily distinguished by the large inflated sacci and taeniae, being more inflated than *Striatopodocarpites* Sp. A and not as punctate. It is rare in the Flowerpot Shale.

Figured specimen: OPC 1072-154-5-10.

Genus STRIATOPICEITES Sedova, 1956

Type Species: *Striatopiceites suchonensis* Sedova, 1956, pl. XLI, fig. 7.

STRIATOPICEITES Sp. A

Plate 7, figure 3

Bilateral bisaccate striatiti; overall outline oval; central body circular with 10 to 12 proximal ribs; sacci attachment equal in length to the diameter of the central body; sacci merge evenly with the central body and do not form angles; interarea between sacci straight to concave; sacci thick walled, dark and reticulate.

Rare in the Blaine Formation, *Striatopiceites* Sp. A is distinctive with its close clasping dark sacci. *S.* Sp. A could possibly be included in *Protohaploxypinus*, but the distinctiveness of its structure and resemblance to the extant genus *Picea* warrants retention of the genus.

Figured specimen: OPC 1071-94-2-1.

Genus FIMBRIAESPORITES Leschik, 1959

Type Species: *Fimbriaesporites globosus* Leschik, 1959, p. 72, pl. 4, fig. 29.

The genus *Fimbriaesporites* Leschik has ribs that are broken and form rectangular patterns, but their organization is such that they may still be considered ribs. Due to the distinct appearance of the aligned rectangular rib areas the genus is here included in the striatiti.

FIMBRIAESPORITES Sp. A

Plate 7, figure 4

Bilateral, disaccate, diploxylonoid striatiti; central body oblong, dark, with ribs broken into rectangular pattern; proximal slit present; sacci large, inflated and inframicroreticulate; area of sacci attachment thick, dark crescent along flanks of central body.

Rare in the Blaine Formation, *Fimbriaesporites* Sp. A differs from *F. globosus* Leschik (1959, p. 72) in having ribs which are borken into rectangular patterns and possessing a dark crescentic area of bladder attachment.

Figured specimen: OPC 1070-238-7-1.

FIMBRIAESPORITES Sp. B

Plate 7, figures 5, 6

Bilateral disaccate, diploxylonoid striatiti; central body circular in outline, dark and broken into irregular rectangular patches; proximal slit present; sacci large, coarse infrareticulate to fine reticulation next to central body; area of bladder attachment dark, crescent shaped covering lateral edges of central body.

Rare in the Dog Creek Shale, *Fimbriaesporites* Sp. B differs from *F*. Sp. A in having a circular outline, more irregular patch-work of ribs and coarsely infrareticulate sacci. Figure 6, plate 8 is a phase-contrast photomicrograph illustrating the coarse nature of the infrareticulation of the sacci and nature of the proximal slit and striae.

Figured specimen: OPC 1071-74-10-1.

Genus RHIZOMASPORA Wilson, 1962

Type Species: *Rhizomaspora radiata* Wilson, 1962, p. 18, pl. II, fig. 7.

RHIZOMASPORA DIVARICATA Wilson, 1962

Plate 7, figure 7

Striatiti with radiating ribs were recognized in the Flowerpot Shale and the Blaine Formation. Members of this genus were not identified in the Dog Creek Shale and were rare in the Blaine Formation and Flowerpot Shale.

Figured specimen: OPC 1071-107-10-3.

RHIZOMASPORA RADIATA Wilson, 1962

Plate 7, figures 8, 9

Distinctive in the arrangement of the radiating ribs, *Rhizomaspora radiata* was recognized in both the Flowerpot Shale and the Blaine Formation where it was rare.

Figured specimens: OPC 1071-94-10-8; OPC 1072-138-10-6.

Genus HAMIAPOLLENITES Wilson, 1962

Type Species: Hamiapollenites saccatus Wilson, 962, p. 23, pl. III, fig. 7.

HAMIAPOLLENITES SACCATUS Wilson, 1962

Plate 8, figures 1, 2

Rare in the Flowerpot Shale, Hamiapollenites saccatus was not recognized in the overlying El Reno Group. Reported in abundance from the Wellington of Kansas, this occurrence of the species in the El Reno Group may mark the upper range of the species.

Figured specimens: OPC 1072-154-1-3; OPC 1072-138-5-6.

HAMIAPOLLENITES PERISPORIS (Jizba) Tschudy and Kosanke, 1966

Plate 8, figure 3

Uncommon in the Blaine Formation and the Flowerpot Shale, specimens called Striatosaccites perisporis by Jizba, 1962, were assigned to the genus Hamiapollenites by Tschudy and Kosanke (1966). H. perisporis differs from H. karrooensis Hart by having eight or more longitudinal ribs on the proximal surface rather than six as in H. karrooensis Hart. H. perisporis differs from H. saccatus in having only a median distal thickening each side of the sulcus and not numerous vertical distal ribs.

Figured specimen: OPC 1071-107-7-2.

HAMIAPOLLENITES TRACTIFERINUS (Samoilovich, 1953) Jansonius, 1962

Plate 8, figures 4, 5

Palynomorphs recognized as being con-specific with Hamiapollenites tractiferinus occurred as uncommon fossils in the Blaine Formation and were missing in the overlying and underlying formations. Recognized in the Canadian Peace River Area (Jansonius, 1962) and in the Cis-Urals of Russia (Samoilovich, 1961), the species apparently has a broad geographic range.

Figured specimens: OPC 1070-197-1-4; OPC 1071-94-2-5.

Genus DISTRIATITES Bharadwaj, 1962

Type Species: Distriatites bilateralis Bharadwaj, 1962, p. 97, pl. 22, fig. 281.

DISTRIATITES Sp. A

Plate 8, figure 6

Bilateral, disaccate, haploxylonoid striatiti; central body quadrately oval, proximal surface with eight to ten longitudinal ribs on the proximal surface and six to eight transverse ribs distally; sacci attach evenly to central body; sacci as broad as the central body, transparent with a very faint suggestion of inframicroreticulation.

Common in the Flowerpot Shale and uncommon in the lower part of the Blaine Formation, Distriatite Sp. A differs from species of Hamiapollenites in having bladders equal in size to the central body and attaching smoothly with it.

Figured specimen: OPC 1072-138-4-1.

Subturma Polysaccites Cookson, 1947

Genus TROCHOSPORITES Wilson, 1962

Type Species: Trochosporites reniformis Wilson, 1962, p. 28, pl. II, fig. 9.

TROCHOSPORITES RENIFORMIS ? Wilson, 1962

Plate 8, figure 7

Trisaccate pollen grains are uncommon in the El Reno Permian, and all but one specimen was reported from the Flowerpot Shale. Trochosporites reniformis differs from Crustaesporites globosus in having a distinct ovoid body cell bounded by a thick rim and lacking proximal striations.

Figured specimen: OPC 1072-154-8-4.

Genus CRUSTAESPORITES Leschik, 1956

Type Species: Crustaesporites globosus Leschik, 1956, p. 130, pl. 21, fig. 2.

CRUSTAESPORITES GLOBOSUS ? Leschik, 1956

Plate 8, figure 8

A single striate monosaccate (?) grain with the sacci separate is assigned to Crustaesporites. This single grain marks the only observed occurrence of this genus within the El Reno Group. Wilson (1962) reported several from approximately the same stratigraphic horizon in the Flowerpot Formation.

Figured specimen: OPC 1072-138-7-6.

Turma Aletes Ibrahim, 1933

Subturma Azonaletes (Luber, 1935) Potonie and Kremp, 1954

Genus CLAVATASPORITES Wilson, 1962

Type Species: Clavatasporites irregularis Wilson, 1962, p. 30, pl. I, fig. 7.

CLAVATASPORITES IRREGULARIS Wilson, 1962

Plate 8, figure 10

Several irregularly shaped clavate to bacclate spores occurred as uncommon fossils in the Flowerpot Shale and were not encountered in the higher stratigraphic units.

Figured specimen: OPC 1072-138-5-1.

Genus GREBESPORA Jansonius, 1962

Type Species: Grebespora concentrica Jansonius, 1962, p. 83, pl. 16, fig. 3.

GREBESPORA Sp. A

Plate 8, figure 11

Grains radial; alete; circular in outline; wall thin and folded to form thickened peripheral ring around central reticulate area. Grains range in size from 43 to 47 microns.

Common in the middle Blaine, this genus is rare above and below this interval and is intimately associated with species of Psophosphaera. Grebespora differs from Psophosphaera by having a folded thickened outline and slight reticulation. Grebespora Sp. A differs from G. concentricus Jansonius in being reticulate and alete.

Figured specimen: OPC 1070-185-10-1.

Genus PSOPHOSPHAERA Naumova, 1937, 1939 ex. Naum. 1950 emend. Potonie, 1958

Lectogenotype: Psophosphaera tenuis Naumova, 1950

PSOPHOSPHAERA Sp. A

Plate 12, figure 1

Grains radial; alete; circular to oval in outline, wall thin, laevigate and randomly folded. Average size 40 to 50 microns.

Occurring in abundance in the middle Blaine these alete forms dominate the recovered assemblage from this horizon both in the southern cores and the northern core. In this interval *Lueckisporites* decreases sharply in abundance and *Psophosphaera* shows a marked increase in this portion of the cores. *Psophosphaera* Sp. A is smaller than *P*. Sp. B by approximately 30 microns and averages being 10-20 microns larger than *P*. Sp. C.

Figured specimen: OPC 1070-197-3-4.

PSOPHOSPHAERA Sp. B

Plate 12, figure 2

Grains radial; alete; circular to oval in outline; wall thin, laevigate, with occasional fold; average size 80 to 90 microns in diameter.

Quite abundant in the middle Blaine, *Psophosphaera* Sp. B differs from *P*. Sp. A in being much larger and much less folded. *Psophosphaera* Sp. B also differs from *P*. Sp. C in its overall size (50 microns).

Figured specimen: OPC 1070-197-3-5.

PSOPHOSPHAERA Sp. C

Plate 12, figure 3

Grains radial; alete; circular to oval in outline; wall thin, rigid, laevigate with occasional fold on periphery; average diameter 30-36 microns.

Very abundant in the middle Blaine but becoming less common in the upper and lower portions of the Blaine and common to rare in the other members of the El Reno Group. Psophosphaera Sp. C differs from P. Sp. B in being approximately 50 microns smaller.

Figured specimen: OPC 1071-204-9-1.

Turma Polyplicates Erdtman, 1952

Genus EQUISETOSPORITES Daugherty, 1941, emend. Pocock and Jansonius, 1964

Type Species: Equisetosporites chinleana Daugherty, 1941, p. 63, pl. 34, fig. 4.

EQUISETOSPORITES Sp. A

Plate 9, figure 8

Fusiform to ellipsoidal bilateral grain; wall finely granular with several longitudinal furrows; no germinal mark seen; size 80 by 34 microns.

Uncommon in the Flowerpot Formation, Equisetosporites Sp. A was not recognized in the younger units studied. Equisetosporites Sp. A differs from E. Sp. B in possessing finely granular walls and no germinal sulcus.

Figured specimen: OPC 1072-154-2-4.

EQUISETOSPORITES Sp. B

Plate 9, figure 6

Grains bilateral; fusiform to elliptical in overall outline; main colpi bounded by numerous furrows, appears pinched at poles forming small protuberances at each end of grain.

Common in the Blaine Formation, Equisetosporites Sp. B differs from E. Sp. C in its smaller size and the shape of the colpi and poles.

Figured specimen: OPC 1071-94-5-3.

