THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

A PALYNOLOGICAL INVESTIGATION OF THE LOWER AND UPPER McALESTER COALS (PENNSYLVANIAN) OF OKLAHOMA

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

JAMES E. DEMPSEY

Norman, Oklahoma

1964

A PALYNOLOGICAL INVESTIGATION OF THE LOWER AND UPPER McALESTER COALS (PENNSYLVANIAN) OF OKLAHOMA

APPROVED BY

L. R. Wilson

Carl C. Branson

E. A. Pederson

[illegible]

R. O. Marcus

DISSERTATION COMMITTEE

ACKNOWLEDGMENTS

The writer wishes to express his thanks to Dr. L. R. Wilson, Research Professor of Geology, The University of Oklahoma, who directed this dissertation and whose advice and suggestions contributed materially to the completion of the investigation.

Appreciation is expressed to Dr. C. C. Branson, Director, Oklahoma Geological Survey, Dr. E. A. Frederickson and Dr. C. A. Merritt, School of Geology, and Dr. G. J. Goodman, Department of Botany, for serving on the doctoral committee and offering constructive criticisms of the manuscript.

To my wife, Ida Lou, a special debt of gratitude is owed for her encouragement throughout all phases of this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

A PALYNOLOGICAL INVESTIGATION OF THE LOWER AND UPPER McALESTER COALS (PENNSYLVANIAN) OF OKLAHOMA*

INTRODUCTION

The present palynological investigation of the Lower and Upper McAlester coals began in the fall of 1962 with the following objectives: 1) to identify, describe, and illustrate the palynological fossils; 2) determine palynological differences of the two coal seams; 3) determine the spore succession in the two coal seams; 4) investigate the ecological distribution of the floral assemblages; and 5) determine the relationship of spore preservation to the fixed-carbon percentages.

Areal distribution of McAlester coals is admirably suited to such an investigation. Preservation of palynomorphs ranges from excellent, near the southern extent of the coals in Coal County, to total destruction of fossil forms in southern Sequoyah County.

Published palynological studies of the McAlester coals includes Morgan (1955), which is brief, somewhat generalized, and contains data from several coals not within the McAlester Formation, and

*The National Science Foundation gave financial aid under Grant No. G-22083.

Wilson (1961) which included six localities of McAlester coals in a study of spore preservation in response to low-grade metamorphism. The investigative approach of this study is designed to demonstrate correlation of the two coal seams based upon detailed examination of the fossil spore flora.

Previous palynological studies of Oklahoma coals within the Krebs Group of the Des Moines Series (Pennsylvanian) have been made by Morgan (1955), Clarke (1961), Davis (1961), Higgins (1961), and Bordeau (1964). Coals from the overlying Cabaniss Group have been studied by Wilson and Hoffmeister (1956), Gibson (1961), Ruffin (1961), Urban (1962), and Bond (1963).

The most important palynological study outside of Oklahoma which has a bearing upon the McAlester coals is that of Kosanke (1950).

STRATIGRAPHY

The McAlester Formation is included in the Krebs Group of the Des Moines Series (Middle Pennsylvanian) (Branson, 1962, p. 440-441). The coals of the McAlester Formation generally occur within the upper half of the formation which is approximately equivalent to the Upper Westphalian B or Lower Westphalian C of Europe.

The McAlester Formation was named, without a designated type locality, by Taff (1899, p. 437) from the town of McAlester, Pittsburg County, Oklahoma. Previously several workers had mentioned the "Coal Measures" of the McAlester district but did not apply the name McAlester in a formational sense.

Shannon, et al., (1926, p. 73-74) discussed the coals of Oklahoma and stated that the McAlester Formation consisted of a great series of sandstones and shales and estimated the thickness to be 2,000 feet. The McAlester coal (p. 75-76) occurs from 1,200 to 1,500 feet above the Hartshorne coal and crops out over a 70-mile extent in the southern part of the district. The coal varies in thickness from three feet in the eastern portion to four and one-half feet in the western portion and is of high quality, being especially adaptable as a steam coal. The Stigler coal (p. 76) is found in an area directly south of the confluence of the Canadian and Arkansas Rivers and occupies an approximately equivalent position to the McAlester

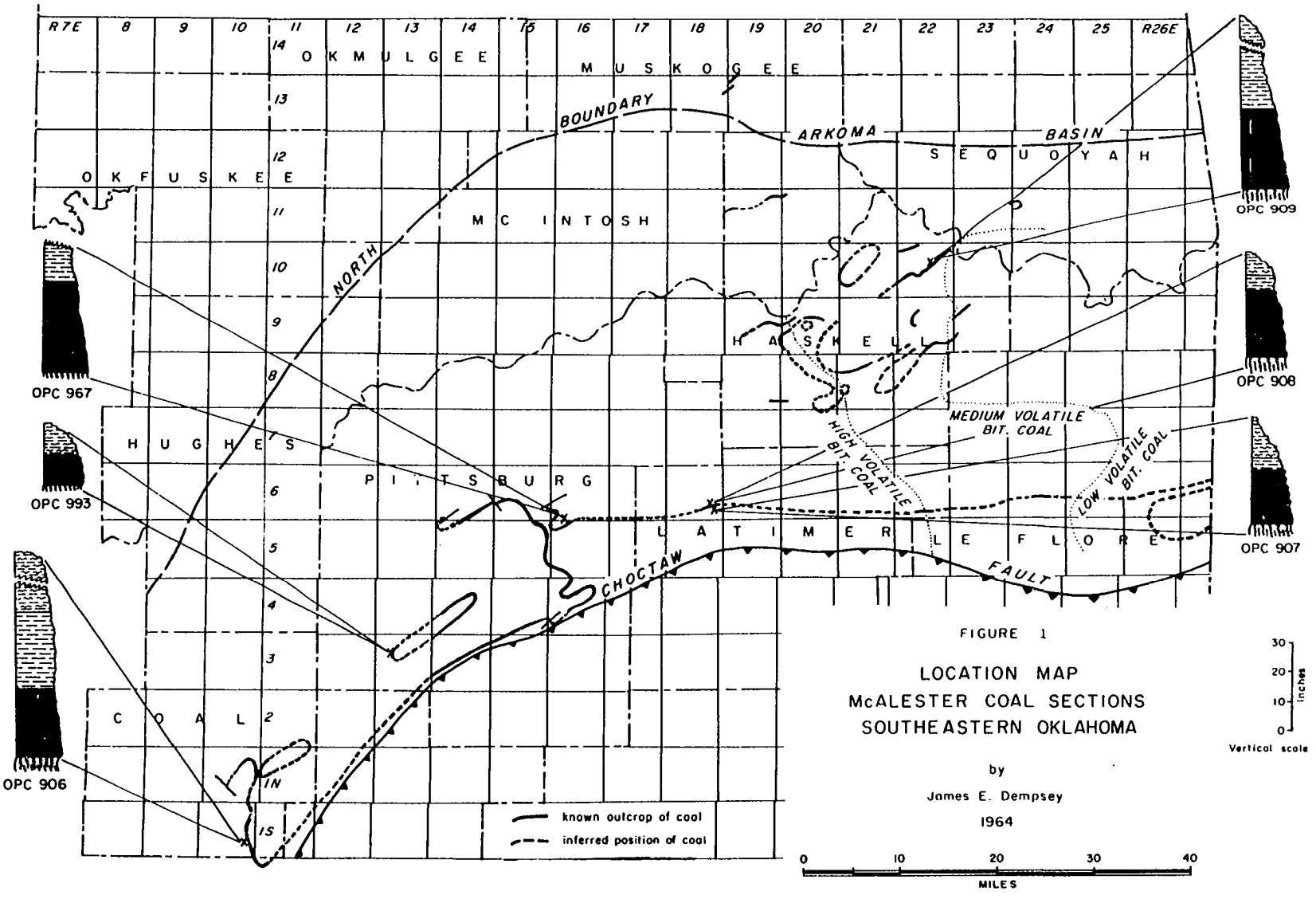


FIGURE 1

LOCATION MAP
McALESTER COAL SECTIONS
SOUTHEASTERN OKLAHOMA

by

James E. Dempsey

1964

coal but has not been proven to be its exact equivalent.

Moose and Searle (1929, p. 8) placed the Lehigh coal equivalent to the McAlester coal in the Coalgate-Lehigh district of the southern part of the Oklahoma coal field.

Hendricks, et al. (1937-1939) discussed the general stratigraphy of the McAlester Formation and reported the areal distribution of the McAlester coals and gave their descriptions and geographic locations.

Dott (1942) believed the McAlester and Lehigh coal beds to be equivalent and widely distributed in eastern Oklahoma. He also stated that the Stigler bed, of Haskell and Muskogee Counties, was probably equivalent to the McAlester-Lehigh bed or to another coal which lies 50 to 60 feet above it.

Oakes and Knechtel (1948, p. 81-85) recorded considerable data on the Stigler coal in Haskell County and (Pl. 2) mapped all the known outcrops. They also listed (Table 3) measurements of coal beds within the county.

Knechtel (1949, p. 17-26) discussed in detail 11 recognized members of the McAlester Formation in northern LeFlore County and reported (p. 48-49) occurrence of Stigler coal in the area.

Trumbull (1957, p. 332-333) stated that along the southern margin of the Oklahoma coalfield the McAlester Formation was from 1,750 to 2,500 feet thick and thinned northward and westward so that it is only 500 to 700 feet thick in northern Haskell County and southern Muskogee County, thinning to 200 feet near Muskogee.

Russell (1960, p. 16) reported that the McAlester Formation

reached a maximum known thickness of 2,830 feet near Red Oak in Latimer County.

Branson (in Doerr, 1961, fwd.) referring to coals within the McAlester Formation stated:

> In the McAlester formation there are two commercial coal beds, the lower, the McAlester coal, mined near McAlester and under the name Lehigh in the Lehigh area, and the Stigler coal, mined at many places in Haskell, LeFlore, Sequoyah, and locally in Pittsburg County.

Frezon (1962, p. 20) reported that in the subsurface of some areas the McAlester Formation apparently contains as many as five coal beds.

Stratigraphically, the unnamed shale above the Cameron Sandstone Member contains the McAlester (Lehigh) and Stigler coals which are overlain, in turn, by the Tamaha and Keota Sandstone Members.

The known outcrops and inferred locations of the McAlester coals are summarized in Figure 1. These coals are known to occur, and have been mined, in the following Oklahoma counties: Atoka, Coal, Haskell, Latimer, LeFlore, McIntosh, Muskogee, Pittsburg, and Sequoyah. In 1962 mining activity of these two coals was confined to Haskell, McIntosh, Pittsburg, and Sequoyah Counties.

The McAlester (Lehigh) and Stigler coals have been, in the past, an important source of coals within the state, ranking second only to the Lower and Upper Hartshorne coals.

Trumbull (1957, p. 307-382) discussed the coal resources of Oklahoma and (p. 312-313) summarized the estimated remaining reserves of coal as of January 1, 1953. With regard especially to the two McAlester coals, a summary, taken from Trumbull, follows:

Reserves in millions of short tons
(Based on beds 14 inches
thick or thicker)

BED	INFERRED	MEASURED	INDICATED	TOTAL
McAlester	211.82	64.00	264.01	539.83
Lehigh	108.29	27.72	119.59	255.60
Stigler	62.76	34.21	57.06	154.03
Stigler (?)	7.32	3.31	5.76	16.39
Totals	390.19	129.24	446.42	965.85

Between 1873 and 1952 approximately 166,453,789 short tons of coal were mined in Oklahoma (Trumbull, 1957, p. 364).

In several localities the two commercially important coals within the upper portion of the McAlester Formation have been variously named as follows (Branson, 1954b): Adams (obsolete name), Coalgate-Lehigh, Lehigh, McAlester, and Stigler.

Stratigraphic Classification of the Krebs Group,

Des Moines Series (Middle Pennsylvanian)

of Southeastern Oklahoma

Modified from Branson, 1954a, 1962 and Trumbull, 1957

Krebs Group

Boggy Formation

Savanna Formation
- Drywood coal
- local coal
- Rowe coal
- Sam Creek limestone
- Spaniard limestone

McAlester Formation
- local coal
- Keota sandstone
- Tamaha sandstone
- McAlester coals
- Cameron sandstone
- Lequire sandstone
- local coal
- Warner sandstone
- McCurtain shale

Hartshorne Formation
- Hartshorne sandstone (with Upper and Lower Hartshorne coals)

COLLECTIONS

Six channel sections of McAlester coals, including roof shales and seat earths, from five separate localities (Figure 1) were measured and collected during late 1962 and early 1963. The six sections are located in Coal, Pittsburg, Latimer, and Haskell Counties. Although the McAlester coals are known to occur in Sequoyah County no attempt was made to collect samples there inasmuch as fossil response to low-grade incipient metamorphism is such that few, if any, fossils remain (Wilson, 1961). All sample localities lie within the Arkoma Basin, an east-west trending structural and depositional basin, which extends approximately 50 miles north-south and 250 miles east-west.

The coal channel samples were generally taken as three-inch segments throughout the seam along with a two-inch sample of both the roof shale and seat earth. Each sample locality was assigned an Oklahoma Palynology Collection (OPC) number and the segment samples designated A, B, C, D, etc., from the seat earth upward through the coal and into the roof shale. Portions of samples not processed for the dissertation research are deposited in the collection of the Oklahoma Geological Survey, Norman, Oklahoma.

Detailed descriptions of sample localities and position of segment samples are listed in Table 1.

TABLE 1

SECTIONS OF McALESTER COALS AND POSITION OF SEGMENT SAMPLES

OPC 906: North bank of small intermittent creek in SW¼ SW¼ section 25, T. 1 S., R. 10 E., approximately 2½ miles south-southeast of Lehigh, Coal County, Oklahoma.

Lithology	Thickness (inches)
Clayey soil, loosely consolidated, tan	77.0
Shale, calcareous, fossiliferous, gray to tan	27.0
Lower McAlester coal (Lehigh)	24.0
Seat earth	8.0

Sample No.	Lithology	Thickness (inches)	Measurement above base of coal (inches)
OPC 906J	shale	3	24.0-27.0
OPC 906I	coal	3	21.0-24.0
OPC 906H	coal	3	18.0-21.0
OPC 906G	coal	3	15.0-18.0
OPC 906F	coal	3	12.0-15.0
OPC 906E	coal	3	9.0-12.0
OPC 906D	coal	3	6.0- 9.0
OPC 906C	coal	3	3.0- 6.0
OPC 906B	coal	3	0.0- 3.0
OPC 906A	seat earth	2	below coal

OPC 907 In west bank of creek approximately 85 feet north of section line between sections 26 and 35, T. 6 N., R. 18 E., (SE¼ SW¼), five miles northwest of Wilburton, Latimer County, Oklahoma.

Lithology	Thickness (inches)
Clayey soil, with clay concretions, tan to brown	16.0
Shale, calcareous, gray	4.0
Upper McAlester coal (Stigler)	18.0
Seat earth	8.0

TABLE 1--continued

Sample No.	Lithology	Thickness (inches)	Measurement above base of coal (inches)
OPC 907H	shale	2	18.0-20.0
OPC 907G	coal	3	15.0-18.0
OPC 907F	coal	3	12.0-15.0
OPC 907E	coal	3	9.0-12.0
OPC 907D	coal	3	6.0- 9.0
OPC 907C	coal	3	3.0- 6.0
OPC 907B	coal	3	0.0- 3.0
OPC 907A	seat earth	2	below coal

OPC 908: In creek bed 15 feet north of section line between sections 26 and 35, T. 6 N., R. 18 E., (SE¼ SW¼), five miles northwest of Wilburton, Latimer County, Oklahoma.

Lithology	Thickness (inches)
Clayey soil, loosely consolidated	9.0
Shale, calcareous, fossiliferous, gray	5.0
Lower McAlester coal (Lehigh)	24.0
Seat earth	8.0

Sample No.	Lithology	Thickness (inches)	Measurement above base of coal (inches)
OPC 908J	shale	2	24.0-26.0
OPC 908I	coal	3	21.0-24.0
OPC 908H	coal	3	18.0-21.0
OPC 908G	coal	3	15.0-18.0
OPC 908F	coal	3	12.0-15.0
OPC 908E	coal	3	9.0-12.0
OPC 908D	coal	3	6.0- 9.0
OPC 908C	coal	3	3.0- 6.0
OPC 908B	coal	3	0.0- 3.0
OPC 908A	seat earth	2	below coal

OPC 909: Garland Coal and Mining Company strip pit located in the N½ NW¼ section 18, T. 10 N., R. 22 E., 8½ miles northeast of Stigler, Haskell County, Oklahoma.

TABLE 1--continued

Lithology	Thickness (inches)
Shale, well-indurated, gray to black	480.0
Shale, fossiliferous, calcareous, gray	10.0
Upper McAlester coal (Stigler)	27.5
Seat earth	8.0

Sample No.	Lithology	Thickness (inches)	Measurement above base of coal (inches)
OPC 909K	shale	2	27.5-29.5
OPC 909J	coal	3½	24.0-27.5
OPC 909I	coal	3	21.0-24.0
OPC 909H	coal	3	18.0-21.0
OPC 909G	coal	3	15.0-18.0
OPC 909F	coal	3	12.0-15.0
OPC 909E	coal	3	9.0-12.0
OPC 909D	coal	3	6.0- 9.0
OPC 909C	coal	3	3.0- 6.0
OPC 909B	coal	3	0.0- 3.0
OPC 909A	seat earth	2	below coal

OPC 967: Lone Star Steel Company Carbon Mine No. 5, 9,800 feet from mine entrance, 1,525 feet below surface in SE¼ NW¼ NE¼, section 32, T. 6 N., R. 16 E., near Carbon, Pittsburg County, Oklahoma.

Lithology	Thickness (inches)
Shale, gray to dark gray, overburden	? covered
McAlester coal (Lehigh)	32.0
Seat earth	2.0

Sample No.	Lithology	Thickness (inches)	Measurement above base of coal (inches)
OPC 967M	shale	3	32.0-35.0
OPC 967L	coal	3	29.0-32.0
OPC 967K	coal	3	26.0-29.0
OPC 967J	coal	3	23.0-26.0
OPC 967I	coal	3	20.0-23.0
OPC 967H	coal	3	17.0-20.0
OPC 967G	coal	3	14.0-17.0
OPC 967F	coal	3	11.0-14.0
OPC 967E	coal	3	8.0-11.0
OPC 967D	coal	3	5.0- 8.0
OPC 967C	coal	3	2.0- 5.0
OPC 967B	coal	2	0.0- 2.0
OPC 967A	seat earth	3	below coal

TABLE 1--continued

OPC 993: Bank of Boggy Creek in SW¼ SE¼ SE¼ section 8, T. 3 N., R. 13 E., approximately four miles west-northwest of Kiowa, Pittsburg County, Oklahoma.

Lithology	Thickness (inches)
Soil, loosely consolidated	12.0
McAlester coal (Lehigh)	6.0
Clayey shale, tan to brown	2.0

Sample No.	Lithology	Thickness (inches)	Measurement above base of coal (inches)
OPC 993D	coal	2	4.0-6.0
OPC 993C	coal	2	2.0-4.0
OPC 993B	coal	2	0.0-2.0
OPC 993A	clay	2	below coal

SAMPLE PREPARATION AND STUDY PROCEDURE

Sample Preparation

Preparation of samples for microscopic examination follows those procedures outlined by Wilson (1959a, p. 110-111; 1959b, p. 43), except for minor variations. These preparation techniques are outlined below.

1. Each sample is crushed and thoroughly mixed and a 10-gram portion is placed in a polyethylene beaker for acid treatments.
2. Samples from roof shales and seat earths are treated first with dilute hydrochloric acid (20 percent HCl) for 18 to 24 hours, washed until free of acid, and returned to the beaker.
3. The sample is then covered with 52 percent hydrofluoric acid (HF), allowed to stand for 24 hours, again washed until free of acid, and returned to the beaker.
4. At this point the sample is mixed (into a paste) with an equal volume of dry, powdered potassium chlorate ($KClO_3$) and covered with concentrated nitric acid (HNO_3) (Schulze's solution). The sample is observed until the initial reaction has ceased and then more concentrated nitric acid is added.

5. This is allowed to stand for 24 hours. Frequent stirring aids in the maceration process.
6. The sample is again washed until free of acid, returned to the beaker, treated with a 10 percent solution of potassium hydroxide (KOH), plus the stain Safranin O.
7. This reaction is permitted to proceed for five to seven minutes and the potassium hydroxide and excess Safranin O removed by repeated washings and centrifuging until the water is clear and nearly neutral. Note: Addition of a staining medium at step 6 is to be desired because excellent staining obtains and less residual 'background' color is preserved on the finished study microslides.

Coal samples are treated as above except that the first treatment (HF) may be omitted in most cases.

The final residue is stored in an aqueous solution containing a few drops of alcohol as a preservative. Four hundred sixty-eight microslides (12 from each sample level) were prepared from the residues.

Study Procedure

The microslides were studied with the aid of an American Optical Microstar compound binocular microscope employing 10X wide-field oculars, and 10X, 43X, and 97X (oil immersion) objectives. Each slide was examined by systematic traverses and each fossil selected to be photographed was ringed with glass marking ink. Specimens so ringed included sample number, slide number, and ring number. For

example, OPC 906B-2-2 refers to the samples of section OPC 906 of the Oklahoma Palynological Collection, level B of the sampled section, slide number 2, ring number 2, of the slides prepared from level B. Selected specimens were photographed with a Zeiss Photomicroscope on Adox KB-14 film. Final prints were made by enlargement on single-weight, Kodabromide No. 5 paper.

Two enlargements were made of each selected specimen, one was mounted on species cards for identification and other pertinent data, and the other was used for the dissertation plates.

Upon completion of species identifications assemblage counts were made. Five slides from each sampled level were employed in the assemblage counts to give random sampling and a total of 200 specimens were counted from each sample level. Relative percentages of the forms encountered in each level were computed and the results are plotted as histograms.

PALEONTOLOGY

Fossil spores and pollen from the McAlester coals and two productive seat earths consist of 91 species which are assignable to 42 genera. Nine genera and 38 species appear to be previously undescribed. Those slides containing newly described genera and species, specimens illustrated in this paper, and those slides employed in the statistical counts are deposited in the palynological collection of the Oklahoma Geological Survey, Norman, Oklahoma.

The taxonomic treatment of fossil spores and pollen in this study follows, in varying degrees, that of Schopf, Wilson, and Bentall (1944), Potonié and Kremp (1955a; 1955b), and Potonié (1956; 1958; 1960). Papers by several different authors, which dealt with emendations of various genera, were also employed.

The taxonomic system proposed by Potonié (1956; 1958; 1960) was generally followed because this system appears to be the most logical approach to an atrificial taxonomic classification. Arrangement of the various palynomorph taxa into this system is based upon morphological similarity rather than upon natural plant affinities because these affinities, and their phylogenies, are largely unknown.

SPORAE DISPERSAE

Anteturma Sporites H. Potonié, 1893

Turma Triletes Reinsch, 1881

Subturma Azonotriletes Luber, 1935

Infraturma Laevigati (Bennie and Kidston, 1886)

R. Potonié, 1956

Genus PUNCTATISPORITES (Ibrahim, 1932) Ibrahim, 1933

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

Type Species: Punctatisporites punctatus (Ibrahim, 1932) Ibrahim, 1933

1932 Sporonites punctatus Ibrahim, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 448, pl. 15, fig. 18.

1933 Punctati-sporites punctatus (Ibrahim) Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers. Würzburg, Dissert., p. 21, pl. 2, fig. 18.

Potonié and Kremp (1955a, p. 120-121) emended the genus Punctatisporites and restricted it to those more or less spherical forms possessing a granulate, punctate, or infragranulate ornamentation. Numerous species, previously assigned to this genus, were transferred to various other genera, based upon the presence of exine ornamentation, which is considered to be of specific, not generic, value. Therefore, the conservative taxonomic approach, and the emendation of Schopf, Wilson, and Bentall (1944), is followed.

PUNCTATISPORITES LATIGRANIFER (Loose, 1932)

S., W., and B., 1944

Plate 1, figure 2

*for Schopf, Wilson, and Bentall, 1944

1932 Sporonites latigranifer Loose, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 452, pl. 19, fig. 54.

1934 Granulati-sporites latigranifer (Loose) Loose, Inst. Paläobot. und Petrog. Brennsteine, Arbeiten, vol. 4, p. 147.

1944 Punctati-sporites latigranifer (Loose) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 31.

Punctatisporites latigranifer was noted in all five fossiliferous sections and all but six levels. In the Lower McAlester (Lehigh) samples from Coal County (OPC 906) it increases steadily from 1.5 percent, in the lowermost coal sample, to 9.5 percent in the topmost coal sample. The parent plant from which spores of P. latigranifer were derived appears to have been associated with early to middle coal swamp development as evidenced by greater percentages being found in the lower two-thirds of the seams. Too, it appears that this parent plant was more prevalent near the areal center of the outcrop area because OPC 967 has a maximum number of specimens.

This species is widely distributed in Desmoinesian coals of the Mid-Continent and is reported from the upper Westphalian B of Germany and Lower Rotliegendes of China.

Figured specimen: Slide No. OPC 907C-3-1, Latimer County, Oklahoma.

PUNCTATISPORITES OBLIQUUS Kosanke, 1950

Plate 1, figure 5

1950 Punctati-sporites obliquus Kosanke, Ill. Geol. Survey, Bull. 74, p. 16, pl. 2, fig. 5.

This species of Punctatisporites was noted in all sections and is confined to the lower two-thirds of the coal seams except in OPC 906 and OPC 907.

Punctatisporites obliquus has been reported from Desmoinesian and Missourian coals of Illinois, Desmoinesian of Indiana, Iowa, and Oklahoma, and from the middle Westphalian B of Germany.

Figured specimen: Slide No. OPC 906A-2-10, Coal County, Oklahoma.

PUNCTATISPORITES cf. P. PROVECTUS Kosanke, 1950

Plate 1, figure 4

1950 Punctati-sporites provectus Kosanke, Ill. Geol. Survey, Bull. 74, p. 17, pl. 2, fig. 11.

This species is rare in the McAlester coals and was encountered in level OPC 906C.

It has been reported from Desmoinesian coals of Illinois, Indiana, and Oklahoma. It has not been reported from outside the United States.