EQUISETOSPORITES Sp. C

Plate 9, figure 7

Bilateral pollen grains, broadly elliptical in overall shape; rounded at ends; colpi extending from pole to pole, gaping slightly; bounded by one or more folds; colpi lips slightly thickened.

Uncommon in the Blaine Formation, Equisetosporites Sp. C differs from E. Sp. A, E. Sp. B and E. Sp. D in the small number of folds and the rounded ends of the open colpi.

Figured specimen: OPC 1071-94-3-5.

EQUISETOSPORITES Sp. D

Plate 9, figure 9

Fusiform to elliptical, bilateral grains; open colpi bounded by many furrows; colpi apex thickened and pointed; wall laevagate and moderately thick.

Ranging from the Flowerpot through the Dog Creek Formations, Equisetosporites Sp. D is uncommon in occurrence. E. Sp. D differs from E. Sp. C in the thickened and pointed apex of the colpi.

Figured specimen: OPC 1072-154-9-2.

EQUISETOSPORITES Sp. E

Plate 9, figure 10

Bilateral fusiform pollen; colpi bounded by 14 or more straight longitudinal ribs; proximal surface with diagonally slanted ribs; wall moderately thick.

Recognized in the Blaine Formation only, this species is rare in that formation. Equisetosporites Sp. E differs from E. Sp. D in possessing more numerous furrows and not having a pointed thickening at its terminal apices.

Figured specimen: OPC 1071-94-2-9.

Genus VITTATINA (Luber, 1940) ex Samoilovich, 1953
emended Wilson, 1962

Type Species: Vittatina subsaccata Samoilovich, 1953, p. 44, pl. IX, fig. 4a.

VITTATINA VITTIFER Luber, 1940

Plate 10, figures 1, 7

The El Reno Group specimens resembling Vittatina vittifer Luber vary in their surface textures and are generally slightly larger. V. vittifer is uncommon throughout the cored interval.

Figured specimens: OPC 1071-64-8-3; OPC 1071-94-5-9.

VITTATINA STRIATA Samoilovich, 1953

Plate 10, figure 3

Specimens assigned to *Vittatina striata* are common in the Blaine and Dog Creek but rare in the Flowerpot Shale. *V. striata* differs from *V. vittifer* in the granular nature of the ribbing.

Figured specimen: OPC 1070-117-3-5.

VITTATINA ELEGANS Zauer, 1965

Plate 10, figure 4

Elongate pollen grains with numerous finely granular ribs (12-18) are assigned to *Vittatina elegans*. Common in the Blaine Formation but rare to uncommon in the Dog Creek and Flowerpot Formations. *V. elegans* differs from *V. striata* in possessing thinner ribs that are more heavily granular and in lacking distal ribbing or thickening.

Figured specimen: OPC 1070-238-4-6.

VITTATINA COSTABILIS Wilson, 1962

Plate 10, figure 2

Occurring as a common species in the Flowerpot Shale, *Vittatina costabilis* becomes uncommon to rare in the upper members of the El Reno Group. *V. costabilis* differs in the nature and number of proximal and distal ribs.

Figured specimen: OPC 1071-107-4-2.

VITTATINA LATA Wilson, 1962

Plate 10, figures 9, 10

A common element in the Flowerpot Formation, this species becomes rare higher in the El Reno section. Vittatina lata differs from Vittatina costabilis and other species by having 6 to 10 longitudinal ribs and 9 to 10 distinct transverse ribs.

Figured specimen: OPC 1071-94-5-1.

VITTATINA SUBSACCATA Samoilovich, 1953

Plate 10, figure 11

Pollen grains assigned to Vittatina subsaccata are uncommon in the Flowerpot Formation and rare in overlying Blaine and Dog Creek Formations.

Figured specimen: OPC 1070-249-4-1.

VITTATINA Sp. A

Plate 10, figure 5

Pollen bilateral; elongate, roundly elliptical when inflated; normally slightly flattened in the plane of the equator; proximal surface with 8 to 10 raised coarsely granular ribs parallel to equator, converging at ends; equatorial rim thickened, granular similar to ribbing; germinal apparatus not apparent.

Pollen grains of this type are uncommon in the Flowerpot Formation.

Figured specimen: OPC 1071-204-7-2.

VITTATINA Sp. B

Plate 10, figure 6

Pollen bilateral; sub-circular to ovoid in equatorial view, slightly flattened in plane of equator; proximal surface with 12 to 16 granular longitudinal ribs, ribs sometimes broken with granules forming a bead-like appearing rib; no distal ribbing observed; no germinal mark seen.

Vittatina Sp. B differs from V. Sp. A in its more ovoid shape and coarser, broken, granular and more numerous ribs. Vittatina Sp. B is common in the upper part of the Flowerpot, and Blaine Formations and the lower portion of the Dog Creek Formation.

Figured specimen: OPC 1070-197-10-4.

VITTATINA Sp. C

Plate 10, figure 8

Pollen bilateral; broadly oval to circular in equatorial view, slightly flattened in the plane of equator; length 50 microns, width 47 microns; proximal surface with 6 to 10 ribs converging at ends, ribs granular in appearance, no transverse ribbing apparent.

Specimens assigned to this species are rare in the Blaine Formation. Vittatina Sp. C is more spherical in shape than V. lata Wilson.

Figured specimen: OPC 1071-94-5-2.

VITTATINA Sp. D

Plate 10, figure 12

Pollen bilateral, sub-quadrate in equatorial view; length 47 microns, width 40 microns; proximal surface with 6 longitudinal ribs, slightly granular in appearance, continuous and tapering at the poles, 4 to 8 distinct distal ribs, slightly tapered at equator, equator with thickened rim.

Rare in the Blaine Formation, *Vittatina* Sp. D has not been observed elsewhere in the El Reno Group. *V*. Sp. D has fewer ribs than *V*. Sp. A or *V*. Sp. B.

Figured specimen: OPC 1071-94-3-4.

Turma Monocolpates Iverson and Torels-Smith, 1950

Subturma Intortes Naumova, 1937 emend. Potonie, 1958

Genus CYCADOPITES Wodehouse, 1933, ex Wilson and Webster, 1946

Type Species: *Cycadopites follicularis* Wilson and Webster, 1946, p. 247, pl. 1, fig. 7.

CYCADOPITES DIJKSTRAE Jansonius, 1962

Plate 9, figures 1, 2

These ellipsoidal-shaped pollen grains occur throughout the El Reno Group. Originally described from the Triassic of Canada, these grains so strongly resemble Jansonius' species description and illustration that they are thought to be con-specific. Uncommon to common in their occurrence, *Cycadopites dijkstrae* is well represented in the Blaine Formation but less prominent in the adjacent formations.

Figured specimens: OPC 1071-94-2-8; OPC 1072-154-2-3.

CYCADOPITES Sp. A

Plate 9, figure 3

Pollen bilateral; ellipsoidal in overall shape; sulcus covered by broad overlap of lip; wall granular; size 60 microns long by 40 microns wide.

This large granular species of Cycadopites is uncommon in the Blaine Formation. It differs from other species in its granular exine and large size.

Figured specimen: OPC 1070-238-5-2.

Subturma Retectines (Malawkina, 1949) emend. R. Potonie, 1958

Genus MONOSULCITES (Erdtman, 1947,) Cookson, 1947

ex Couper, 1953, pl. 11, fig. 133

Type Species: Monosulcites minimus Cookson, 1947, p. 134, 135, pl. 15, fig. 48.

MONOSULCITES cf. M. MINIMUS Cookson, 1947

Plate 9, figure 4

Strongly resembling Cookson's species except for a somewhat smaller size, Monosulcites cf. M. minimus is uncommon to rare in the Blaine Formation.

Figured specimen: OPC 1070-197-5-2.

MONOSULCITES Sp. A

Plate 9, figure 5

Elongate, strongly ellipsoidal bilateral pollen; sulcus extending full length of grain and not overlapping or gaping; wall moderately thick and finely infrapunctate; size 95 by 31 microns.

The Blaine Formation contained many fusiform elongate grains of several genera, *Vittatina*, *Equisetosporites*, *Cycadopites* and *Monosulcites*. *Monosulcites* Sp. A differs from all species of these by its extreme fusiform elliptical outline and infrapunctate walls. *Monosulcites* Sp. A is rare in the Blaine Formation.

Figured specimen: OPC 1071 204-2-4.

SPORAE DISPERSAE INCERTAE SEDIS

GENUS A SP. A

Plate 1, figure 9

Spores radial; trilete; triangular in outline; trilete raised and thickened, 16 microns long, not extending to cingulum, distal surface covered with widely spaced lunae 1 to 3m in diameter; total diameter 54 microns; central body 44 microns.

This distinctive species, easily recognized by its distal lunae and raised trilete rays is rare in the Flowerpot Shale.

Figured specimen: OPC 1072-138-10-5.

GENUS B Sp. A

Plate 1, figure 8

Spores radial; trilete; triangular in outline; trilete distinct, sinuous and three-fourths the central body in size; central body at the equator surrounded by a flange 4-5 microns wide; distal surfact ornamented by broad knobs and baculae 2-3 microns in diameter with fine granules between; overall diameter 46 microns.

Genus B Sp. A differs from *Verrucosisporites permatus* Balme and Hennelly by possessing a wide flange rather than a dense cingulum. This species is rare in the Flowerpot Shale and not recorded above this formation.

Figured specimen: OPC 1072-138-7-5.

GENUS C Sp. A

Plate 3, figures 5, 6

Bisaccate bilateral pollen grains; central body elongate longitudinally with proximal laesura crossing the full length of the central body; laesura may or may not have thickened borders; sacci diploxylonoid and offset distally so that a distinct sac-free area is present; sulcus not apparent; sacci semi-circular or larger in shape with fine radial reticulation.

This new genus resembles the genus Sahnisporites Bhardwaj, 1954 (now thought to be a junior synonym of Potoniesporites Bhardwaj, 1954) except that this genus is distinctly bisaccate and does not approach the monosaccate condition. Rare in the Flowerpot Shale.

Figured specimens: OPC 1072-154-8-5; OPC 1072-138-7-2.

GENUS D Sp. A

Plate 3, figures 9, 10, 11

Disaccate pollen; bilateral; central body circular to elongate oval in outline; equatorially bounded by folded body wall; proximally exine ruptures irregularly along the longitudinal axis exposing monolete laesura of the intexine; bladders slightly diploxylonoid and infrareticulate with radial alignment of the rays evident.

This genus is abundant in the Flowerpot Shale and the Blaine Formation. Resembling Lueckisporites, it is differentiated from it by the nature of the dihiscence of the proximal exine. It is a continuous membrane that is rent by a tear which leaves opposing saw-teeth (pl. 3, fig. 9), also the circumtorial fold is a constant feature of the body. It differs from Lueckisporites virkkiae in not possessing thickened proximal caps (Kulatte of Klaus) but a torn proximal exine. Gardenasporites Klaus resembles this new genus somewhat but is differentiated from it by the lack of the monolete mark of the intexine and the consistent folding of the central body.

Figured specimen: OPC 1072-117-4-2.

Additonal figured specimens: OPC 1072-117-4-3;
OPC 1071-107-1-4.

GENUS E Sp. A

Plate 8, figure 9

Polysaccate to modified monosaccate with radial symmetry; alete; thin ellipsoidal central body embraced by three or more thin infrareticulate bladders; central body darker at point of bladder attachments forming arci.

This small variable polysaccate is rare in the Flowerpot Shale and absent from the rest of the recovered assemblages. It has been reported in the Wellington Formation of Kansas where three and occasionally four thin sacci have been observed. Except for the additional sacci it is identical to the three-sacci form. Clarke (1965a) illustrated a trisaccate grain from the Permian of Britain that belongs to the same genus as the Flowerpot species. Genus E Sp. A differs from Trochosporites in not possessing a thickened marginal zone and from Crustaesporites by lacking proximal striations of the central body.