Figured specimen: Slide No. OPC 906C-3-5, Coal County, Oklahoma.

PUNCTATISPORITES cf. P. VERMICULATUS Kosanke, 1950

Plate 1, figure 1

1950 Punctati-sporites vermiculatus Kosanke, Ill. Geol. Survey, Bull. 74, p. 19, pl. 2, fig. 4.

This form is rare in the McAlester coals and was encountered in four levels of OPC 906 and five levels of OPC 967.

The only previous report of this species is from the LaSalle (Missourian) coal bed of northern Illinois.

Figured specimen: Slide No. OPC 906A-2-15, Coal County, Oklahoma.

PUNCTATISPORITES SP. A

Plate 1, figure 3

Spores radial, trilete; circular in equatorial outline; overall dimensions 68.9 by 63.8 microns; trilete straight, bifurcated slightly at ends of rays; trilete emphasized by distinct, raised lips which do not extend beyond ends of the rays; lips 1.5 to 2.0 microns wide; exine 2.0 to 3.0 microns thick, exine finely punctate.

The McAlester species differs from P. labiatus Playford in the nature of the lips, the bifurcated trilete rays, and the somewhat smaller size.

Punctatisporites sp. A occurs in only two of the sampled localities, OPC 906 and OPC 907. It reaches a high of 2.0 percent in level OPC 906I and in the other levels, where noted, is only 1.0 percent of the relative assemblage counts.

Figured specimen: Slide No. OPC 906H-5-1, Coal County, Oklahoma.

PUNCTATISPORITES SP. B

Plate 1, figure 7

Spores radial, trilete; circular in outline; overall diameter 35.7 microns; trilete distinct, straight, rays 10.2 to 12.8 microns long; lips raised, distinct, thin; exine smooth but finely punctate under oil immersion; minor folding parallel with equator.

This species is rare and only three specimens were noted, two

from OPC 908H and the figured specimen from OPC 906D

Figured specimen: Slide No. OPC 906D-4-2, Coal County, Oklahoma.

PUNCTATISPORITES SP. C

Plate 1, figure 6

Spores radial, trilete; circular, or nearly so, in outline; overall dimensions 25.5 by 33.2 microns; trilete rays distinct, wavy, widening to about 2.0 microns at ends; spore wall finely punctate; folds numerous on equator and may circle spore.

Punctatisporites sp. C is rare in the McAlester coals. Three specimens were observed, two from level OPC 993B, and one specimen from level OPC 967L which is the figured specimen.

Figured specimen: Slide No. OPC 967L-5-4, Pittsburg County, Oklahoma.

Genus LEIOTRILETES (Naumova, 1937)

emend. Potonié and Kremp, 1955

Type Species: Leiotriletes sphaerotriangulus (Loose, 1932) Potonié and Kremp, 1955

1932 Sporonites sphaerotriangulus Loose, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 451, pl. 18, fig. 45.

1933 Laevigati-sporites sphaerotriangulus (Loose) Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 20.

1944 Punctati-sporites sphaerotriangulus (Loose) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 31.

1955 Leiotriletes sphaerotriangulus (Loose) Potonié and Kremp, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 120.

LEIOTRILETES ADNATOIDES Potonié and Kremp, 1955

Plate 1, figure 8

1955 Leiotriletes adnatoides Potonié and Kremp, Palaeontographica, Abt. B, vol. 98, p. 38, pl. 11, figs. 112-115.

Leiotriletes adnatoides is rare in the McAlester coals and was present in all sections but OPC 993. When present it varies from about 0.5 to 2.5 percent of the relative assemblage counts.

Previous occurrences of this species are from the Weir-Pittsburg coal of Oklahoma and Kansas, and from Westphalian B to D in Germany.

Figured specimen: Slide No. OPC 906A-8-3, Coal County, Oklahoma.

LEIOTRILETES CONVEXUS (Kosanke, 1950)

Potonié and Kremp, 1955

Plate 1, figure 9

1950 Granulati-sporites convexus Kosanke, Ill. Geol. Survey, Bull. 74, p. 20-21, pl. 3, fig. 6.

1955 Leiotriletes convexus (Kosanke) Potonié and Kremp, Palaeontographica, Abt. B, vol. 98, p. 39-40, pl. 11, fig. 110.

Leiotriletes convexus is rare in the McAlester coals and was noted only in the sample OPC 907E. Four specimens were found and no ecological significance can be attached to this limited occurrence.

This form has been reported from the Desmoinesian of Illinois and Oklahoma. In Europe it ranges from middle to upper Westphalian B in the Ruhr Basin of Germany. If Plani-sporites deltoides Knox (1950, p. 315, pl. 17, fig. 216) is conspecific with Leiotriletes

convexus, as it seems to be, then it is also found in the Westphalian A and B horizons of Scotland.

Figured specimen: Slide No. OPC 907E-2-2, Latimer County, Oklahoma.

Genus AHRENSISPORITES Potonié and Kremp, 1955

Type Species: Ahrensisporites guerickei Potonié and Kremp, 1955

1955 Ahrensisporites guerickei Potonié and Kremp, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 155, pl. 11, fig. 47.

Horst (1943), in a doctoral dissertation, erected the name Triletes guerickei but, under the rules of botanical nomenclature, a dissertation is not considered valid publication. Potonié and Kremp (1955a) erected the genus Ahrensisporites and designated Horst's previously invalid species as the type species. The valid publication of the genus Ahrensisporites and designation of the type species by Potonié and Kremp is accepted in this paper.

AHRENSISPORITES ? SP. A

Plate 1, figure 15

Spores radial, trilete; triangular in equatorial outline; overall dimensions 20.4 by 20.4 microns; trilete rays distinct, straight, rays almost reach equator; apices opposite rays thickened, 15.0 to 17.0 microns wide; each trilete ray crossed by a subangular arcuate band concave toward equator; spore wall laevigate.

This species, which is believed to be reworked from Mississippian strata, is rare, being found only in the seat earth of the Coal County section (OPC 906).

Figured specimen: Slide No. OPC 906A-8-5, Coal County, Oklahoma.

Genus CALAMOSPORA S., W., and B., 1944

Type Species: Calamospora hartungiana Schopf, 1944

1944 Calamospora hartungiana Schopf, in S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 51-52 text fig. 1.

CALAMOSPORA BREVIRADIATA Kosanke, 1950

Plate 1, figures 19, 20, 22

Calamospora breviradiata is the most persistent observed species of Calamospora in the McAlester coals. It was found in all of the 38 examined levels. This species reaches its maximum abundance in the Coal and Pittsburg County localities. It generally increases in number toward the top of the coal seam, except in OPC 907 where the topmost sample is only 1.0 percent of the assemblage count. The remainder of OPC 907 follows the normal abundance sequence which may be observed in the samples from OPC 906, OPC 908, and OPC 967. The differences in OPC 993 may be due to the degree of weathering to which the coal had been subjected. The stratigraphic and geographic distributional pattern of this species suggests that the parent plant was evidently an abundant floral element of the coal swamp.

This species has been reported from the Mid-Continent Des Moines Series strata and from middle Westphalian B to Stephanian C of western Europe. Wilson (1962) reported, and figured, Calamospora cf. C. breviradiata from the Flowerpot Formation (Permian) of western Oklahoma.

Figured specimens: Slide Nos. OPC 906B-1-2, OPC 906G-3-1, and OPC 906C-3-7, Coal County, Oklahoma.

CALAMOSPORA FLEXILIS Kosanke, 1950

Plate 1, figure 23

Calamospora flexilis is sporadically distributed in OPC 906, absent from OPC 907, and found in all levels of OPC 908, OPC 967, and OPC 993. The samples from OPC 907 are of the Upper McAlester (Stigler) coal and absence of C. flexilis may be indicative of changing swamp conditions during the interval since the Lower McAlester coal was deposited. Both C. pallida and C. parva occur in limited numbers in OPC 907 whereas in the other localities of Lower McAlester coal these two species occur with greater abundance.

Calamospora flexilis has been reported from Des Moines strata of Illinois, Indiana, and Oklahoma.

Figured specimen: Slide No. OPC 906G-3-2, Coal County, Oklahoma.

CALAMOSPORA PALLIDA (Loose, 1932) S., W., and B., 1944

Plate 1, figure 18

1932 Sporonites pallidus Loose, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 450, pl. 18, fig. 31.

1933 Punctati-sporites pallidus (Loose) Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 21.

1944 Calamospora pallidus (Loose) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 52.

Calamospora pallida is rare in all but the southernmost sec-

tion from Coal County where a maximum of 6.0 percent was observed. In all other localities it occurs as less than 4.0 percent of the spore and pollen flora.

Calamospora pallida has been recorded from the Mineral coal in Oklahoma and Kansas and from the upper Westphalian A to middle Westphalian C of western Europe.

Figured specimen: Slide No. OPC 906A-2-4, Coal County, Oklahoma.

CALAMOSPORA PARVA Guennel, 1958

Plate 1, figure 17

1958 Calamospora parva Guennel, Ind. Dept. Conservation, Geol. Survey, Bull. 13, p. 70-71, pl. 4, fig. 12, text fig. 16.

Calamospora parva has a distribution and abundance similar to C. pallida. Both are sporadically distributed in all five fossiliferous sections.

Reported from Des Moines age coals in Indiana by Guennel; tnis form has also been reported from two Oklahoma coals of the same age.

Figured specimen: Slide No. OPC 906G-2-3, Coal County, Oklahoma.

CALAMOSPORA SP. A

Plate 1, figure 21

Spores radial, trilete; spherical; 240.0 microns in diameter; trilete distinct, rays 51.0 to 71.0 microns in length; labra absent; commissure thin, relatively straight, distinct; wall over 2.0 microns thick, apparently laevigate, with numerous, randomly oriented, com-

pression folds.

Calamospora sp. A is a rare spore and was not encountered in the assemblage counts.

Figured specimen: Slide No. OPC 906G-8-2, Coal County, Oklahoma.

Infraturma Apiculati (Bennie and Kidston, 1886)Potonié and Kremp, 1955

Genus GRANULATISPORITES (Ibrahim, 1933) emend. S., W., and B., 1944

Type Species: Granulatisporites granulatus Ibrahim, 1933

1933 Granulati-sporites granulatus Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 22, pl. 6, fig. 51.

GRANULATISPORITES GRANULARIS Kosanke, 1950

Plate 1, figure 14

1950 Granulati-sporites granularis Kosanke, Ill. Geol. Survey, Bull. 74, p. 22, pl. 3, fig. 2.

This form is rare in the McAlester coals having been found only in level OPC 906D, where three specimens (1.5 percent) were counted.

Granulatisporites granularis has been reported from Des Moines strata in Illinois, Iowa, and Oklahoma.

Figured specimen: Slide No. OPC 906C-1-6, Coal County, Oklahoma.

GRANULATISPORITES VERRUCOSUS (Wilson and Coe, 1940) S., W., and B., 1944

Plate 1, figures 10, 11

1940 Triquitrites verrucosus Wilson and Coe, Amer. Midland Naturalist, vol. 23, p. 185, pl. 1, fig. 10.

1944 Granulati-sporites verrucosus (Wilson and Coe) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 33.

Granulatisporites verrucosus is sporadically distributed throughout the outcrop area but is slightly more prevalent in the lower one-third of the coal seams. Maximum occurrence is from the Coal County locality where, in OPC 906D, it reaches 5.0 percent of the assemblage count.

This fossil species has been reported only from the Des Moines strata of the Mid-Continent.

Figured specimens: Slides No. OPC 907D-3-7, Latimer County, and OPC 993B-4-3, Pittsburg County, Oklahoma.

Genus CYCLOGRANISPORITES Potonie and Kremp, 1955

Type Species: Cyclogranisporites leopoldi (Kremp, 1952) Potonie and Kremp, 1955

1952 Granulatisporites leopoldi Kremp, Troisieme Congres de Stratigraphie Carbonifere, vol. 1, p. 348, pl. 15b, figs. 15-16.

1955 Cyclogranisporites leopoldi (Kremp) Potonie and Kremp, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 126, pl. 20, fig. 103 11 .

CYCLOGRANISPORITES SP. A

Plate 2, figure 1

Spores radial, trilete; spherical, except when accompanied by folding; overall dimensions 76.5 by 53.6 microns; trilete simple, straight, with well-defined, raised labra, trilete three-fourths to seven-eights of spore radius; exine finely granulate, grana less than 1.5 microns in height, generally about 1.0 micron, grana not

densely set, less than 30 percent of surface area.

This new species differs from C. lasius (Waltz) Playford in that the trilete mark is much longer and possesses well-developed labra, and the grana are not so dense.

This rare species was observed only in the seat earth of the Coal County locality, OPC 906A.

Figured specimen: Slide No. OPC 906A-6-1, Coal County, Oklahoma.

CYCLOGRANISPORITES SP. B

Plate 2, figure 2

Spores radial, trilete; spherical, or nearly so, in outline, with numerous randomly oriented folds; overall dimensions 71.4 by 71.4 microns; trilete distinct, straight, with slightly developed lips, rays 22.0 to 30.0 microns long; spore surface characterized by numerous fine to medium granulations, less than 0.5 microns in height; spore wall thin, less that 2.0 microns.

This form differs from Cyclogranisporites sp. A in having smaller grana. It is rare in the McAlester coals. Specimens were observed in levels OPC 906B and OPC 907D.

Figured specimen: Slide No. OPC 906B-5-9, Coal County, Oklahoma.

Genus CONVERRUCOSISPORITES Potonié and Kremp, 1955

Type Species: Converrucosisporites triquetrus (Ibrahim, 1933) Potonié and Kremp, 1955

1933 Verrucosi-sporites triquetrus Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 26, pl. 7, fig. 61.

1944 Granulati-sporites triquetrus (Ibrahim) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 33.

1955 Converrucosisporites triquetrus (Ibrahim) Potonie and Kremp, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 137.

CONVERRUCOSISPORITES SULCATUS (Wilson and Kosanke, 1944)

Potonie and Kremp, 1955

Plate 2, figure 7

1944 Punctati-sporites sulcatus Wilson and Kosanke, Iowa Acad. Sci., Proc., vol. 51, p. 331, fig. 4.

1955 Converrucosisporites sulcatus (Wilson and Kosanke) Potonie and Kremp, Palaeontographica, Abt. B, vol. 98, p. 64.

This distinctive species of Converrucosisporites is present at all sample localities and was noted in 23 separate levels. It reaches a maximum of 5.0 percent in OPC 907E. In general it decreases in number toward the top of the coal seams.

Converrucosisporites sulcatus has been found in Desmoinesian and Missourian coals of Illinois and is widely distributed in the Desmoinesian of Indiana, Iowa, and Oklahoma.

Figured specimen: Slide No. OPC 907E-1-7, Latimer County, Oklahoma.

CONVERRUCOSISPORITES SP. A

Plate 2, figure 8

Spores radial, trilete; spores spherical, but frequently misshapen due to flattening; overall dimensions 58.7 by 51.0 microns; trilete may be partially obscured by ornamentation, rays 15.0 to 20.0 microns in length; anastomasing vermiculae, strongly convoluted,

cover entire surface of spore; vermiculae 2.5 to 5.0 microns in width, 1.5 to 3.0 microns in height; intervermiculate areas appear laevigate.

Converrucosisporites sp. A, although quite rare, was noted in all sections but OPC 908. Its maximum occurrence is 1.5 percent in levels OPC 907D and OPC 993C.

Figured specimen: Slide No. OPC 906F-4-1, Coal County, Oklahoma.

Genus VERRUCOSISPORITES (Ibrahim, 1933)

emend. Potonié and Kremp, 1955

Type Species: Verrucosisporites verrucosus (Ibrahim, 1932) Ibrahim, 1933

1932 Sporonites verrucosus Ibrahim, in Potonie, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 448, pl. 15, fig. 17.

1933 Verrucosi-sporites verrucosus (Ibrahim) Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 25, pl. 2, fig. 17.

1944 Punctati-sporites verrucosus (Ibrahim) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 32.

1950 Verrucoso-sporites verrucosus (Ibrahim) Knox, Bot. Soc. Edinburgh, Trans., vol. 35, p. 319, pl. 17, fig. 230.

1955 Verrucosisporites verrucosus (Ibrahim) Potonie and Kremp, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 137.

VERRUCOSISPORITES SP. A

Plate 2, figure 3

Spores radial, trilete; spherical to oval; trilete rarely obscured by ornamentation, individual rays reach equator; overall

dimensions 53.6 by 40.8 microns; spore body covered with irregular, somewhat rounded projections, 1.0 to 1.5 microns in height and 2.0 to 2.5 microns in diameter.

Only two specimens of this form were seen in the assemblage counts from OPC 906G. Several other specimens were seen in the preliminary scanning.

Figured specimen: Slide No. OPC 906G-1-8, Coal County, Oklahoma.

Genus CYCLOBACULISPORITES Bhardwaj, 1956

Type Species: Cyclobaculisporites grandiverrucosus (Kosanke, 1943) Bhardwaj, 1956

1943 Punctati-sporites grandiverrucosus Kosanke, Amer. Midland Naturalist, vol. 29, p. 127-128, pl. 3, fig. 4.

1956 Cyclobaculisporites grandiverrucosus (Kosanke) Bhardwaj, Palaeobotanist, vol. 4, p. 123-125, pl. 1, fig. 1.

CYCLOBACULISPORITES GRANDIVERRUCOSUS (Kosanke, 1943)

Bhardwaj, 1956

Plate 2, figure 4

This species is rare in the examined sections but was noted in all five of the sections. It reaches a maximum occurrence in level OPC 908E of 3.0 percent of the relative assemblage count.

Only two previous occurrences of this species have been reported, from the Pittsburgh coal (Desmoinesian) of Ohio and from the Mineral coal (Desmoinesian) of Oklahoma and Kansas.

Figured specimen: Slide No. OPC 906B-2-6, Coal County, Oklahoma.

CYCLOBACULISPORITES SP. A

Plate 2, figure 5

Spores radial, trilete; circular to oval in shape; overall dimensions 57.0 by 70.0 microns; trilete distinct, 8.0 to 18.0 microns in length, slightly obscured by baculae which are thickly set; baculae 0.5 to 2.5 microns in width, averaging about 2.0 microns; interbacular areas measure from 0.5 to 2.0 microns and are unevenly spaced; periphery displays 50 to 70 baculae; one or two minor folds noted on several specimens.

This form differs from C. grandiverrucosus (Kosanke) Bhardwaj in being somewhat smaller and having fewer, and less evenly spaced, baculae. The baculae on C. sp. A are considerably smaller and upon occasion two baculae appear to fuse. The trilete mark on C. grandiverrucosus is much longer than any found in the McAlester forms.

Several specimens of this species were noted during preliminary phases of this study but none was encountered in the assemblage counts.

Figured specimen: Slide No. OPC 906G-4-1, Coal County, Oklahoma.

Genus LOPHOTRILETES Naumova, 1937

emend. Potonié and Kremp, 1955

Type Species: Lophotriletes gibbosus (Ibrahim, 1933) Potonié and Kremp, 1955

1933 Verrucosi-sporites gibbosus Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 25, pl. 6, fig. 49.

1944 Granulati-sporites gibbosus (Ibrahim) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 33.

1955 Lophotriletes gibbosus (Ibrahim) Potonie and Kremp, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 129-130, pl. 20, fig. 94 2 .

LOPHOTRILETES cf. L. GIBBOSUS (Ibrahim, 1933)

Potonie and Kremp, 1955

Plate 2, figure 9

Six specimens strongly resembling L. gibbosus were encountered in the assemblage counts. These were found in levels OPC 907C, OPC 907F, OPC 908G, and OPC 967C. The species was not observed in sections OPC 906 and OPC 993. These two sections are the two southernmost localities collected for this study.

Lophotriletes gibbosus has been reported from Desmoinesian and Missourian coals of Illinois and from Desmoinesian strata of Iowa and Oklahoma. It has also been reported from the Westphalian of western Europe and from the Lower Permian of the Angara Basin in Siberia.

Figured specimen: Slide No. OPC 908B-3-1, Latimer County, Oklahoma.

LOPHOTRILETES MICROSAETOSUS (Loose, 1932)

Potonié and Kremp, 1955

Plate 1, figures 12, 13

1932 Sporonites microsaetosus Loose, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B., p. 450, pl. 18, fig. 40.

1933 Setosi-sporites microsaetosus (Loose) Ibrahim,

Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 26.

1944 Granulati-sporites microsaetosus (Loose) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 33.

1955 Lophotriletes microsaetosus (Loose) Potonié and Kremp, Palaeontographica, Abt. B, vol. 98, p. 74-75, pl. 14, figs. 229-231.

Lophotriletes microsaetosus occurs in all examined levels with percentages ranging from 1.0 in several levels to a maximum of 26.0 in OPC 906E.

It has been reported from Des Moines strata of Indiana and Oklahoma. In Europe it occurs from Namurian A to Stephanian C. Schemel (1950) reported a species from the Upper Mississippian of Utah that may be conspecific with L. microsaetosus.

Figured specimens: Slides No. OPC 906C-1-7 and CPC 906B-5-1, Coal County, Oklahoma.

Genus RAISTRICKIA S., W., and B., 1944

Type Species: Raistrickia grovensis Schopf, 1944, in S., W., and B., 1944

1944 Raistrickia grovensis Schopf, in S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 55, text fig. 3.

RAISTRICKIA ACULEOLATA Wilson and Kosanke, 1944

Plate 2, figures 12, 14, 15, 17

1944 Raistrickia aculeolata Wilson and Kosanke, Iowa Acad. Sci., Proc., vol. 51, p. 331, fig. 5.

Raistrickia aculeolata is rare in the McAlester coals and reaches a maximum of 3.5 percent in OPC 906G. It is present in all five sections but occurs in only 15 of the 38 fossiliferous levels,

where it varies from about 1.0 to 2.0 percent of the assemblage counts.

It is widely distributed in Desmoinesian strata of the Mid-Continent and one occurrence has been noted from the Stephanian of Germany.

Figured specimens: Slides No. OPC 906A-7-2, OPC 906D-6-1, and OPC 906G-1-1, Coal County, Oklahoma.

RAISTRICKIA CROCEA Kosanke, 1950

Plate 2, figure 16

1950 Raistrickia crocea Kosanke, Ill. Geol. Survey, Bull. 74, p. 47, pl. 11, fig. 6.

This species of Raistrickia is rare in the examined levels reaching a maximum of 1.5 percent in OPC 907G.

The present known distribution of this species is from Des Moines age coals of Illinois and Oklahoma.

Figured specimen: Slide No. OPC 906A-7-6, Coal County, Oklahoma.

RAISTRICKIA IMBRICATA Kosanke, 1950

Plate 2, figure 18

1950 Raistrickia imbricata Kosanke, Ill. Geol. Survey, Bull. 74, p. 47, pl. 11, fig. 8.

In the McAlester coals R. imbricata is the dominant raistrickian form but its distributional pattern indicates no discernible ecological trend. It occurs in 23 levels, representing all five sample localities, and reaches 3.5 percent in OPC 908H.

This species has an identical distributional pattern with

R. aculeolata, i. e., Desmoinesian of Mid-Continent.

Figured specimen: Slide No. OPC 907D-2-4, Latimer County, Oklahoma.

RAISTRICKIA PILOSA Kosanke, 1950

Plate 2, figure 13

1950 Raistrickia pilosa Kosanke, Ill. Geol. Survey, Bull. 74, p. 48, pl. 11, fig. 4.

This species is exceedingly rare and was not encountered in the assemblage counts.

Raistrickia pilosa has been reported from Desmoinesian coals of Illinois and Oklahoma. One report, by Wiggins (1962), from the Goddard Formation (Mississippian) of Oklahoma is somewhat doubtful.

Figured specimen: Slide No. OPC 906A-3-3, Coal County, Oklahoma.

Infraturma Muronati Potonie and Kremp, 1955

Genus CONVOLUTISPORA H., S., and M.*, 1955

Type Species: Convolutispora florida H., S., and M., 1955

1955 Convolutispora florida H., S., and M., Jour. Paleontology, vol. 29, p. 384, pl. 38, figs. 5-6.

CONVOLUTISPORA FLORIDA H., S., and M., 1955

Plate 2, figure 6

This species was noted from four of the five fossiliferous localities and is missing from OPC 967. It reaches a maximum of 2.5 percent in level OPC 993C.

Convolutispora florida was described from the Hardinsburg Formation (Chester Series, Mississippian) of Kentucky and has since

*for Hoffmeister, Staplin, and Malloy, 1955

been found in several Des Moines age coals of Oklahoma. It has not been reported from Europe.

Figured specimen: Slide No. OPC 906A-1-18, Coal County, Oklahoma.

Genus RETICULATISPORITES (Ibrahim, 1932)

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

Type Species: Reticulatisporites reticulatus (Ibrahim, 1932) Ibrahim, 1933

1932 Sporonites reticulatus Ibrahim, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 447, pl. 14, fig. 3.

1933 Reticulati-sporites reticulatus (Ibrahim) Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 33-34, pl. 1, fig. 3.

RETICULATISPORITES SP. A

Plate 2, figures 10, 11

Spores radial, trilete; spherical to subspherical before compression; overall dimensions 32.5 by 27.5 microns; outline subcircular to oval; trilete generally obscured by an ornamentation of anastomosing ridges, 2.0 to 2.5 wide and 1.0 to 1.5 microns high.

This form resembles Spore 34K of Knox (1948, p. 5, fig. 40) which Knox (1950, p. 323) named Reticulati-sporites alveolatus. R. sp. A may be distinguished from the Knox species by its less massive ridges, or reticulations, and it is slightly larger in overall dimensions.

This species is rare in the McAlester coals, having been recorded in the assemblage counts by single specimens from OPC 906B and OPC 907F.

Figured specimens: Slides No. OPC 907F-2-2 and OPC 907B-2-7, Latimer County, Oklahoma.