Figured specimen: OPC 1072-138-9-2.

GENUS F

Plate 11, figures 1, 2, 3

Generic diagnosis: Bilateral disaccate pollen, overall shape roundly elliptical; central body circular in outline with the exoexine displaying four broad punctate, granular to reticulate ribs separated by three grooves, of which the center groove may gape; may possess two, one or no broad transverse distal ribs; sacci small, merging smoothly with the central body and enclosing it leaving a thin marginal band encircling it. Sacci infrareticulate. Average overall size (20 measured specimens) 30 to 35 microns long by 24 to 28 microns deep.

This distinctive genus occurs commonly in the Blaine Formation. Due to its diagnostic shape and apparently short stratigraphic range, it may prove to be a very good index form for the El Reno Group.

Zauer, 1965, illustrates several new genera that he assigns under the family name Paucistriatiti. Though no description was given and only line drawings illustrate them, the El Reno forms are recognized as different and warrant assignment to a new genus. They should be assigned to the striatiti.

GENUS F Sp. A

Plate 11, figure 1

Bilateral, disaccate haploxylonoid pollen; overall shape roundly ellipsoidal; central body circular in outline; proximal surface of central body with four broad reticulate ribs; distally two overlapping transverse reticulate ribs are present and well defined; sacci small, reticulate and merge smoothly with the central body, overlapping and forming a narrow rim around it.

Common in the Blaine Formation and uncommon in the Flowerpot and Dog Creek Shales, Genus F Sp. A differs from species of Taeniaepollenites in its elliptical shape and vertical distal ribs. It differs from Prothaploxypinus in having four proximal longitudinal ribs and two transverse distal ribs. Genus F Sp. A differs from Genus F Sp. B in having two distal ribs instead of only one.

Figured specimen: OPC 1071-204-2-2.

GENUS F Sp. B

Plate 11, figure 2

Bilateral, disaccate striatiti; overall shape elliptical to fusiform; central body indistinct, with four longitudinal ribs, of which the two median ribs are thick, distinct and reticulate; distally a single broad transverse reticulate rib crosses the central body; sacci reticulate and areas of attachment indistinct;

crescent shaped sacci merging smoothly with central body which shows slight rim development.

Common in the Blaine Formation, Genus F Sp. B differs from Genus F Sp. A in having a more elongate shape, only one distal rib and two strong and two weak ribs on the proximal surface.

Figured specimen: OPC 1070-185-3-3.

GENUS F Sp. C

Plate 11, figure 3

Bilateral, disaccate striatiti; overall shape roundly elliptical; central body circular, crossed proximally by four broad reticulate ribs; sacci small, crescent shaped, merging evenly over central body; dorsally sacci attach along a line near mid-region of central body; broad sac-free area of central body present distally.

Uncommon in the El Reno Group, Genus F Sp. C differs from other species of this genus in lacking the transverse distal rib or ribs.

Figured specimen: OPC 1071-204-1-1.

GENUS G Sp. A

Plate 11, figures 4, 5

Bilateral, disaccate pollen; overall shape elongate, elliptical to fusiform; central body oblong, elliptical; proximally divided into three elongate thickened exinous caps bounded by deep sulci; distally with longitudinal slit; caps infrareticulate; sacci small, inflated, diploxylonoid, infrareticulate.

Uncommon in the Flowerpot Shale, Genus G was rare in the overlying Blaine and Dog Creek Formations. Genus G differs from Genus F noticeably in the longitudinal fissure-bounded caps and small inflated sacci. The organization of Genus G is such that the longitudinal fissures of sulci divide the grain into three elongate, inflated portions with the small sacci at the terminus. With inflection of the distal laesura and reduction of the sacci this type of grain would resemble closely a tricolpate angiosperm pollen grain.

Figured specimen: OPC 1072-138-10-3, proximal view.

Additional figured specimen: OPC 1072-154-8-2, distal view.

GENUS H Sp. A

Plate 11, figure 6

Bilateral, bisaccate miospore; overall shape roundly elliptical; central body elongate; large single sulcus showing slight thickening; coarse body reticulations merging with those of the extremely small sacci; sacci bases indistinct.

Rare in the Blaine Formation, this unusual bisaccate was not reported from the other studied samples. Genus H Sp. A differs from Genus G Sp. A in having as strong single sulcus and much smaller tightly fitting coarsely reticulate sacci.

Figured specimen: OPC 1071-107-9-1.

GENUS I

Generic diagnosis: Bilateral, bisaccate miospores; overall shape broadly oval; central body large circular and inflated; convolute pattern on proximal surface of dark circular to oval inner body; sacci pendant, infrareticulate; distal point of sacci attachment smaller than diameter of the central body, centrally located and somewhat indistinct.

The unusual nature of the large, thin inflated central body with the dark inner body reflecting the brain-like sculptured pattern differentiates Genus I from Fimbriaesporites whose small circular central body slightly resembles this form. The species of Genus I appear to be restricted to the Blaine Formation.

GENUS I Sp. A

Plate 11, figure 7

Bilateral, bisaccate miospore; overall shape broadly oval; central body large, circular and inflated with the proximal surface broken into fine convolute brain-like patterns; dark brown circular inner body present; sacci small, semi-circular, pendant, infrareticulate; attachment area distally shorter than the diameter of central body; overall size 48 by 41 microns; central body 40 microns in diameter; inner body 28 microns in diameter.

Uncommon in occurrence, Genus I Sp. A appears to be restricted to the Blaine Formation. Genus I Sp. A differs from

Rhizomaspora radiata in the nature of the large inflated central body, small pendant sacci and convolute pattern of the proximal exine.

Figured specimen: OPC 1071-94-9-4.

GENUS I Sp. B

Plate 11, figure 8

Bilateral, bisaccate miospore; overall shape broadly oval; central body oval in outline, large, inflated; proximal surface with coarse brain-like convolutions; dark oval innerbody present; no germinal opening visible; sacci semi-circular, pendant, infrareticulate, attach distally along short portion of central body mid-line; overall dimensions 76 by 57 microns, central body 55 microns in diameter, dark inner portion 38 microns wide.

Genus I Sp. B is uncommon in occurrence in the Blaine Formation. Genus I Sp. B is distinguished from Genus I Sp. A by its larger overall size, coarser convolutions and larger sacci.

Figured specimen: OPC 1071-94-10-6.

GENUS J Sp. A

Plate 12, figure 4

Grains radial; alete; circular to oval in outline; bladder rigid; central body dark and indistinct, place and mode of attachment also indistinct; outer bladder wall fairly thick, covered with numerous small fold oriented in similar directions.

Genus J Sp. A differs from *Psophosphaera* Sp. A in possessing a dark central body and by lacking strong peripheral folds. This form is rare in the Dog Creek Shale.

Figured specimen: OPC 1071-64-5-2.

GENUS J Sp. B

Plate 12, figure 5

Grains radial; alete; circular in outline; bladder wall rigid, laevigate, not folded; central body dark and indistinct.

Rare in the Blaine Formation, Genus J Sp. B differs from Genus J Sp. A in having thicker bladder walls and possessing a dark indistinct central body and a 20 microns smaller overall size.

Figured specimen: OPC 1070-197-6-2.

GENUS J Sp. C

Plate 12, figure 6

Grains radial; alete; circular in outline; bladder wall thin, rigid and vermiculate, somewhat folded; central body dark and infrareticulate.

An uncommon palynomorph in the middle Blaine, Genus J Sp. C differs from Genus J Sp. A and Sp. B in its distinct central body and thinner bladder wall.

Figured specimen: OPC 1072-154-3-2.

Turma Acritarcha Evitt

Subturma Diacromorphitae Downie, Evitt and Sarjeant, 1963

Genus ACANTHODIACRODIUM Timofeev, 1958

Type Species: Acanthodiacrodium dentiferum Timofeev, 1958, p. 831, pl. 1, fig. 2 and pl. 3, fig. 2.

ACANTHODIACRODIUM Sp. A

Plate 12, figures 7, 8, 9

Bilateral acritarch, overall shape roundly elliptical; central body circular to oval, covered by outer elliptical membrane; poles similar and possess many short to moderately long spines from 5 to 7 microns in length; overall average size 36 by 28 microns, central body 20 by 28 microns.

This acritarch was common in the El Reno Group. Timofeev (1958), in his monumental work, recognized 107 species from the Cambrian of Russia. This marks the first report of the genus in the United States and first occurrence in the Permian. It occurs with frequency throughout the section in all three units. Due to this frequency of occurrence it is thought to be in place and not recycled.

Figured specimen: OPC 1071-64-1-5.

Additional figured specimens: OPC 1072-117-4-5; OPC 1071-64-7-3.

DISCUSSION

The overall palynologic spectra of the El Reno Group is predominantly gymnospermous in nature with bisaccate pollen, both striate and non-striate types, making up 75% or more of the fossils present in the palynologic assemblages (Fig. 2). Monosaccate and trilete spores which are diverse in types and species, are not found in abundance but occur sparsely throughout the studied section. Lueckisporites is the dominant genus in the Flowerpot, Lower Blaine, Upper Blaine and Dog Creek assemblages. It is only in the middle Blaine assemblages that there is not a predominance of the genus. In those strata it is replaced by the genus Psophosphaera. Lueckisporites is the dominant genus in the Zechstein Formation of Germany (Grebe, 1957, Klaus, 1963) which is also an evaporite sequence quite similar to the El Reno. The resemblance of the assemblages is a result of a similarity in age and environment of the two areas.

Comparison of the El Reno palynologic assemblages with published Permian assemblages in selected literature from throughout the world is summarized on Table 2. As previously noted, the Zechstein of Germany (Klaus, 1963) bears the closest palynologic resemblance of all spore and pollen assemblages reviewd outside the United States. The Flowerpot assemblage of Wilson (1962a) bears closest resemblance (75%) of all published data. The Wellington microfossil assemblage is second in resemblance (22%) of the published material from the Permian of the United States.

The palynologic assemblages recovered from the several different Flowerpot Shale samples are similar in composition but vary somewhat in the relative percentage of the spores and pollen present (see Figure 2). The Greer County Flowerpot Shale assemblages contain from 56 to 65% of the genus Lueckisporites, from 6 to 12% Strotersporites communis and from 3 to 5% of the genus Vittatina. In comparison, the Blaine County Flowerpot sample contains 42% Lueckisporites, 14% striate genera (Protohaploxypinus, Strotersporites richteri, Hamiapollenites) and 10% Vittatina. The remaining 34% of the assemblage is composed of non-striate disaccate and monosaccate pollen, rare trilete spores and a few specimens of Psophosphaera.

The two Flowerpot Shale locations, OPC 1070 from Blaine County and OPC 1071 from Greer County, are geographically more than one hundred miles apart and are situated on opposite sides of the Anadarko Basin. The sedimentary material (as well as the spores and pollen) deposited at the two localities, according to Fay (Fay, 1964, p. 27) had two different source areas. The material for the Blaine County Flowerpot Shale may have been derived from the Ozark Dome while the Greer County material probably had its origin in the Arbuckles and Ouachita Mountain system or perhaps a western or southeasterly source.

The Blaine Formation assemblages contain many distinctive genera and species which either are restricted to the Blaine or are best developed in that assemblage. It is in the Blaine that Psophosphaera, Genus F, Genus G and the granulose ornamented species of Vittatina are best represented. The different genera of striatiti pollen grains also reach their greatest relative abundance within this formation. Strotersporites communis, Strotersporites Sp. A, species of Protohaploxypinus and grains of Genus F, Genus G constitute the percentage of the assemblage encompassed by the group striatiti. The lower portion of the Blaine Formation contains the highest relative percentage of Lueckisporites in the El Reno Group (see Figure 2). The middle Blaine, however, has the smallest percentage of Lueckisporites and the highest percentage of Psophosphaera. This latter genus completely dominates the middle Blaine ranging from 62% in Blaine County sample OPC 1070-185 to 72% in Harmon County sample OPC 1071-204. This fossil may be a marine form. In the levels where Psophosphaera is dominant the terrestrial spore and pollen abundance is at minimum indicating that either land was a greater distance away or possibly that spores and pollen were not being produced, transported or preserved at the same rate.

The fossiliferous horizons collected within the Van Vacter (see Figure 1) Gypsum Member (OPC 1071-107 and 94) differ palynologically with the underlying Blaine assemblages. The

Van Vacter assemblage contains 18-26 percent Striatites physema comb. nov. which characterizes not only the Van Vacter assemblages but also the Dog Creek Shale assemblages (OPC 1071-64 and 74). Within the Van Vacter assemblage there is a marked increase in the relative abundance of Lueckisporites and a corresponding decrease in Psophosphaera (sample OPC 1071-107). Species of Vittatina with granulose ornamentation attain their highest relative abundance (22% in sample OPC 1071-94).

The assemblage of palynomorphs from the Dog Creek Shale is distinctive in that they contain an abundance of the fungal spore, Reduviasporonites catenulus Wilson and the striate grain, Striatites physema comb.nov. Lueckisporites constitutes from 41 to 62% of the assemblages. Also in the Dog Creek assemblage rare forms occur such as Cycadopites, Parasaccites, Genus F and a small percentage of Psophosphaera.

The degree of palynological resemblance of the Van Vacter assemblage with the overlying Dog Creek assemblage suggests, palynologically, a closer affinity of the Van Vacter with the overlying Dog Creek Shale than with the underlying Blaine Formation. Scott and Ham (1957) mapped the Van Vacter Gypsum as part of the Blaine Formation in the Carter Area because of its gross lithologic similarities with the Blaine as exposed elsewhere. They noted, however, that "...the top of the Van Vacter or top of the Blaine is shown to be stratigraphically higher than the top of the Blaine in the type locality." (Scott and Ham, 1957, p. 20). Dr. R. O. Fay of the Oklahoma Geological Survey, described the type locality of the Blaine Formation (Fay, 1962), reviewed the palynologic data and suggested a possible assignment of the Van Vacter to the Dog Creek Formation based on the close palynologic resemblance of the assemblages (Fay, personal communication, 1967).

In general, it may be stated that the portion of the El Reno Group covered by the present investigation is characterized by four major palynological assemblages:

1. Strotersporites communis assemblage of the Flowerpot Formation.

2. Lueckisporites assemblage of the Lower Blaine Formation.

3. Psophosphaera assemblage of the Blaine Formation.

4. Striatites physema assemblage of the Dog Creek Shale and Van Vacter Gypsum.

The palynological record of the El Reno Group illustrates a change from a possible near-shore brackish environment in the Flowerpot, dominated by land-derived gymnospermous saccate pollen and containing rare marine acritarchs, to a condition that permitted Psophosphaera to apparently dominate. The samples containing this latter assemblage (OPC 1070-185 and OPC 1071-204) are from shales associated with massive gypsum beds. These samples may indicate a more marine condition by the dominance of Psophosphaera. The Dog Creek Shale was probably deposited under the same conditions as was the Flowerpot Shale.

The spores and pollen recognized in the El Reno Group substantiate an age assignment of Upper Permian for these strata. *Strotersporites*, *Tubantiapollenites*, *Taeniaepollenites* and *Klausipollenites* have been recorded elsewhere in sediments of Upper Permian age. There are also present in the studied assemblages genera that range from Lower Permian into Upper Permian. These forms, however, are rare in the El Reno but are generally abundant in Lower Permian assemblages. These genera are *Hamiapollenites*, *Potonieisporites* and *Nuskoisporites*.

TABLE 2

SUMMARY OF DISTRIBUTION OF PERMIAN PALYNOMORPHS

FROM REPRESENTATIVE LOCALITIES

Comparison	Ru*	Ca	Ge	In	OW	OH	OE
Number of named species reported	72	76	49	28	24	22	37
Species in common with El Reno Group	6	8	15	1	18	5	-
Percentage in common with El Reno Group	7.3	10.5	30.6	3.5	75.0	22.7	-

*Ru-Russia (Zauer, V. V., 1965)
Ca-Canada (Jansonius, Jay, 1962)
Ge-Germany (Klaus, Wilhelm, 1963)
In-India (Bharadwaj, D. C., 1962)
OW-Oklahoma Wilson (Wilson, L. R., 1962)
OH-Oklahoma Hedlund (Hedlund, Richard, 1965)
OE-Oklahoma El Reno Group

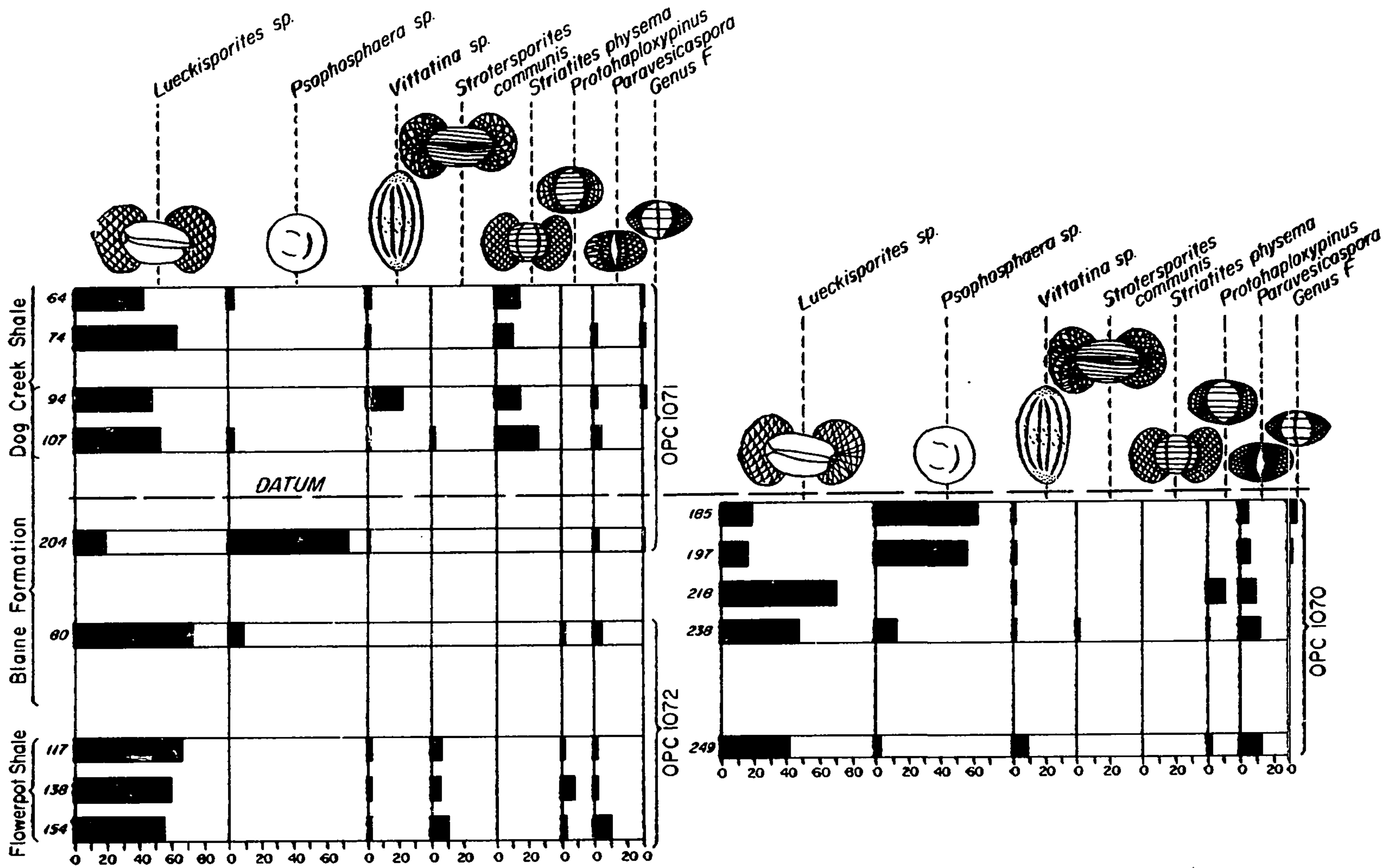


Figure 2. Histogram of Selected Genera and Species in Permian El Reno Group, Western Oklahoma