Turma Zonales (Bennie and Kidston, 1886) emend. Potonié, 1956

Subturma Auritotriletes Potonié and Kremp, 1955

Infraturma Auriculati (Schopf, 1938) emend. Potonié, 1960

Genus TRIQUITRITES Wilson and Coe, 1940

Type Species: Triquitrites arculatus Wilson and Coe, 1940

1940 Triquitrites arculatus Wilson and Coe, Amer. Midland Naturalist, vol. 23, p. 185, fig. 8.

TRIQUITRITES BRANSONII Wilson and Hoffmeister, 1956

Plate 3, figures 1, 2

Triquitrites bransonii is the most abundant representative of the genus found in the McAlester coals, having been observed from 30 levels representing all five sections. Vertical distribution within the seams is such that only a tenuous pattern could be observed. In section OPC 906 the upper half of the seam has a greater abundance of T. bransonii than the lower half. This pattern may be noted in all sections except OPC 967 where the upper half of the coal has fewer specimens of T. bransonii than the lower half.

This species, first recorded from the Croweburg coal of Oklahoma by Wilson and Hoffmeister (1956), has been reported from the Pottsville coals of Indiana and is widely distributed in the Desmoinesian coals of Oklahoma. In Europe it has been reported from Saar coals of Stephanian C age. Bhardwaj and Venkatachala (1961 1962) reported a form that more nearly resembled T. bransonii than any other known species of Triquitrites from a Lower Carboniferous

shale of Spitzbergen. Wiggins (1962) reported T. bransonii from the Goddard Formation (Mississippian) of Oklahoma.

Figured specimens: Slides No. OPC 906C-5-6 and OPC 906D-4-3, Coal County, Oklahoma.

TRIQUITRITES CRASSUS Kosanke, 1950

Plate 3, figure 3

1950 Triquitrites crassus Kosanke, Ill. Geol. Survey, Bull. 74, p. 38, pl. 8, fig. 6.

Triquitrites crassus is rare in the McAlester coals being represented in the assemblage study by five specimens which occur in OPC 907 and OPC 993. Its maximum occurrence does not exceed 1.0 percent in any one level.

This species is widely distributed in coals of Desmoinesian age in Oklahoma and was originally reported from coals of Desmoinesian and Missourian age in Illinois.

Figured specimen: Slide No. OPC 907G-4-2, Latimer County, Oklahoma.

TRIQUITRITES EXIGUUS Wilson and Kosanke, 1944

Plate 3, figures 4, 5

1944 Triquitrites exiguus Wilson and Kosanke, Iowa. Acad. Sci., Proc., vol. 51, p. 332, fig. 2.

This species, first reported by Wilson and Kosanke in 1944, from Des Moines strata of Iowa occurs only in the seat earth (OPC 906A) of the Coal County locality where it reaches 1.5 percent of the total assemblage count for that level.

Triquitrites exiguus is widely distributed in coals of Desmoinesian age in Illinois, Iowa, Indiana, and Oklahoma. It has been

reported from coals of Lower Westphalian D and Stephanian C age in western Germany.

Figured specimens: Slides No. OPC 906A-1-9 and OPC 906A-6-2, Coal County, Oklahoma.

TRIQUITRITES PRAETEXTUS Wilson and Hoffmeister, 1956

Plate 3, figure 6

1956 Triquitrites praetextus Wilson and Hoffmeister, Okla. Geol. Survey, Circ. 32, p. 25-26, pl. 3, figs. 15-16.

This form was not found in the two southernmost coal sections, OPC 906 and OPC 993. In the three other sections it is sporadically distributed within the seams and reaches 1.5 percent maximum occurrence in level OPC 907B.

Triquitrites praetextus has been reported only from Desmoinesian coals of Oklahoma.

Figured specimen: Slide No. OPC 907B-3-4, Latimer County, Oklahoma.

TRIQUITRITES PROTENSUS Kosanke, 1950

Plate 3, figure 7

1950 Triquitrites protensus Kosanke, Ill. Geol. Survey, Bull. 74, p. 40, pl. 8, fig. 2.

Triquitrites protensus is rare in the examined material, being observed in 11 levels from four sections (missing from OPC 993). Generally this form is confined to the lower half of the section but in OPC 967K it reaches a maximum of 2.5 percent.

This species has been reported from Desmoinesain strata of Illinois, Iowa, and Oklahoma.

Figured specimen: Slide No. OPC 906E-3-2, Coal County, Oklahoma.

TRIQUITRITES SP. A

Plate 3, figure 8

Spores radial, trilete; roundly triangular in outline, interradial margins slightly convex; overall dimensions 58.7 by 53.4 microns; trilete distinct, rays 20.0 to 25.0 microns long, lips thin, slightly raised, two rays almost perpendicular to the third ray; arcuate thickenings at apices and originating on proximal surface, thickenings measure 12.8 microns wide and 17.8 microns long; spore coat finely granular.

Triquitrites sp. A is rare but was observed in all examined sections. It reaches a maximum of 2.0 percent in level OPC 906I.

Figured specimen: Slide No. OPC 908D-1-3, Latimer County, Oklahoma.

TRIQUITRITES SP. B

Plate 3, figure 9

Spores radial, trilete; roundly triangular in outline; interradial margins almost straight; overall dimensions 38.3 by 33.2 microns; trilete distinct, open, 1.0 to 2.5 microns wide, rays reach almost to equator of spore body; arcuate areas not thickened and are much lighter in color than spore body; spore wall laevigate.

Triquitrites sp. B is almost identical to T. bransonii except that in the McAlester forms there is no arcuate thickening. All other parameters appear to be equal. This form was observed in all

examined sections and its maximum occurrence is 1.5 percent in level OPC 906H.

Figured specimen: Slide No. OPC 906C-2-4, Coal County, Oklahoma.

TRIQUITRITES SP. C

Plate 3, figure 10

Spores radial, trilete; subtriangular in outline; overall dimensions 40.8 by 38.3 microns; interradial margins strongly concave with large cushion-like thickenings at the apices, thickenings appear to originate both proximally and distally and measure 10.2 microns long and 17.8 microns wide; trilete distinct, straight, reaching almost to arcuate thickenings; spore wall laevigate.

Triquitrites sp. C is unlike any known species of Triquitrites and although rare in the McAlester coals was observed in 19 of the 38 fossiliferous levels representing all five sections. In level OPC 906I it constitutes 3.5 percent of the relative spore and pollen flora.

Figured specimen: Slide No. OPC 906I-1-1, Coal County, Oklahoma.

Genus MUROSPORA Somers, 1952

Type Species: Murospora kosankei, Somers, 1952

1952 Murospora kosankei Somers, Nova Scotia Research Foundation, Halifax, N. S., Canada, p. 21, fig. 13A.

MUROSPORA SP. A

Plate 3, figure 11

Spores radial, trilete; roundly triangular in outline; overall dimensions 35.7 by 30.6 microns; trilete distinct, almost straight, reaching two-thirds distance to equator; equatorial areas with numerous blunt projections, 1.5 to 3.0 microns high and 2.0 to 4.0 microns wide, projections give equator a convoluted appearance; spore wall laevigate.

Murospora sp. A is rare in the examined material and only one specimen, from the Latimer County locality (OPC 908), was seen.

Figured specimen: Slide No. OPC 908I-5-1, Latimer County, Oklahoma.

Subturma Zonotriletes Waltz, 1935

Infraturma Cingulati Potonie and Klaus, 1954

Genus DENSOSPORITES Berry, 1937

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

Type Species: Densosporites covensis Berry, 1937

1937 Denso-sporites covensis Berry, Amer. Midland Naturalist, vol. 18, p. 157, fig. 11.

DENSOSPORITES cf. D. COVENSIS Berry, 1937

Plate 3, figures 12, 13

Densosporites cf. D. covensis is rare in the McAlester coals. Twenty-one specimens were observed from the three localities OPC 906, OPC 908, and OPC 993. In level OPC 993B it reaches a maximum of 3.5 percent of the assemblage counts.

Figured specimens: Slides No. OPC 906B-4-8 and OPC 906I-1-3, Coal County, Oklahoma.

Genus LYCOSPORA S., W., and B., 1944

Type Species: Lycospora micropapillata (Wilson and Coe, 1940) S., W., and B., 1944

1940 Cirratriradites micropapillatus Wilson and Coe, Amer. Midland Naturalist, vol. 23, p. 184, pl. 1, fig. 6.

1944 Lycospora micropapillata (Wilson and Coe) S., W., and B., Ill. Geol. Survey, Rept. Inv., p. 54.

LYCOSPORA BREVIJUGA Kosanke, 1950

Plate 3, figures, 14, 15, 16

1950 Lycospora brevijuga Kosanke, Ill. Geol. Survey, Bull. 74, p. 44, pl. 10, fig. 5.

Lycospora brevijuga was the most abundant species noted in the assemblage counts. In sections OPC 906 and OPC 907 it is the dominant form in the basal one-third of the coal, decreasing in number at mid-section and increasing again in the top one-third of the seam. It comprises 50.0 percent of the total palynological flora in level OPC 906B; level OPC 906E has decreased to 4.5 percent, and in the topmost sample it has increased to 25.0 percent. In OPC 967 the highest count is again in the basal one-third but the assemblage counts diminish steadily from level A (33.5 percent) to level J (1.0 percent). The two topmost coal samples, K and L, do not have any representatives of the genus Lycospora in them. Sampled section OPC 908 is similar to OPC 967 in that there is a steady decrease in number of specimens of L. brevijuga toward the top of the coal seam.

Lycospora brevijuga has been reported from the Des Moines of Illinois and from the Krebs Group (Des Moines) of Oklahoma.

Smith (1963, p. 6), in the 1963 report of the 'Commission

Internationale de Microflore du Paleozoique', proposed that L. brevijuga Kosanke and L. parva Kosanke are synonymous with L. pusilla (Ibrahim) S., W., and B. This proposal, which at present probably has no validity, is not followed in this study.

Figured specimens: Slides No. OPC 906C-1-12, OPC 906H-1-10, and OPC 906H-4-2, Coal County, Oklahoma.

LYCOSPORA GRANULATA Kosanke, 1950

Plate 3, figure 17

1950 Lycospora granulata Kosanke, Ill. Geol. Survey, Bull. 74, p. 45, pl. 10, figs. 4, 6.

This species is rare in the McAlester coals and was seen in only four levels where it reaches a maximum occurrence of 2.0 percent in OPC 906H and OPC 907G.

First reported from the Des Moines of Illinois, this species has been found in several coals of the Krebs and Cabaniss Groups (Desmoinesian) of Oklahoma.

Figured specimen: Slide No. OPC 906G-4-7, Coal County, Oklahoma.

LYCOSPORA INTERMEDIA (Wilson and Hoffmeister, 1956)

Wilson and Hoffmeister, 1964

Plate 3, figure 18

1956 Cirratriradites intermedius Wilson and Hoffmeister, Okla. Geol. Survey, Circ. 32, p. 14, pl. 2, fig. 9.

1964 Lycospora intermedia (Wilson and Hoffmeister) Wilson and Hoffmeister, Okla. Geol. Survey, Okla. Geology, Notes, vol. 24, p. 33-34, pl. 1, figs. 1-6.

Lycospora intermedia is a rare fossil and was not observed

during the assemblage counts.

Wilson and Hoffmeister (1956) originally assigned this form to the genus Cirratriradites. Its occurrence in coals of the McAlester Formation lowers its range into the Krebs Group in Oklahoma. It has not been reported from outside of Oklahoma.

Figured specimen: Slide No. OPC 906H-1-5, Coal County, Oklahoma.

LYCOSPORA PUNCTATA Kosanke, 1950

Plate 3, figure 19

1950 Lycospora punctata Kosanke, Ill. Geol. Survey, Bull. 74, p. 45, pl. 10, fig. 3.

Representatives of L. punctata are rare in the McAlester coals and the species was not noted in the assemblage counts.

The only known occurrences of this form are from Illinois and Oklahoma coals of Desmoinesian age.

Figured specimen: Slide No. OPC 906A-1-17, Coal County, Oklahoma.

LYCOSPORA TORQUIFER (Loose, 1932)

Potonié and Kremp, 1956

Plate 3, figure 20

1932 Sporonites torquifer Loose, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 450, pl. 18, fig. 43.

1934 Reticulati-sporites torquifer (Loose) Loose, Inst. Palaobot. und. Petrog. Brennsteine, Arbeiten, vol. 4, p. 154.

1956 Lycospora torquifer (Loose) Potonié and Kremp, Palaeontographica, Abt. B, vol. 99, p. 104, pl. 17, figs. 355-359.

This rare species of Lycospora, as is the case with L. punctata, does not appear in the assemblage counts. It was noted only from level OPC 908D.

Lycospora torquifer, originally described from upper Westphalian B strata in Germany, has been reported from the Iron Post and Rowe coals of Des Moines age in Oklahoma.

Figured specimen: Slide No. OPC 908D-3-2, Latimer County, Oklahoma.

Infraturma Zonati Potonié and Kremp, 1955

Genus CIRRATRIRADITES Wilson and Coe, 1940

Type Species: Cirratriradites maculatus Wilson and Coe, 1940

1940 Cirratriradites maculatus Wilson and Coe, Amer. Midland Naturalist, vol. 23, p. 183, pl. 1, fig. 7.

1955 Cirratriradites saturni (Ibrahim) Potonié and Kremp, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 162, pl. 20, fig. 101 9 .

1956 non Cirratriradites saturni (Ibrahim) S., W., and B., emend. Potonié and Kremp, Palaeontographica, Abt. B, vol. 99, p. 128, pl. 18, figs. 411-415.

CIRRATRIRADITES SATURNI (Ibrahim, 1932)

S., W., and B., 1944

Plate 3, figures 21, 22

1932 Sporonites saturni Ibrahim, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 448, pl. 15, fig. 14.

1933 Zonales-sporites saturni (Ibrahim) Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 30, pl. 2, fig. 14.

1944 Cirratriradites saturni (Ibrahim) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 44.

Cirratriradites saturni is rare in the McAlester coals, occurring only in the lower coal (Lehigh). It was observed in four levels of OPC 908, levels C, D, G, and I and from OPC 993D. Maximum development is 3.5 percent of the assemblage count from level OPC 908C. It appears to become rarer toward the uppermost portion of the coal seam.

This species has been reported from Desmoinesian coals of Indiana and Oklahoma. In Europe it ranges from upper Westphalian B to Stephanian C. Wiggins (1962) illustrated a form which he assigned to this species. This Mississippian occurrence is somewhat doubtful.

Figured specimens: Slides No. OPC 908C-1-2 and OPC 908C-2-1, Latimer County, Oklahoma.

Turma Monoletes Ibrahim, 1933

Subturma Azonomonoletes Luber, 1935

Genus LAEVIGATOSPORITES (Ibrahim, 1932) Ibrahim, 1933 emend. S., W., and B., 1944

Type Species: Laevigatosporites vulgaris (Ibrahim, 1932) Ibrahim, 1933

1932 Sporonites vulgaris Ibrahim, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 448, pl. 15, fig. 16.

1933 Laevigato-sporites vulgaris (Ibrahim) Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 39-40, pl. 2, fig. 16; pl. 5, figs. 37-39.

Spores assigned to the genus Laevigatosporites have been taxonomically confused since Ibrahim erected the genus in 1933. Schopf,

Wilson, and Bentall (1944) included many monolete forms in the genus Laevigatosporites. Potonié and Kremp (1956a) emended the genus to include only laevigate to infrapunctate spores. Size differences were considered the basis for specific differentation. The discussion by Urban (1962, p. 68-72) points out many of the difficulties concerned with the genus Laevigatosporites and need not be restated here. The generic emendation of Schopf, Wilson, and Bentall (1944) is followed and that of Potonié and Kremp (1956a) is rejected.

LAEVIGATOSPORITES DESMOINESENSIS (Wilson and Coe, 1940)

S., W., and B., 1944

Plate 4, figures 3, 4

1940 Phaseolites desmoinesensis Wilson and Coe, Amer. Midland Naturalist, vol. 23, p. 182-183, pl. 1, fig. 4.

1944 Laevigato-sporites desmoinesensis (Wilson and Coe) S., W., and B., Ill. Geol. Survey, Rept. Inv., 91, p. 37.

This species occurs throughout all examined levels, reaching a maximum of 8.0 percent in OPC 908D. In the McAlester coals, it varies from about 2.5 to 5.0 percent of the spore and pollen flora. There seems to be no significant trend to its distribution in that it is quite abundant in number and distribution, laterally as well as vertically, within the seams. The parent plant, or plants, from which L. desmoinesensis spores were derived must have been a pioneer and abundant element throughout the developmental stages of the coal swamp as evidenced by its lateral and vertical distribution within the seams.

Laevigatosporites desmoinesensis has been reported from

Desmoinesian and Missourian coals of Illinois, from Desmoinesian strata of Iowa, Indiana, and Oklahoma, from Westphalian A to Stephanian C of western Europe, and from the Kaiping Basin of China.

Figured specimens: Slides No. OPC 906B-3-3, Coal County, and OPC 907D-6-1, Latimer County, Oklahoma.

LAEVIGATOSPORITES MEDIUS Kosanke, 1950

Plate 4, figure 7

1950 Laevigato-sporites medius Kosanke, Ill. Geol. Survey, Bull. 74, p. 29, pl. 16, fig. 2.

Laevigatosporites medius, although missing from levels A and B, is abundantly represented in section OPC 906. It reaches a maximum of 11.0 percent in two levels, OPC 907G and OPC 908E. This species is absent from all levels of OPC 967 and OPC 993 and appears to have been replaced by an increase of L. minutus and L. ovalis. The two previously mentioned coal sections lie closer to the northern boundary of the Arkoma Basin than the other three sections. Some ecological factor, or factors, may have affected the parent plants of L. medius and perhaps that of L. punctatus in sections OPC 967 and OPC 993 and consequently controlled the abundance of these two spore types.

Laevigatosporites medius has a distributional pattern that is identical with L. desmoinesensis.

Figured specimen: Slide No. OPC 906D-6-3, Coal County, Oklahoma.

LAEVIGATOSPORITES MINIMUS (Wilson and Coe, 1940)

S., W., and B., 1944

Plate 4, figure 11

1940 Phaseolites minimus Wilson and Coe, Amer. Midland Naturalist, vol. 23, p. 183, pl. 1, fig. 5.

1944 Laevigato-sporites minimus (Wilson and Coe) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 37.

This form, although present in all fossiliferous sections, is absent from several levels. It generally decreases in number toward the top of the seams and its greatest abundance is 16.5 percent in level OPC 908D.

The distributional pattern of this species is the same as for L. desmoinesensis and L. medius, except that it has not been reported from China.

Figured specimen: Slide No. OPC 906C-6-2, Coal County, Oklahoma.

LAEVIGATOSPORITES MINUTUS (Ibrahim, 1933)

S., W., and B., 1944

Plate 4, figures 8, 9

1933 Punctato-sporites minutus Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 40, pl. 5, fig. 33.

1944 Laevigato-sporites minutus (Ibrahim) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 37.

This finely punctate species of Laevigatosporites exhibits a distributional pattern similar to L. desmoinesensis in that it was noted in all 38 fossiliferous levels. In each section, except OPC 906, it is abundant in the lower one-third of the seam and de-

creases steadily toward the top of the coal. It reaches a maximum of 31.0 percent in OPC 967B and in the seat earths of OPC 906 and OPC 967 it reaches values of 8.5 and 9.5 percent, respectively. With respect to the species of Laevigatosporites in the McAlester coals, it is second in abundance, exceeded only by L. ovalis.

Laevigatosporites minutus has been reported from Desmoinesian and Missourian coals of Illinois and from Desmoinesian strata of Iowa. It occurs in numerous Oklahoma coals of the Krebs and Cabaniss Groups, and from the Westphalian B and C of Germany and Russia.

Figured specimens: Slides No. OPC 906C-1-1 and OPC 906D-2-2, Coal County, Oklahoma.

LAEVIGATOSPORITES OVALIS Kosanke, 1950

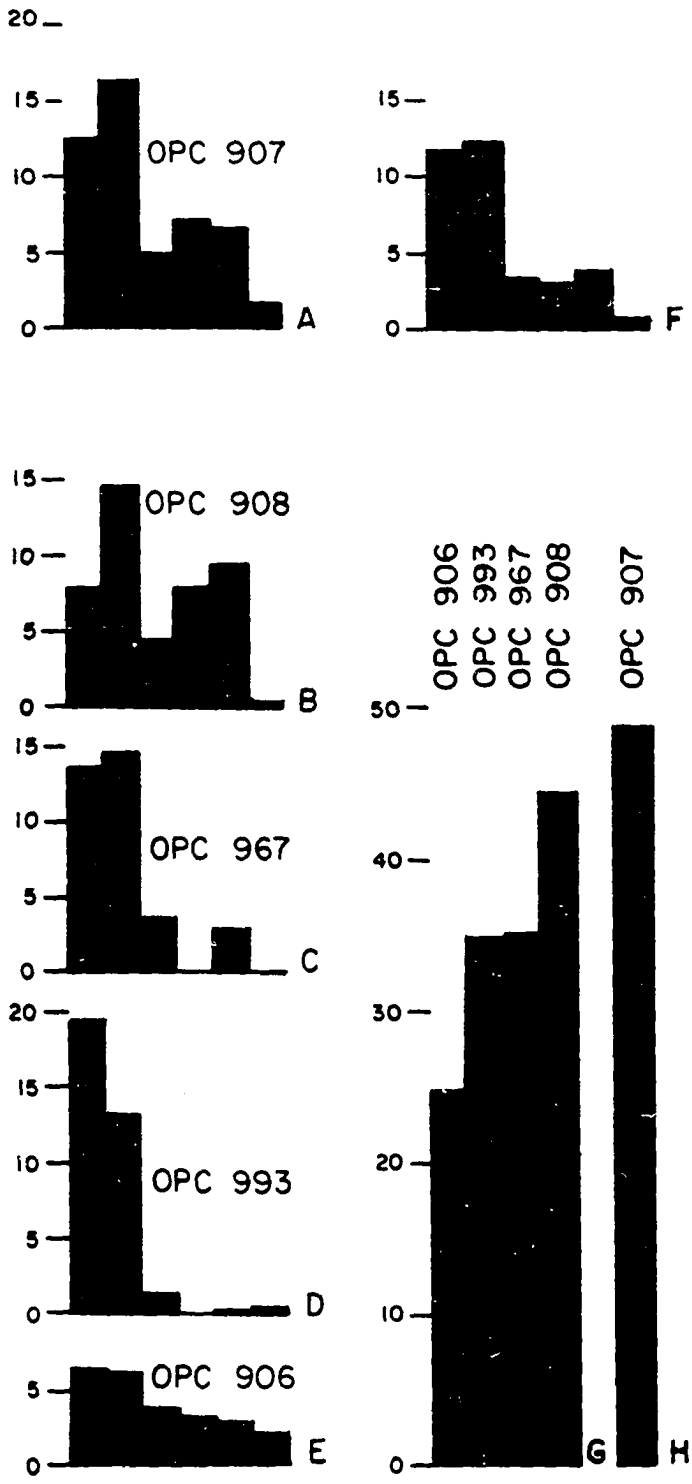
Plate 4, figures 5, 6

1950 Laevigato-sporites ovalis Kosanke, Ill. Geol. Survey, Bull. 74, p. 29-30, pl. 5, fig. 7.

Laevigatosporites ovalis appears in all examined sections and is the dominant species of Laevigatosporites in the McAlester coals. In OPC 967H it reaches a maximum of 23.5 percent. Relative assemblage counts in excess of 15.0 percent were noted in 13 of the 38 fossiliferous levels. The two fossiliferous seat earths, OPC 906A and OPC 967A, contain 8.0 and 11.0 percent L. ovalis, respectively.

This species has a distributional pattern similar to L. desmoinesensis.

Figured specimens: Slides No. OPC 906C-3-2, Coal County, and OPC 907D-2-8, Latimer County.



2A Upper McAlester coal
2B–E Lower McAlester coal
2F Composite Lower McAlester coal
2G & H Composite for each section

Species of Laevigatosporites are indicated by number in Figs. 2A through F as listed below.

1. L. minutus
2. L. ovalis
3. L. desmoinesensis
4. L. medius
5. L. minimus
6. L. punctatus

FIGURE 2. HISTOGRAMS REFLECTING RELATIVE PERCENTAGES OF SIX SPECIES OF LAEVIGATOSPORITES IN FIVE SECTIONS OF OF McALESTER COALS.

LAEVIGATOSPORITES PUNCTATUS Kosanke, 1950

Plate 4, figure 10

1950 Laevigato-sporites punctatus Kosanke, Ill. Geol. Survey, Bull. 74, p. 30, pl. 5, fig. 3.

This species is represented sporadically in the assemblage counts and is absent from 19 of the 38 fossiliferous levels. No significant distributional pattern could be determined from these data except in the sections containing L. punctatus it is slightly reduced in abundance toward the top of the coal. The seat earth, OPC 906A, contains 8.5 percent of this species, which is greatly in excess of percentages found in any of the coal levels where the maximum is 3.0 percent.

Laevigatosporites punctatus has been reported from Des Moines and Missouri Series coals of Illinois and from Des Moines strata of Iowa, Indiana, and Oklahoma. It has not been reported from outside the United States.

Figured specimen: Slide No. OPC 906C-1-4, Coal County, Oklahoma.

Anteturma Pollenites R. Potonié, 1931

Turma Saccites Erdtman, 1947

Subturma Monosaccites (Chitaley, 1951) Potonié and Kremp, 1955

Infraturma Triletesacciti Leschik, 1955

Genus WILSONITES (Kosanke, 1950) Kosanke, 1959

Type Species: Wilsonites vesicatus (Kosanke, 1950) Kosanke, 1959

1950 Wilsonia vesicatus Kosanke, Ill. Geol. Survey, Bull. 74, p. 54, pl. 14, figs. 1-3.

1959 Wilsonites vesicatus (Kosanke) Kosanke, Jour. Paleontology, vol. 33, p. 700.

WILSONITES VESICATUS (Kosanke, 1950) Kosanke, 1959

Plate 5, figures 11, 12, 13

This species, although widely distributed in the McAlester coals, does not show a noticeable distributional trend. It does not exceed 6.0 percent of the spore and pollen flora in any level and this comparatively consistent low number of specimens might be indicative that these spores were wind-borne from a nearby upland into the coal swamp.

Wilsonites vesicatus is reported from Desmoinesian and Missourian coals of Illinois and in Oklahoma it is widely distributed in coals of Desmoinesian age.

Figured specimens: Slide No. OPC 906G-4-2, Coal County, and OPC 907B-1-7 and OPC 907F-5-1, Latimer County, Oklahoma.