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APPENDIX

PLATE 1

Figure

1. Reduviasporonites catenulatus Wilson, 1962
   92 x 15 microns; OPC 1071-74-8-5

2. Leiotriletes Sp. A
   51 microns; OPC 1070-249-5-1

3. Calamospora cf. C. breviradiata Kosanke, 1950
   61 microns; OPC 1071-74-3-4

4. Punctatisporites Sp. A
   29 x 28 microns; OPC 1071-204-7-5

5. Phyllothecatriletes Sp. A
   31 microns; OPC 1072-117-2-3

6. Anguisporites intonsus Wilson, 1962
   40 microns; OPC 1072-238-4-2

7. Anguisporites contortus Wilson, 1962
   40 microns; OPC 1070-197-9-5

8. Genus B Sp. A
   46 microns; OPC 1072-138-7-5

9. Genus A Sp. A
   54 microns; OPC 1072-138-10-5

10. Lycospora imperialis Jansonius, 1962
    32 microns; OPC 1072-138-3-2

11. Zonalasporites Sp. B
    28 microns; OPC 1072-154-1-1

12. Zonalasporites Sp. A
    41 microns; OPC 1072-154-4-8

13. Kraeuselisporites Sp. A
    52 microns; OPC 1072-138-5-5

PLATE I

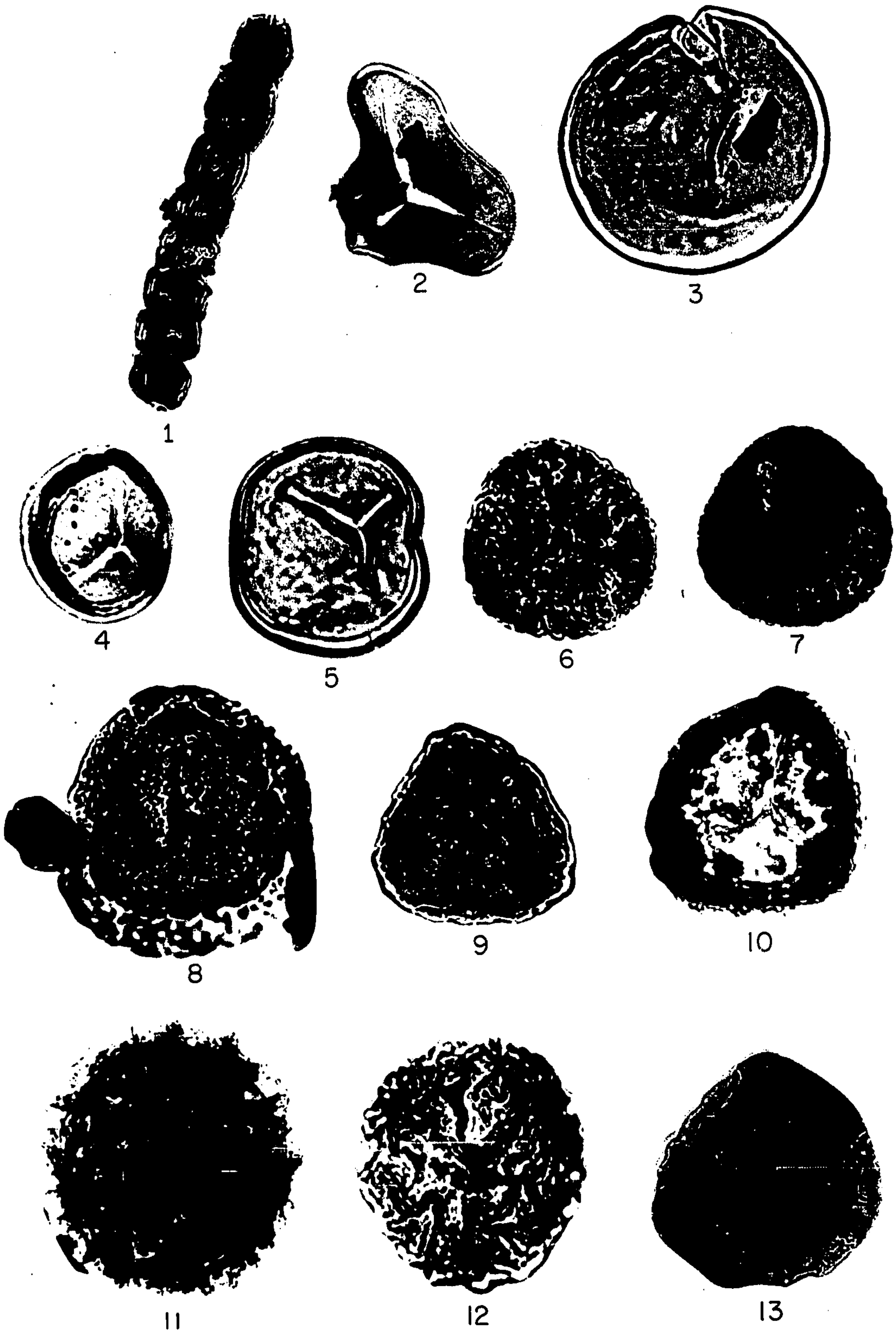


PLATE 2

Figure

1. Kraeuselisporites Sp. A
   54 microns; OPC 1072-138-3-1

2, 3. Lundbladispora Sp. A
   32 microns; OPC 1071-204-1-2

4. Aucleisporites Sp. A
   76 microns; OPC 1072-138-6-1

5. Potonieisporites simplex Wilson, 1962
   114 microns; OPC 1070-249-9-1

6. Potonieisporites microdens (Wilson) Wilson and Venkatachala, 1965
   128 x 79 microns; OPC 1072-117-7-1

7. Potonieisporites Sp. A
   89 x 53 microns; OPC 1071-94-9-2

8. Nuskoisporites Sp. A
   76 microns; OPC 1070-238-3-1

9. Parasaccites Sp. A
   69 microns; OPC 1071-74-3-2

10. Parasaccites Sp. B
   51 microns; OPC 1070-197-5-1

11. Parasaccites Sp. C
   52 microns; OPC 1072-154-4-2

12. Barakarites Sp. A
   66 microns; OPC 1072-30-4-1

PLATE II

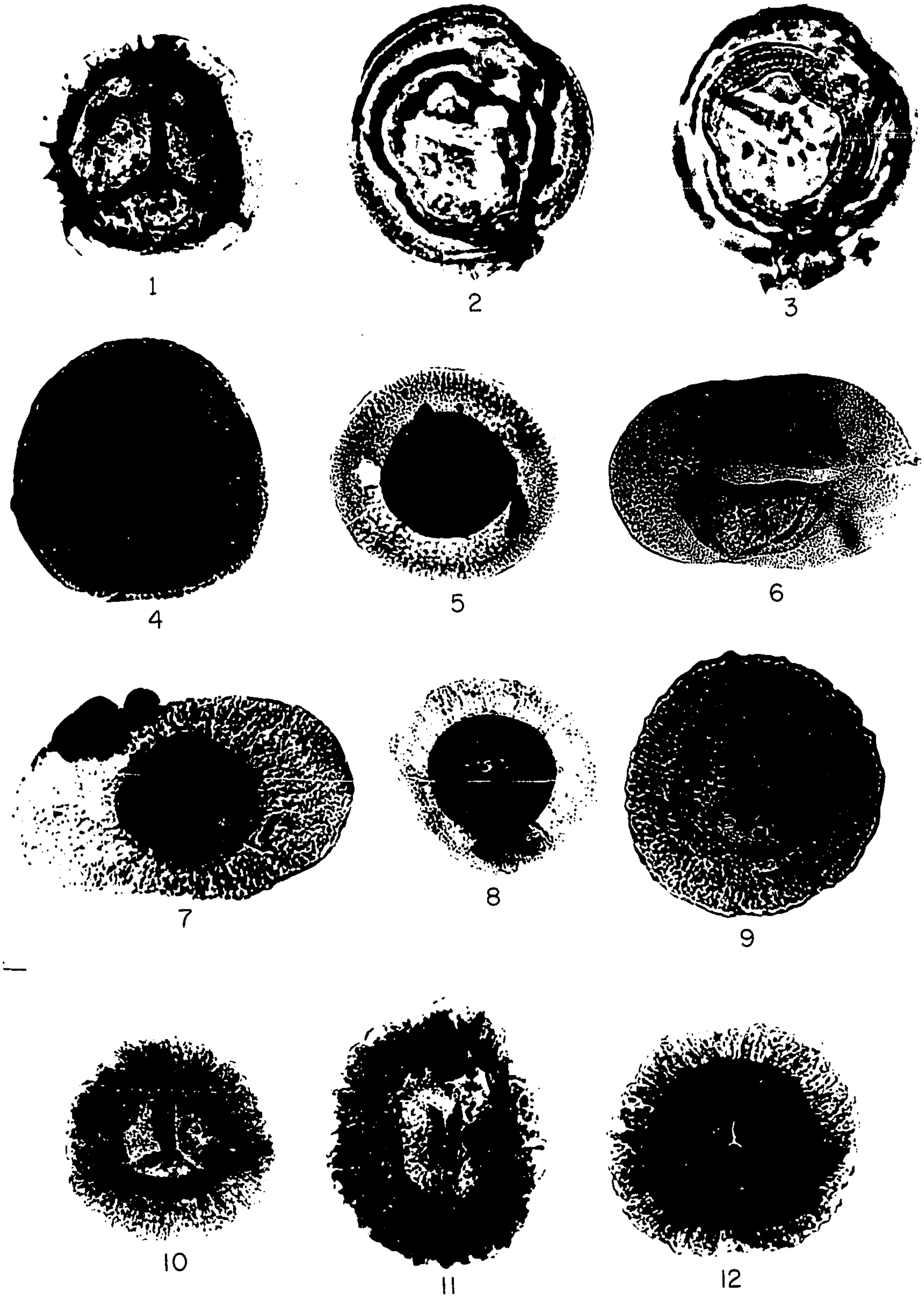


PLATE 3

Figure

1, 2. Limitisporites delasaucci (R. Potonie and Klaus) Schaarschmidt, 1963
(1) 60 x 45 microns; OPC 1070-249-6-2
(2) 60 x 44 microns; OPC 1070-249-7-1

3. Limitisporites Sp. A
73 microns; OPC 1072-117-3-3

4. Limitisporites perspicuus (Leschik) comb. nov.
53 microns; OPC 1071-107-1-2

5, 6. Genus C Sp. A
(5) 62 x 43 microns; OPC 1072-154-8-5
(6) 64 x 38 microns; OPC 1072-138-7-2

7, 8. Gigantosporites aletoides Klaus, 1963
105 x 84 microns; OPC 1071-74-6-1
(7) Proximal view
(8) Distal view

9,10, 11. Genus D Sp. A
(9) 63 x 49 microns; OPC 1072-117-4-2
(10) 68 x 48 microns; OPC 1072-117-4-3
(11) 63 x 51 microns; OPC 1072-117-5-9

PLATE III

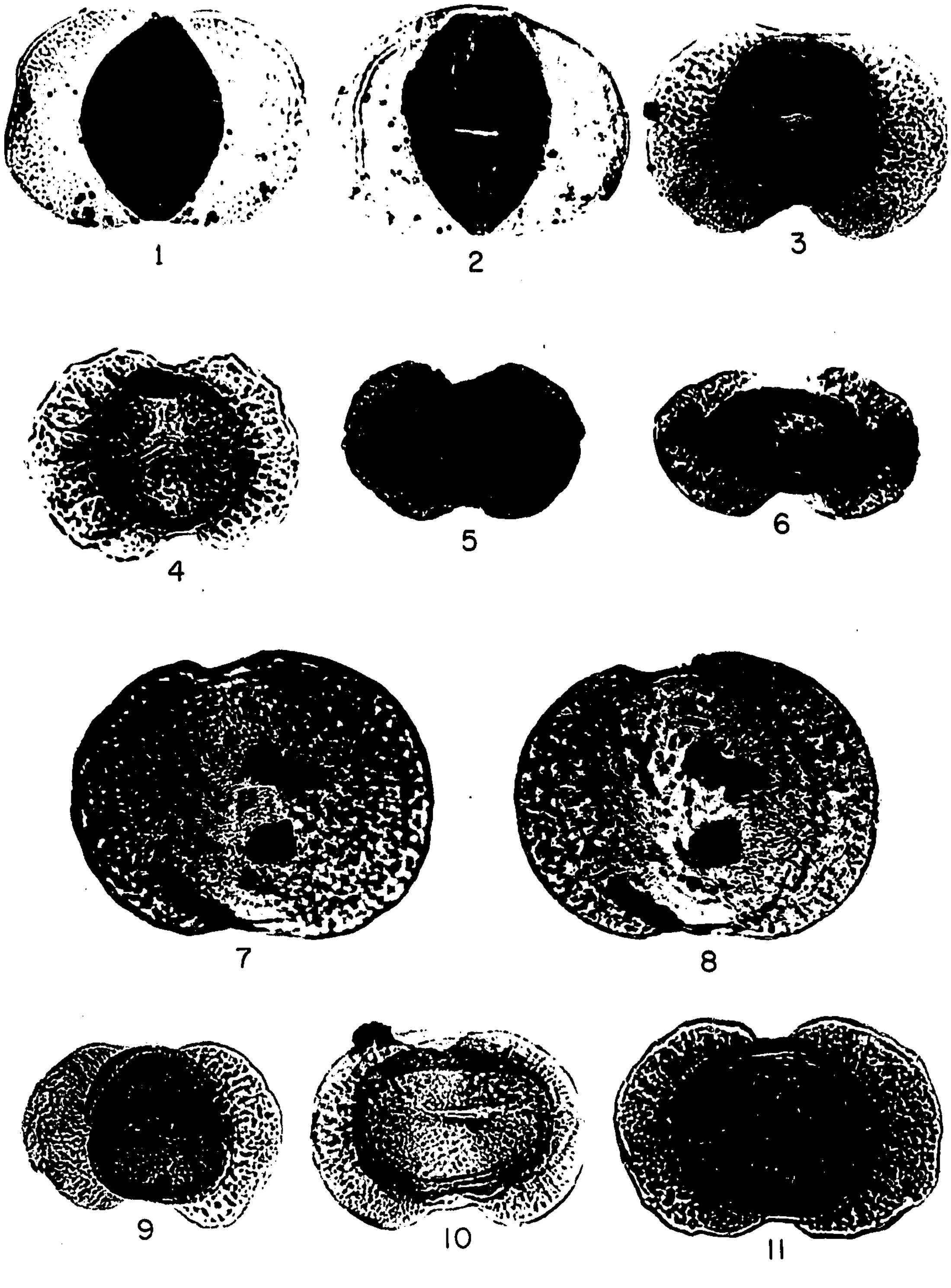


PLATE 4

Figure

1. Alisporites aequus Wilson, 1962
   100 x 60 microns; OPC 1072-154-6-2

2. Vesicaspora Sp. A
   32 x 26 microns; OPC 1070-218-1-1

3,7,8,
9. Paravesicaspora splendens (Leschik) Klaus, 1963
   average 54 x 32 microns;
   (3) OPC 1070-249-1-3
   (7) OPC 1070-249-1-1
   (8) OPC 1070-249-2-1
   (9) OPC 1071-204-2-1