WILSONITES DELICATUS (Kosanke, 1950) Kosanke, 1959

Plate 5, figure 8

1950 Wilsonia delicata Kosanke, Ill. Geol. Survey, Bull. 74, p. 54-55, pl. 14, fig. 4.

1959 Wilsonites delicatus (Kosanke) Kosanke, Jour. Paleontology, vol. 33, p. 700.

Wilsonites delicatus was observed in one level (OPC 906G) and only two specimens (1.0 percent) were seen.

Only three previous occurrences of this species are known; from Desmoinesian and Missourian coals of Illinois, Desmoinesian of Iowa, and from the Iron Post coal of Oklahoma.

Figured specimen: Slide No. OPC 906G-4-1, Coal County, Oklahoma.

WILSONITES SP. A

Plate 5, figure 14

Spores radial; spherical to subspherical in outline; trilete not observed; overall diameter 122.5 microns; central body indistinct, or probably missing, 58.0 microns; saccus and central body laevigate to finely granular, infrareticulate.

The McAlester forms are unlike any described species of Wilsonites and are rare. Two specimens were encountered during the assemblage study from level OPC 908C.

Figured specimen: Slide No. OPC 908C-1-3, Latimer County, Oklahoma.

Genus ENDOSPORITES Wilson and Coe, 1940

Type Species: Endosporites ornatus Wilson and Coe, 1940

1940 Endosporites ornatus Wilson and Coe, Amer. Midland Naturalist, vol. 23, p. 184, pl. 1, fig. 2.

ENDOSPORITES ORNATUS Wilson and Coe, 1940

Plate 5, figure 3

This species, although not as abundant as E. angulatus, is found in all but six levels and it reaches a maximum development of 18.5 percent in OPC 967J.

Florinites, Calamospora, and Endosporites are considered to be indicative of the upper, or swamp-forest, stage of an idealized Pennsylvanian coal swamp succession and the assemblage counts for these three genera appear to substantiate this.

This species is widely distributed in Desmoinesian strata of the Mid-Continent and from the Upper Westphalian and Stephanian

of western Europe.

Figured specimen: Slide No. OPC 906B-6-1, Coal County, Oklahoma.

ENDOSPORITES ANGULATUS Wilson and Coe, 1940

Plate 5, figures 6, 7

1940 Endosporites angulatus Wilson and Coe, Amer, Midland Naturalist, vol. 23, p. 184, pl. 1, fig. 1.

Endosporites angulatus was observed in all but three examined levels and generally it increases in number of specimens from the basal one-third upward through the topmost one-third of the seams. It appears to replace Lycospora brevijuga in many levels, i. e., as L. brevijuga becomes reduced in number Endosporites angulatus (and E. ornatus) increase in number. A maximum occurrence of 20.0 percent is reached in level OPC 906C. Four examined levels are in excess of 15.0 percent.

This species has been reported only from the Desmoinesian strata of Illinois, Iowa, and Oklahoma.

Figured specimens: Slides No. OPC 906A-1-2B and OPC 906A-2-5, Coal County, Oklahoma.

ENDOSPORITES SP. A

Plate 5, figure 2

Spores radial, trilete; roundly triangular in equatorial view; overall dimensions 118.5 by 107.1 microns, central body 74.0 by 74.0 microns; trilete obscured by tetradal folds varying in width from 4.0 to 8.0 microns and from 25.0 to 58.9 microns in length; saccus encloses central body and is attached proximally;

saccus surface finely granular; central body laevigate.

This form may be conspecific with Endosporites sp. A of Ruffin (1961, p. 67-68, pl. 5, fig. 10). Observed in only a few levels, this form did not appear in the assemblage counts.

Genus GRANDISPORA H., S., and M., 1955

Type Species: Grandispora spinosa H., S., and M., 1955

1955 Grandispora spinosa H., S., and M., Jour. Paleontology, vol. 29, p. 388-389, pl. 39, figs. 10, 14.

GRANDISPORA SP. A

Plate 5, figures 1, 4

Spores radial, trilete; subcircular to roundly triangular in both proximal and distal views; trilete mark obscured by lips and tetradal folds which reach the equator; central body enclosed by a saccus; overall dimensions 91.8 by 61.0 microns, central body 61.2 by 40.8 microns; saccus and central body laevigate to finely granular, ornamented by numerous small, scattered ampullate spines 2.0 to 5.0 microns in height.

Grandispora was first described from the Hardinsburg Formation (Upper Mississippian) of Illinois and Kentucky. Hoffmeister, Staplin, and Malloy (1955, p. 388-389) reported only one species of this new genus and stated that it differed from Endosporites by the possession of spines on the saccus. The occurrence of a single specimen of Grandispora sp. A in the seat earth of section OPC 906A, which differs from G. spinosa H., S., and M. only in its much smaller size, is, it is here believed, the result of reworking of Mississippian material which was deposited in the seat earth of OPC 906 just

prior to the invasion of the coal swamp. In this same seat earth one other Mississippian form is recorded, namely, Ahrensisporites sp. A.

Figured specimen: Slide No. OPC 906A-1-2A, Coal County, Oklahoma.

Genus VESTISPORA Wilson and Hoffmeister, 1956

emend. Wilson and Venkatachala, 1963

Type Species: Vestispora profunda Wilson and Hoffmeister, 1956

1956 Vestispora profunda Wilson and Hoffmeister, Okla. Geol. Survey, Circ. 32, p. 27, pl. 2, figs. 16-19.

Spores assignable to the genus Vestispora have presented a taxonomic problem in the literature since the genus was erected by Wilson and Hoffmeister (1956). Too often, as previously stated, specific characters are stressed to such a degree that new genera are erected based upon these characters. This is the case in the emendation by Bhardwaj (1957b).

A recent emendation by Wilson and Venkatachala (1963, p. 94-100) pointed out many of the difficulties previously encountered and several genera were placed in synonymy with Vestispora. These genera are as follows: Foveolatisporites Bhardwaj, 1956; Novisporites Bhardwaj, 1957; Cancellatisporites Dybová and Jachowicz, 1957; and Glomospora Butterworth and Williams, 1958.

Clarke (1961), Gibson (1961), and Ruffin (1961) figured species which they assigned to the genus Microreticulatisporites and which should now be assigned to the genus Vestispora.

VESTISPORA PROFUNDA Wilson and Hoffmeister, 1956

Plate 4, figures 12, 15

Vestispora profunda is rare in the McAlester coals and only one specimen was found in level OPC 907E, an Upper McAlester (Stigler) coal from Latimer County.

This species of Vestispora has not been reported from outside the United States but forms assignable to the genus have been reported from strata of Westphalian age in Germany and England. Potonié (1960) and Wilson and Venkatachala (1963) placed Glomospora Butterworth and Williams in synonymy with Vestispora and forms previously assigned to Glomospora have been reported from the Namurian of Scotland. Vestispora profunda has been found in numerous coals of Desmoinesian age in Oklahoma but has not been reported from outside the state.

Figured specimen: Slide No. OPC 908I-1-1, Latimer County, Oklahoma.

VESTISPORA FOVEATA (Kosanke, 1950)

Wilson and Venkatachala, 1963

Plate 4, figure 17

1950 Punctati-sporites foveatus Kosanke, Ill. Geol. Survey, Bull. 74, p. 17, pl. 1, fig. 6.

1955 Microreticulatisporites foveatus (Kosanke) Potonié and Kremp, Palaeontographica, Abt. B, vol. 98, p. 98.

1956 Foveolatisporites foveatus (Kosanke) Bhardwaj, Palaeobotanist, vol. 4, p. 126.

1963 Vestispora foveata (Kosanke) Wilson and Venkatachala, Okla. Geol. Survey, Okla. Geology Notes, vol. 23, p. 99.

Vestispora foveata is found in 15 of the 38 fossiliferous levels representing all five localities. Although sporadically distributed within the seams, there is a definite tendency for a greater abundance of specimens in the lower half. It was not noted in either of the fossiliferous seat earths. In level OPC 907B it reaches 7.0 percent of the relative abundance count.

This species has been reported from Desmoinesian strata of Illinois and Oklahoma but has not been reported from outside the United States.

Figured specimen: Slide No. OPC 906B-2-1, Coal County, Oklahoma.

VESTISPORA SP. A

Plate 4, figure 14

Spores radial, trilete; circular in outline; overall dimensions 84.2 by 81.5 microns; central body 38.3 microns; trilete is obscured by operculum in most specimens, rays approximately 15.0 microns long; spore wall covered by closely arranged muri distally, irregular concentric muri proximally, muri vary from 2.0 to 3.0 microns in width; operculate structure measures approximately one-third of spore diameter.

This species differs from Vestispora profunda Wilson and Hoffmeister in possessing less massive muri and less pronounced concentric mural development on the proximal side. One other unusual difference that may be of importance is that Vestispora sp. A is generally found with the operculum still attached.

Vestispora sp. A, although rare in the examined material,

was noted from nine levels and all sample localities except OPC 993. It seldom reaches more than 1.5 percent of the total spore and pollen flora in any one level but reaches a maximum of 2.5 percent in level OPC 906H. It was not observed from either of the fossiliferous seat earths.

Figured specimen: Slide No. OPC 906H-4-3, Coal County, Oklahoma.

Infraturma Triradites (Pant, 1954) emend. Bhardwaj, 1956

Genus GUTHOERLISPORITES Bhardwaj, 1954

Type Species: Guthoerlisporites magnificus Bhardwaj, 1954

1954 Guthoerlisporites magnificus Bhardwaj, Neues Jahrb. für Geologie und Paläontologie, Monatsh., Jahrg. 1954, p. 519, fig. 8.

GUTHOERLISPORITES SP. A

Plate 5, figure 9

Spores radial, trilete; saccus and central body circular in outline; overall diameter 53.6 microns, central body 28.0 microns; trilete simple, straight, rays 12.8 microns long; central body fairly distinct, laevigate, peripheral compression folds present; saccus surface laevigate to finely punctate, infrareticulate.

This species is rare in the McAlester coals. Two specimens from level OPC 993D plus the figured specimen from level OPC 967G make up the total observed from all localities.

Figured specimen: Slide No. OPC 976G-1-1, Pittsburg County, Oklahoma.

Genus CANDIDISPORA Venkatachala, 1963

Type Species: Candidispora candida Venkatachala, 1963

1963 Candidispora candida Venkatachala, Palaeobotanist, vol. 11, p. 41-42, pl. 1, figs. 7-8.

CANDIDISPORA TRILETA (Kosanke, 1950)

Venkatachala, 1963

Plate 9, figure 10

1950 Florinites triletus Kosanke, Ill. Geol. Survey, Bull. 74, p. 50, pl. 12, figs. 3-4.

1963 Candidispora trileta (Kosanke) Venkatachala, Palaeobotanist, vol. 11, p. 41.

Candidispora trileta was noted from sections OPC 906, OPC 908, OPC 967, and OPC 993 and in each it reaches a value of from 0.5 to 1.0 percent of the spore and pollen flora. This rare form may not have been indigenous to the coal swamp but may have originated from uplands some distance away.

This Desmoinesian species of Candidispora has been reported from Illinois and from one Oklahoma coal, the Weir-Pittsburg (Secor). One occurrence from Europe has been reported in the Stephanian of France.

Figured specimen: Slide No. OPC 906D-5-3, Coal County, Oklahoma.

Infraturma Vesiculomonoraditi (Pant, 1954) Bhardwaj, 1956

Genus POTONIEISPORITES Bhardwaj, 1954

Type Species: Potonieisporites novicus Bhardwaj, 1954

1954 Potonieisporites novicus Bhardwaj, Neues Jahrb. für Geologie und Paläontologie, Monatsh., Jahrg. 1954, p. 519-520, fig. 9.

POTONIEISPORITES SP. A

Plate 6, figure 9

Monosaccate miospores; broadly oval in proximal or distal views; suture straight, monolete, parallel with long axis; overall dimensions 66.3 by 48.5 microns, central body oval to circular, 30.5 microns; central body laevigate to finely granular; saccus surface smooth, infrareticulate.

Several specimens of Potonieisporites sp. A were seen during preliminary work and the known size range of these were 55.0 to 68.0 microns in the longest diameter and 40.0 to 50.0 microns in the shortest diameter. Specimens were not encountered during the assemblage study but noted from levels OPC 906F, OPC 907C, and OPC 908H.

Figured specimen: Slide No. OPC 908H-4-2, Latimer County, Oklahoma.

POTONIEISPORITES SP. B

Plate 6, figure 10

Monosaccate miospores; circular, or nearly so, in proximal or distal views; suture straight, monolete; overall dimensions 112.2 by 107.1 microns; central body oval to circular, 63.8 by 58.5 microns; central body laevigate to finely granular; body displays two distinct rings of folding; saccus smooth, infrareticulate.

This species differs from Potonieisporites sp. A in its greater size, circular to nearly circular outline, and prominence of folding on the central body.

This form is rare in the McAlester coals and was not observed in the assemblage counts. One specimen was observed from level OPC

906G during preliminary scanning.

Figured specimen: Slide No. OPC 906G-8-3, Coal County, Oklahoma.