4. Falcisporites zapfei (R. Potonie and Klaus, 1954)
   Leschik, 1956
   48 x 30 microns; OPC 1070-197-10-6

5, 6. Paravesicaspora Sp. A
   (5) 45 x 32 microns; OPC 1070-249-3-1
   (6) 45 x 45 microns; OPC 1070-249-8-2

10,11. Klausipollenites Sp. A
   (10) 29 x 17 microns; OPC 1070-197-1-5
   (11) 32 x 18 microns; OPC 1072-154-1-4

12. Vitreisporites Sp. A
   24 x 18 microns; OPC 1071-204-3-3

PLATE IV

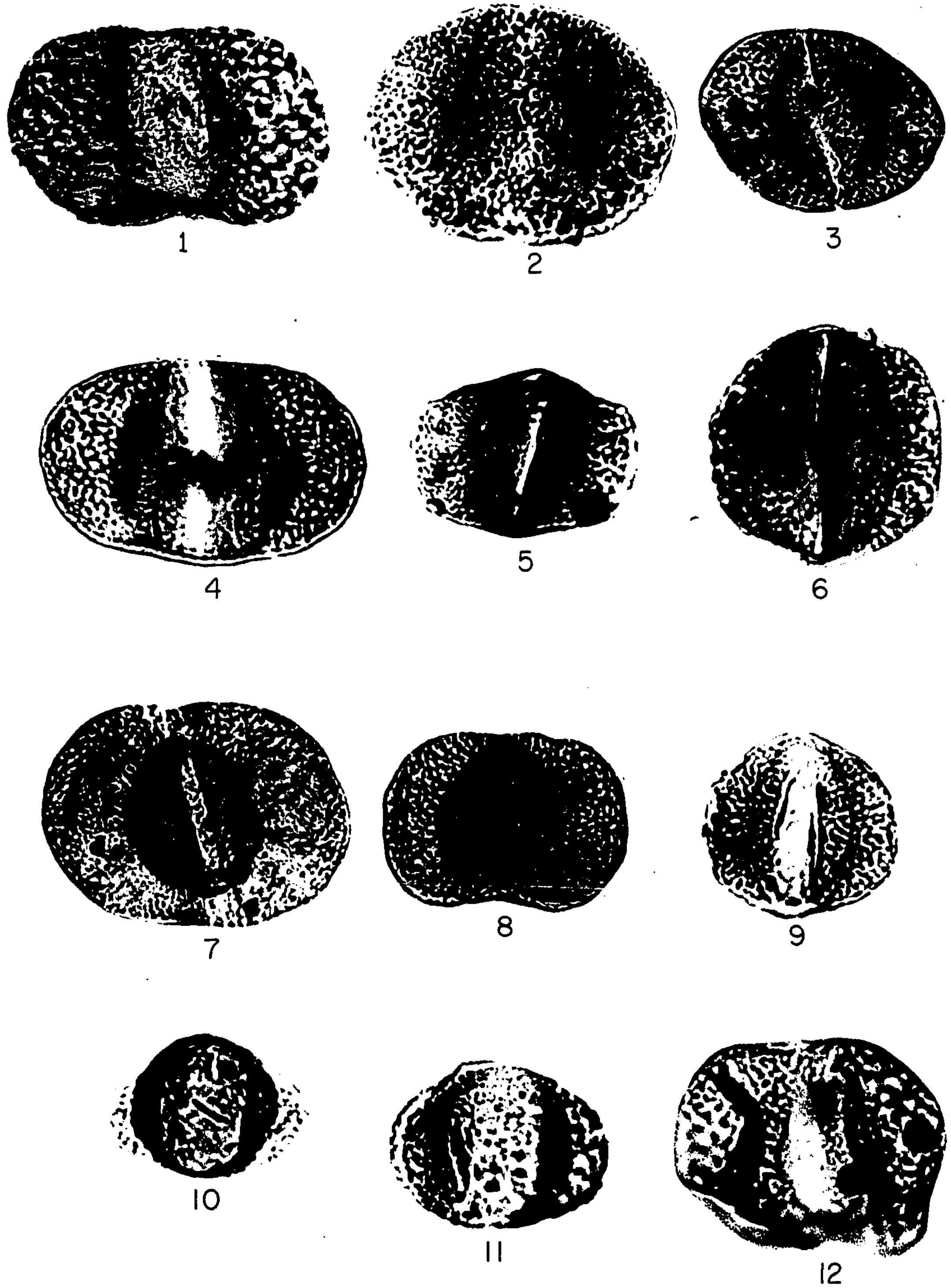


PLATE 5

Figure

1, 4. Lueckisporites virkkiae Potonie and Klaus, 1954
(1) 50 x 40 microns; OPC 1070-218-2-1
(4) 51 x 51 microns; OPC 1070-197-5-4

2. Lueckisporites microgranulatus Klaus, 1963
48 x 28 microns; OPC 1072-154-4-9

3. Lueckisporites globosus Klaus, 1963
66 x 42 microns; OPC 1070-185-7-2

5. Lueckisporites parvus Klaus, 1963
32 x 23 microns; OPC 1070-218-8-3

6. Taeniaepollenites Sp. A
65 x 38 microns; OPC 1070-218-4-4

7. Taeniaepollenites Sp. B
69 x 41 microns; OPC 1072-117-6-1

8. Taeniaepollenites Sp. C
53 x 37 microns; OPC 1071-74-3-3

9. Taeniaepollenites Sp. D
90 x 54 microns; OPC 1072-117-5-7

10. Lunatisporites Sp. A
100 x 70 microns; OPC 1070-185-1-8

11. Lunatisporites cf. L. sulcatus Pautsch comb. nov.
116 x 92 microns; OPC 1070-249-9-3

12. Lunatisporites Sp. B
130 x 82 microns; OPC 1071-107-2-3

PLATE V

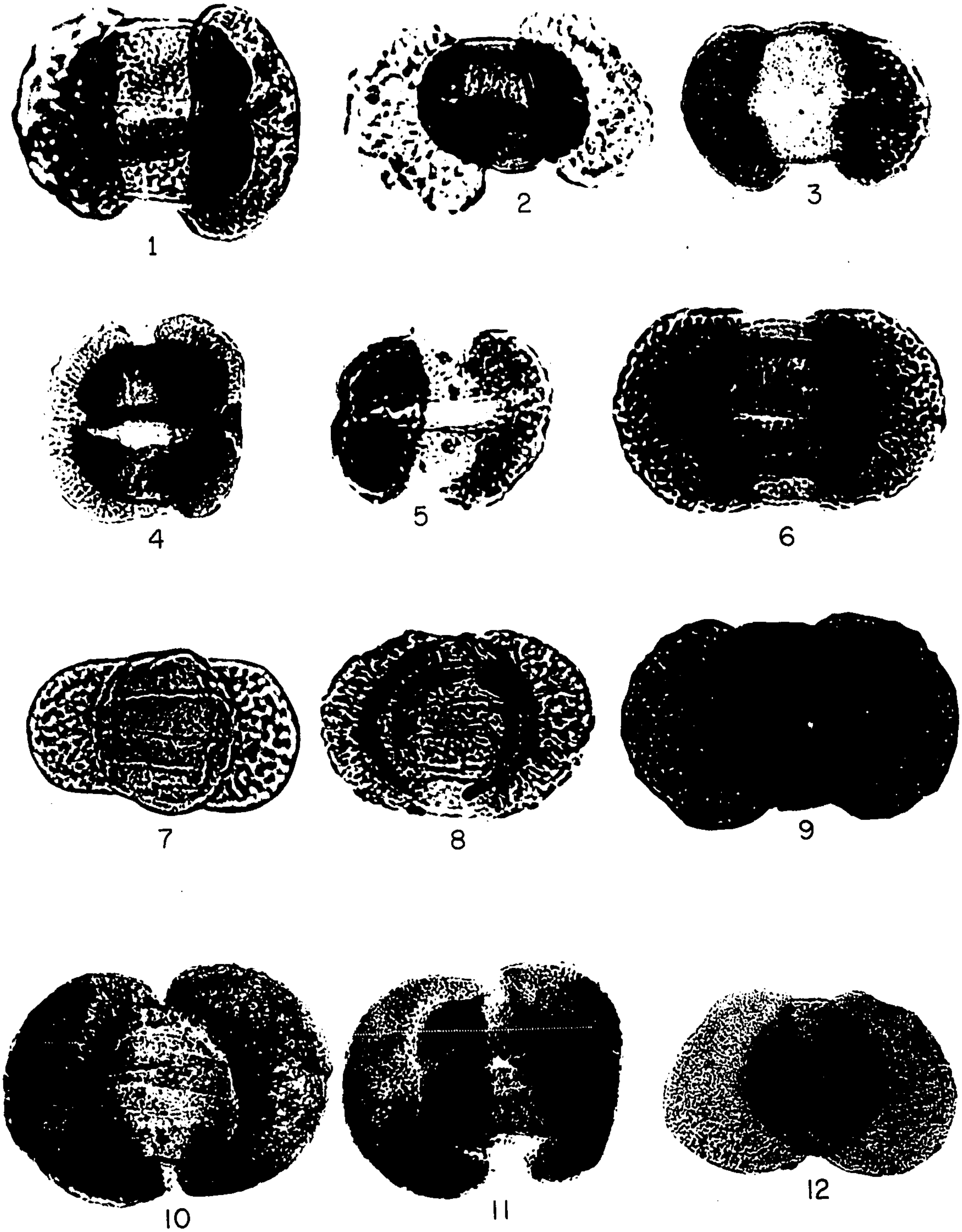


PLATE 6

Figure

1. *Lunatisporites* Sp. C
   140 x 110 microns; OPC 1072-154-5-7

2. *Protohaploxypinus* Sp. A
   35 x 24 microns; OPC 1072-154-6-1

3. *Protohaploxypinus* Sp. B
   33 x 23 microns; OPC 1070-197-10-7

4. *Protohaploxypinus* Sp. C
   90 x 45 microns; OPC 1072-117-5-7

5. *Striatoabietites* Sp. A
   80 x 47 microns; OPC 1071-74-2-5

6. *Striatites physema* comb. nov.
   107 x 63 microns; OPC 1071-107-5-2

7. *Strotersporites communis* Wilson, 1962
   122 x 74 microns; OPC 1071-117-1-2

8. *Strotersporites* Sp. A
   75 x 36 microns; OPC 1070-238-9-4

9. *Strotersporites richteri* (Klaus, 1952) Wilson, 1962
   77 x 41 microns; OPC 1070-218-1-2

10. *Tubantiapollenites* Sp. C
    91 x 66 microns; OPC 1071-107-5-1

11. *Tubantiapollenites* Sp. B
    58 x 51 microns; OPC 1070-249-7-2

12. *Tubantiapollenites* Sp. A
    75 x 36 microns; OPC 1072-138-7-2

PLATE VI

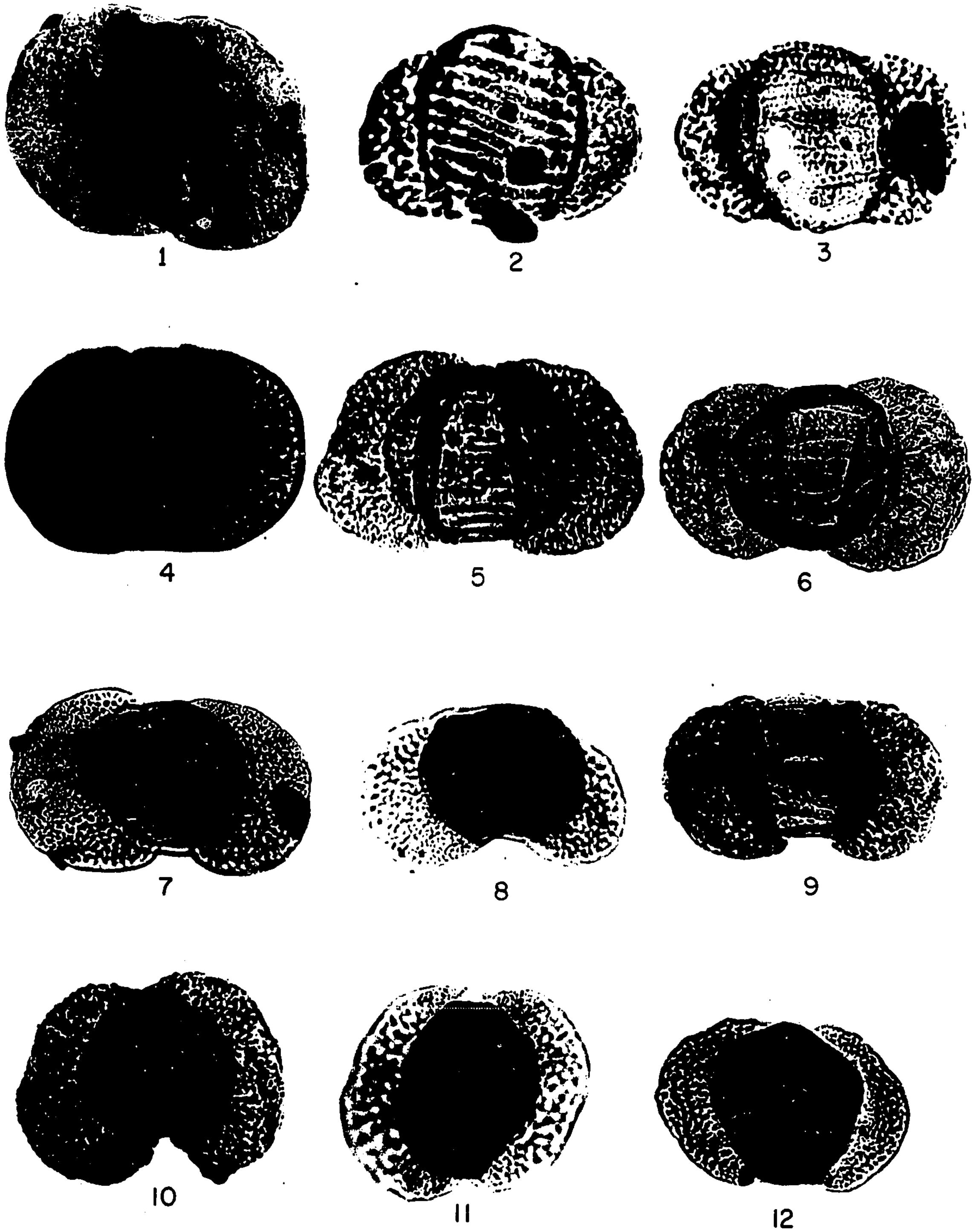


PLATE 7

Figure

1. <u>Striatopodocarpites</u> Sp. A
   102 x 68 microns; OPC 1072-138-3-7

2. <u>Striatopodocarpites</u> Sp. B
   99 x 70 microns; OPC 1072-154-5-10

3. <u>Striatopiceites</u> Sp. A
   65 x 60 microns; OPC 1071-94-2-1

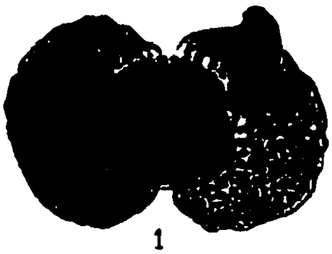
4. <u>Fimbriaesporites</u> Sp. A
   101 x 65 microns; OPC 1070-238-7-1

5, 6. <u>Fimbriaesporites</u> Sp. B
   (5) 70 x 38 microns; OPC 1071-74-10-1
   (6) Phase contrast photomicrograph

7. <u>Rhizomaspora</u> <u>devaricata</u> Wilson, 1962
   84 x 52 microns; OPC 1071-107-10-3

8, 9. <u>Rhizomaspora</u> <u>radiata</u> Wilson, 1962
   (8) 77 x 56 microns; OPC 1071-94-10-8
   (9) 78 x 58 microns; OPC 1072-138-10-6

PLATE VII



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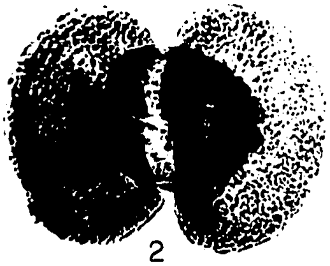

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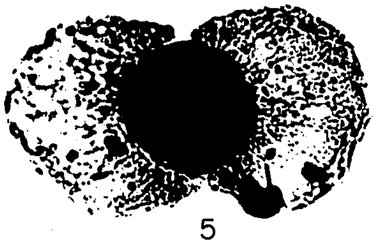

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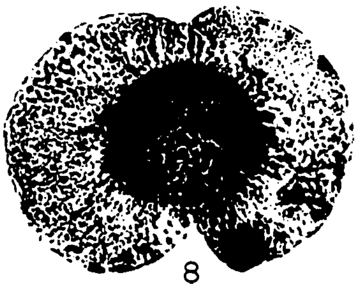

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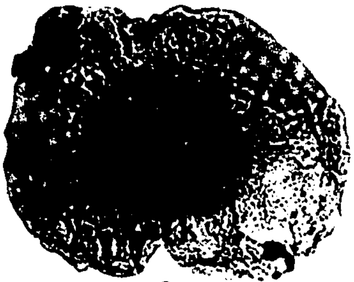

9

PLATE 8

Figure

1, 2. Hamiapollenites saccatus Wilson, 1962
(1) 70 x 42 microns; OPC 1072-154-1-3
(2) 44 x 26 microns; OPC 1072-138-5-6

3. Hamiapollenites perisporis (Jizba, 1962) Tschudy and Kosanke, 1965
41 x 31 microns; OPC 1071-107-7-2

4, 5. Hamiapollenites tractiferinus (Samoilovich, 1953) Jansonius, 1962
(4) 42 x 22 microns; OPC 1070-197-1-4
(5) 31 x 18 microns; OPC 1071-94-2-5

6. Distriatites Sp. A
29 x 22 microns; OPC 1072-138-4-1

7. Trochosporites reniformis Wilson, 1962
66 x 56 microns; OPC 1072-154-8-4

8. Crustaesporites globosus ? Leschik, 1956
89 x 77 microns; OPC 1072-138-7-6

9. Genus E Sp. A
78 x 46 microns; OPC 1072-138-9-2

10. Clavatasporites irregularis Wilson, 1962
76 x 64 microns; OPC 1072-138-5-1

11. Grebespora Sp. A
46 microns in diameter; OPC 1070-185-10-1

PLATE VIII

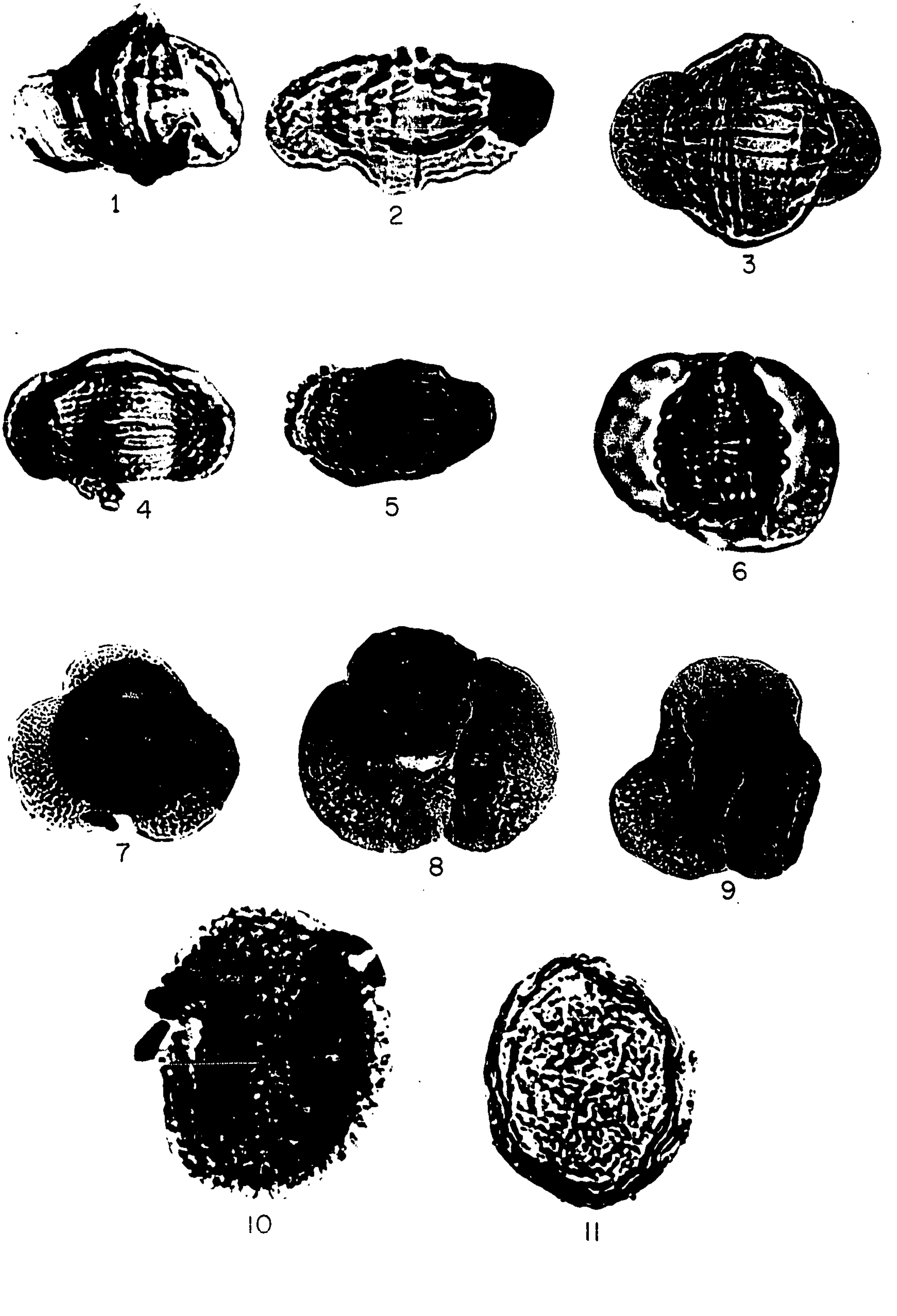

PLATE 9

Figure

1, 2. Cycadopites dijkstrae Jansonius, 1962
(1) 26 x 15 microns; OPC 1071-94-2-8
(2) 37 x 20 microns; OPC 1072-154-2-3

3. Cycadopites Sp. A
60 x 40 microns; OPC 1070-238-5-2

4. Monosulcites cf. M. minimus Cookson, 1947
18 x 9 microns; OPC 1070-197-5-2

5. Monosulcites Sp. A
95 x 31 microns; OPC 1071-204-2-4

6. Equisetosporites Sp. B
40 x 15 microns; OPC 1071-94-5-3

7. Equisetosporites Sp. C
55 x 20 microns; OPC 1071-94-3-5

8. Equisetosporites Sp. A
80 x 34 microns; OPC 1072-154-2-4

9. Equisetosporites Sp. D
34 x 22 microns; OPC 1072-154-9-2

10. Equisetosporites Sp. E
52 x 23 microns; OPC 1071-94-2-9

PLATE IX

PLATE 10

Figure

1, 7. Vittatina vittifer Luber, 1940
75 x 51 microns; OPC 1072-64-8-3; OPC 1071-94-5-9

2. Vittatina costabilis Wilson, 1962
68 x 48 microns; OPC 1071-107-4-2

3. Vittatina striata Samoilovich, 1953
51 x 42 microns; OPC 1070-117-3-5

4. Vittatina elegans Zauer, 1965
59 x 31 microns; OPC 1070-238-4-6

5. Vittatina Sp. A
16 x 50 microns; OPC 1071-204-7-2

6. Vittatina Sp. B
52 x 42 microns; OPC 1070-197-10-4

8. Vittatina Sp. C
50 x 47 microns; OPC 1071-94-5-2

9, 10. Vittatina lata Wilson, 1962
84 x 52 microns; OPC 1071-94-5-1

11. Vittatina subsaccata Samoilovich, 1953
61 x 61 microns; OPC 1070-249-4-1

12. Vittatina Sp. D
47 x 40 microns; OPC 1071-94-3-4

PLATE X

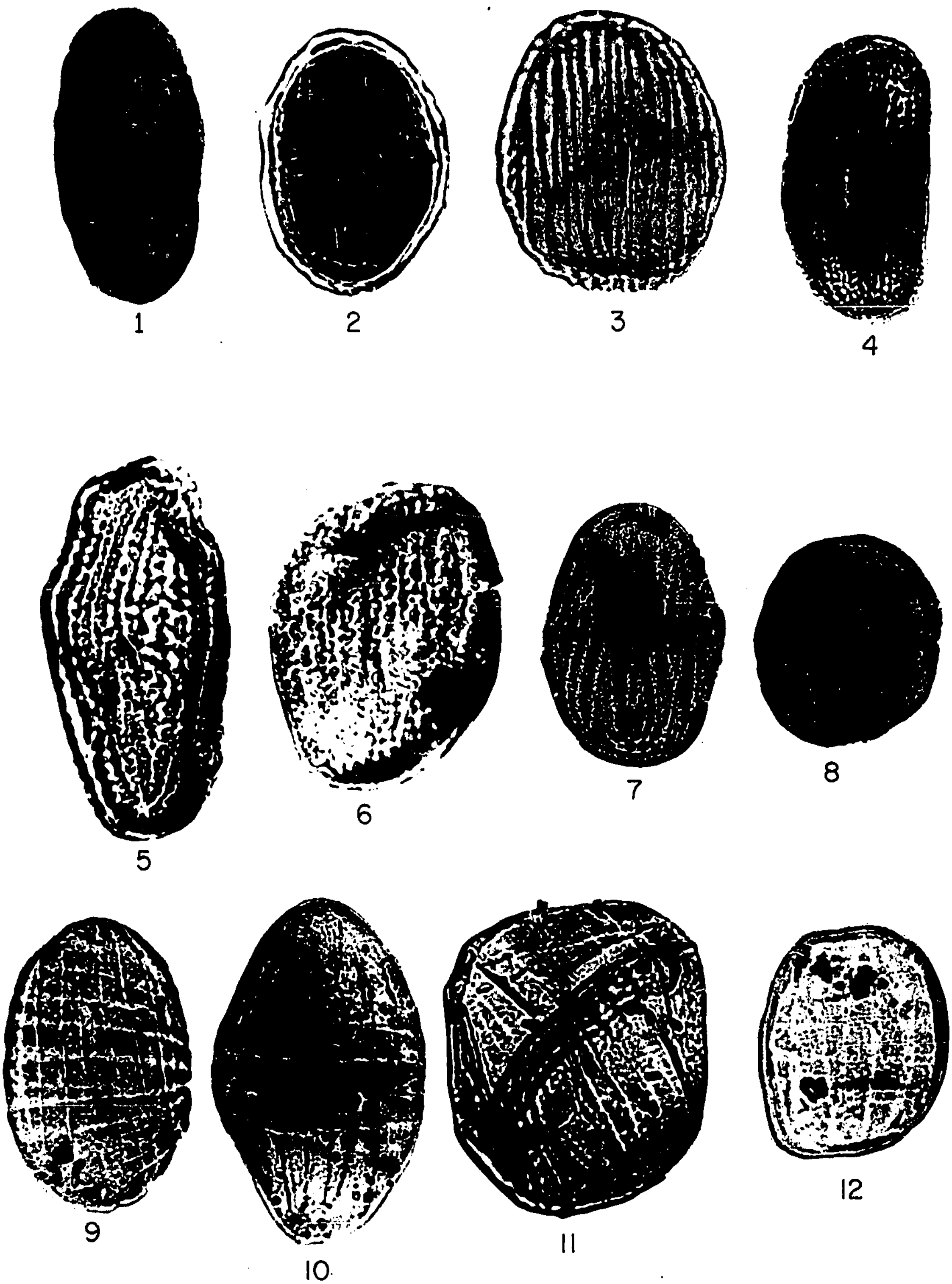

PLATE 11

Figure

1. Genus F Sp. A
   33 x 24 microns; OPC 1071-204-2-2

2. Genus F Sp. B
   34 x 28 microns; OPC 1070-185-3-3

3. Genus F Sp. C
   31 x 26 microns; OPC 1071-204-1-1

4, 5. Genus G Sp. A
   (4) 80 x 44 microns; OPC 1072-138-10-3
   (5) 55 x 33 microns; OPC 1072-154-8-2

6. Genus H Sp. A
   47 x 32 microns; OPC 1071-107-9-1

7. Genus I Sp. A
   48 x 41 microns; OPC 1071-94-9-4

8. Genus I Sp. B
   76 by 57 microns; OPC 1071-94-10-6

PLATE XI

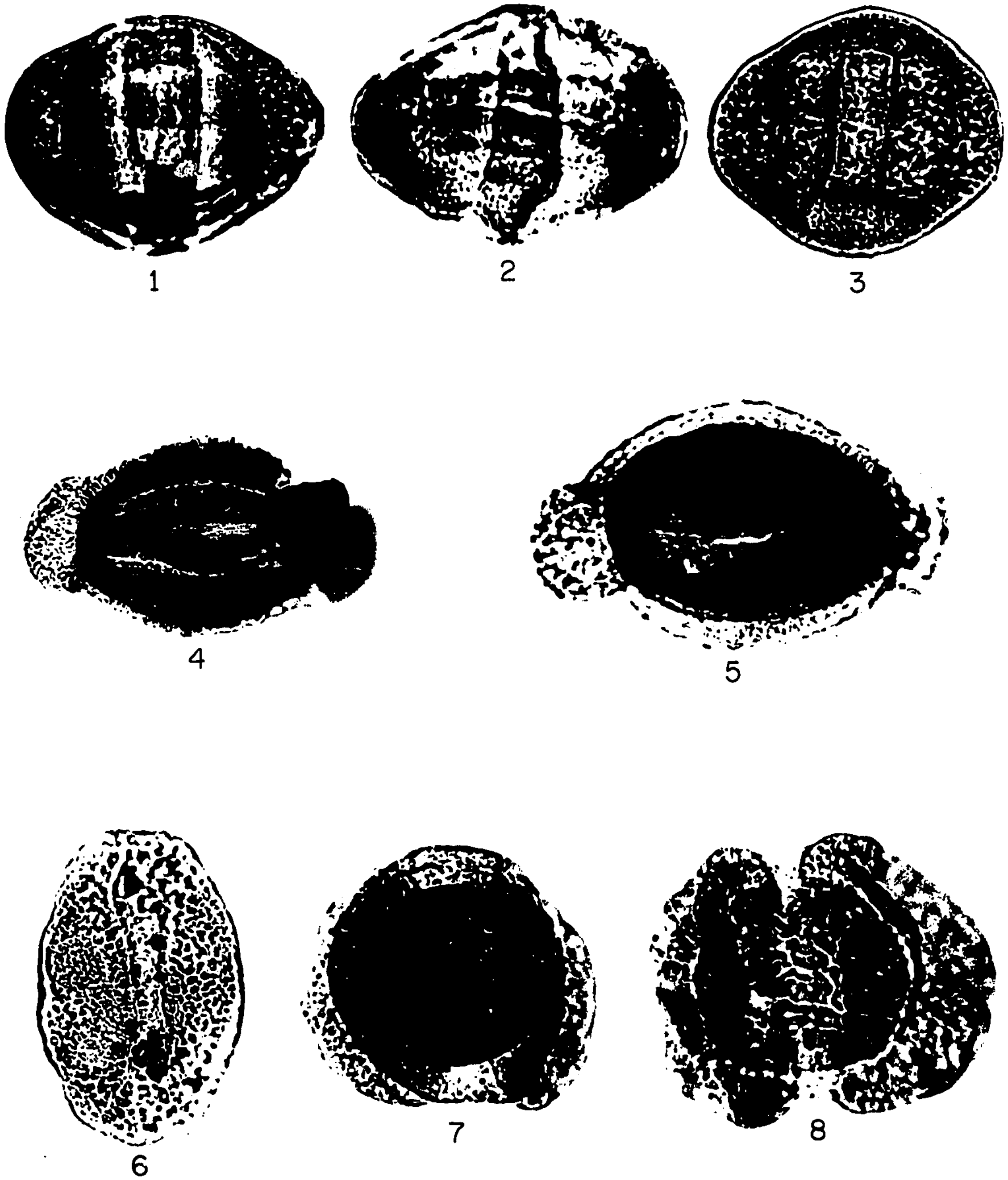

PLATE 12

Figure

1. Psophosphaera Sp. A
   45 microns in diameter; OPC 1070-197-3-4

2. Psophosphaera Sp. B
   87 x 66 microns; OPC 1070-197-3-5

3. Psophosphaera Sp. C
   34 x 30 microns; OPC 1071-204-9-1

4. Genus J Sp. A
   66 x 56 microns; OPC 1071-64-5-2

5. Genus J Sp. B
   44 microns in diameter; OPC 1070-197-6-2

6. Genus J Sp. C
   58 x 53 microns; OPC 1072-154-3-2

7,8,9. Acanthodiacrodium Sp. A
   (7) 38 x 30 microns; OPC 1071 64-7-3
   (8) 36 x 28 microns; OPC 1071-64-1-5
   (9) 31 x 26 microns; OPC 1072-117-4-5

PLATE XII