Infraturma Aletesacciti Leschik, 1955

Genus FLORINITES S., W., and B., 1944

Type Species: Florinites pellucidus (Wilson and Coe, 1940) Wilson, 1958

1940 Endosporites pellucidus Wilson and Coe, Amer. Midland Naturalist, vol. 23, p. 184, pl. 1, fig. 3.

1944 Florinites antiquus (Wilson and Coe) Schopf, in S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 58-59, fig. 4

1958 Florinites pellucidus (Wilson and Coe) Wilson, Okla. Geol. Survey, Okla. Geology Notes, vol. 18, p. 99, pl. 1, fig. 3.

FLORINITES PELLUCIDUS (Wilson and Coe, 1940)

Wilson, 1958

Plate 6, figures 3, 4

Florinites pellucidus is an abundant form, being found in 31 sample levels. Its distributional pattern is sporadic and no trend can be noted except in OPC 993 where it increases markedly toward the top of the seam. In OPC 908 F. pellucidus increases steadily toward the top of the coal from 0.5 (at the base) to 26.5 percent in the next to the top sample and then is reduced to 11.0 percent in the top coal sample. With minor exceptions this trend was observed in the samples from OPC 967.

This species has been reported from Desmoinesian and Missourian coals of Illinois and from the Desmoinesian of Indiana, Iowa, and Oklahoma. In western Europe it ranges from Westphalian A

to Stephanian C.

Figured specimens: Slides No. CPC 906D-1-2 and OPC 906D-3-3, Coal County, Oklahoma.

FLORINITES PARVUS Wilson and Hoffmeister, 1956

Plate 6, figure 5

1956 Florinites parvus Wilson and Hoffmeister, Okla. Geol. Survey, Circ. 32, p. 16, pl. 4, figs. 11-12.

This rare species of Florinites was encountered in only one level (OPC 967F) during the assemblage study where three specimens (1.5 percent) were noted.

Florinites parvus has been reported only from the Croweburg and Rowe coals (Desmoinesian) of Oklahoma.

Figured specimen: Slide No. OPC 967F-4-2, Pittsburg County, Oklahoma.

FLORINITES SP. A

Plate 7, figure 4

Monosaccate pollen, apparently alete; broadly elliptical when compressed; 120.0 to 140.0 microns in longest diameter, 95.0 to 115.0 microns in shortest diameter; spore wall finely infrareticulate, with saccus margins entire; central body missing or extremely reduced, only a faint impression remaining.

This species differs from Florinites pumicosus (Ibrahim) S., W., and B. only in its much larger size and smooth margins.

Fourteen specimens of F. sp. A were encountered during the assemblage study yet not one was noted to have a central body. This

species is found in only nine levels and reaches 1.5 percent of the relative assemblage counts in OPC 906G and OPC 993C.

Figured specimen: Slide No. OPC 906G-4-4, Coal County, Oklahoma.

FLORINITES SP. B

Plate 6, figure 6

Monosaccate pollen, bilateral; apparently alete; round to elliptical when compressed; overall dimensions 38.0 by 30.0 microns, central body 28.1 by 12.8 microns; central body dense, almost opaque; saccus covers central body distally; saccus laevigate, finely infrareticulate.

This form is rare in the McAlester coals being represented by two specimens from level OPC 908F, neither of which appear in the assemblage counts.

Figured specimen: Slide No. OPC 908F-1-3, Latimer County, Oklahoma.

Subturma Disaccites Cookson, 1947

Infraturma Disaccitrileti Leschik, 1955

Genus ILLINITES Kosanke, 1950 emend. Potonié and Klaus, in Potonié and Kremp, 1954

Type Species: Illinites unicus Kosanke, 1950

1950 Illinites unicus Kosanke, Ill. Geol. Survey, Bull. 74, p. 51, pl. 1, figs. 1-4.

ILLINITES UNICUS Kosanke, 1950

Plate 7, figure 10

Illinites unicus is a rare element in the McAlester coals. Three specimens were noted in the assemblage study, two from CPC 906B and one from OPC 908G.

Kosanke (1950, pl. 17) shows the range of Illinites unicus to lie completely in the McLeansboro Group (Missourian) in Illinois. This species has been reported from five Oklahoma coals to date, all of which are Desmoinesian in age. The only other known report of this species is from the Middle Zechstein of western Germany.

Infraturma Sulcati Bhardwaj, 1956

Genus KOSANKEISPORITES (Kosanke, 1950)

Bhardwaj, 1956

Type Species: Kosankeisporites elegans (Kosanke, 1950) Bhardwaj, 1956

1950 Illinites elegans Kosanke, Ill. Geol. Survey, Bull. 74, p. 52, pl. 1, figs. 1-2.

1956 Kosankeisporites elegans (Kosanke) Bhardwaj, Palaeobotanist, vol. 4, p. 135-137, pl. 2, figs. 16a-d, 17.

KOSANKEISPORITES cf. K. ELEGANS (Kosanke, 1950)

Bhardwaj, 1956

Plate 7, figures 7, 8

The McAlester forms are considerably larger than those reported by Kosanke (1950, p. 52) from the McClearys Bluff coal (Missourian) of central southeastern Illinois. In all other respects the two appear to be conspecific.

Kosankeisporites cf. K. elegans is rare in the examined material, having been noted from levels OPC 908C, OPC 908H, and OPC

976A.

This species has been reported from the Missourian coals of Illinois and from several Desmoinesian coals of Oklahoma. It has also been reported from the Stephanian A in the Saar coal basin in Germany.

Figured specimens: Slides No. OPC 906B-4-4, Coal County, and OPC 908C-6-1, Latimer County, Oklahoma.

KOSANKEISPORITES SP. A

Plate 7, figure 11

Bisaccate miospores; bilateral, distinct sulcus on distal side between sacci and parallel to lateral axis, sulcus narrow, widening slightly at the ends; overall dimensions 97.0 by 76.5 microns, central body 76.5 by 71.5 microns; central body laevigate externally, finely infragranulate; sacci surfaces smooth, finely infrareticulate.

Kosankeisporites sp. A is a rare element in the McAlester samples. It was noted from OPC 906E and OPC 908I, in each case reaching a maximum of 1.0 percent of the assemblage counts.

Figured specimen: Slide No. OPC 908I-4-1, Latimer County, Oklahoma.

Infraturma Podocarpoiditi Potonié, Thomson, and Thiergart, 1950

Genus PLATYSACCUS (Naumova, 1937) ex. Potonié and Klaus, 1954

Type Species: Platysaccus papilionis Potonié and Klaus, 1954

1954 Platysaccus papilionis Potonié and Klaus, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 68, p. 539-541, pl. 10, figs. 11-12.

PLATYSACCUS SP. A

Plate 7, figure 6

Bisaccate pollen; bilateral, broadly oval in proximal or distal views; furrow narrow, 2.5 to 3.5 microns wide, 51.0 microns long; overall dimensions 94.4 by 66.3 microns; central body oval, 51.0 microns, body delineated by a distinct, raised ridge 2.0 to 4.0 microns wide; body finely punctate; sacci broadly oval, each 66.3 by 50.0 microns, coarsely infrareticulate.

Platysaccus sp. A may be distinguished from P. papilionis Potonié and Klaus which is smaller, both with regard to body and sacci. Platysaccus sp. A bears no folding on the sacci as does P. papilionis. Platysaccus saarensis Bhardwaj is also much smaller than the McAlester species and the strongly distally inclined sacci and faint internal reticulations of P. saarensis are distinct.

A single specimen of this new species was observed from OPC 906E but is not in the assemblage counts.

Figured specimen: Slide No. OPC 906E-5-7, Coal County, Oklahoma.

Genus COMPLEXISPORITES Jizba, 1962

Type Species: Complexisporites polymorphus Jizba, 1962

1962 Complexisporites polymorphus Jizba, Jour. Paleontology, vol. 36, p. 878-879, pl. 121, figs. 1-14.

COMPLEXISPORITES SP. A

Plate 7, figure 9

Bisaccate pollen; laesurate, with few to many fissures encircled by a distinct groove; area enclosed by groove equals about two-thirds of total pollen body; overall dimensions 99.5 by 81.5 microns; body wall finely reticulate to granulate (apparently depending upon degree of maceration); sacci crescent-shaped, overlapping on distal side, each saccus about two-thirds of pollen body; two to many folds, all contained within grooved area.

This species does not appear in the assemblage counts.

Figured specimen: Slide No. OPC 908C-4-1, Latimer County, Oklahoma.

Turma Praecolpates Potonié and Kremp, 1955

Genus SCHOPFIPOLLENITES Potonié and Kremp, 1955

Type Species: Schopfipollenites ellipsoides (Ibrahim, 1932) Potonié and Kremp, 1955

1932 Sporonites ellipsoides Ibrahim, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 449, pl. 17, fig. 29.

1933 Laevigato-sporites ellipsoides (Ibrahim) Ibrahim, Sporenformen des Aegirhorizonts des Ruhr-Reviers, Würzburg. Dissert., p. 40, pl. 4, fig. 29.

1934 Punctato-sporites ellipsoides (Ibrahim) Loose, Inst. Paläobot. und Petrog. Brennsteine, Arbeiten, vol. 4, p. 158-159, pl. 7, fig. 35.

1938 Monoletes ellipsoides (Ibrahim) Schopf, Ill. Geol. Survey, Rept. Inv. 50, p. 45, pl. 1, fig. 14; pl. 6, figs. 5-6.

1955 Schopfipollenites ellipsoides (Ibrahim) Potonié and Kremp, Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 180, pl. 20, fig. 107 15 .

SCHOPFIPOLLENITES ELLIPSOIDES (Ibrahim, 1932)

Potonié and Kremp, 1955

Plate 7, figures 1, 2

Schopfipollenites ellipsoides was recorded from four sections and is missing from OPC 908. It is a rare form in the McAlester coal flora assemblage.

Reported occurrences include the Desmoinesian of Illinois and Oklahoma and Westphalian B to D of western Europe. Winslow (1959, pl. 14, figs. 5, 8, and 9) illustrated several specimens which might be conspecific with S. ellipsoides. No ranges were given.

Figured specimens: Slides No. OPC 906A-3-9 and OPC 906G-4-5, Coal County, Oklahoma.

SCHOPFIPOLLENITES SP. A

Plate 7, figure 3

Bilateral, monolete; broadly oval, tapering to rather blunt ends; overall dimensions 224.5 by 140.3 microns; monolete extends length of body; body wall laevigate to finely punctate.

The description of Schopfipollenites ellipsoides (Ibrahim) Potonié and Kremp by Bhardwaj (1957a, p. 118) stated that there were two folds parallel to the long axis of the body. These folds are missing in S. sp. A, and the McAlester species tend to be laevigate to finely punctate and not rugose as in S. ellipsoides.

Schopfipollenites sp. A is missing from the assemblage counts but several specimens were observed during preliminary

phases of this study.

Figured specimen: Slide No. OPC 993D-6-1, Pittsburg County, Oklahoma.

SPORAE DISPERSAE INCERTAE SEDIS

GENUS A SP. A

Plate 6, figures 1, 2

Spores radial, trilete; circular in outline; overall diameter 54.0 microns; trilete distinct, straight, rays 6.0 to 8.5 microns long; wall laevigate to finely granulate, finely infrareticulate.

Eight specimens have been observed and the known size range is from 50.0 to 60.0 microns. These spores probably were oval prior to compression as most specimens show a preferred orientation such that the trilete mark is easily observed. Level CPC 906A, the seat earth of the Coal County locality, is the only level that has this form and three specimens (1.5 percent) were noted in the assemblage counts. It is likely that this form is an Upper Mississippian or Morrowan form that has been reworked.

Figured specimens: Slides No. OPC 906A-1-15 and OPC 906A-2-11, Coal County, Oklahoma.

GENUS B SP. A

Plate 4, figure 1

Spores radial, trilete; broadly oval to elliptical due to compression; overall dimensions 76.5 by 56.1 microns; trilete dis-

tinct, straight, rays 15.0 to 18.0 microns long; spore body laevigate, except for numerous blunt, rounded projections 1.0 to 4.5 microns in height, 2.0 to 5.0 microns in diameter, projections appear to be randomly spaced; spore coat bears two to four peripheral folds parallel with the long axis.

Recorded, in the assemblage counts, from seven levels, this form reaches a maximum occurrence of 1.5 percent in level OPC 906I. It was not observed from localities OPC 967 and OPC 993.

Figured specimen: Slide No. OPC 907E-1-6, Latimer County, Oklahoma.

GENUS C SP. A

Plate 7, figure 5

Pollen bilateral, monosaccate; equatorial outline broadly elliptical; overall dimensions 91.8 by 61.2 microns, central body 64.0 by 43.4 microns; central body indistinct, or probably missing, with only the impression remaining; two major folds parallel with the long axis; central body finely granular; saccus surface finely granular, coarsely infrareticulate.

This form is unlike any described genus and is rare in the McAlester coals. Two or three specimens, in addition to the figured specimen, have been seen.

Figured specimen: Slide No. OPC 908I-1-2, Latimer County, Oklahoma.

GENUS D SP. A

Plate 6, figure 12

Spores radial, trilete; roundly triangular in both proximal and distal views; overall dimensions 115.0 by 102.0 microns, central body 65.0 to 70.0 microns in diameter; trilete distinct, straight, rays 10.0 to 13.5 microns long; central body circular, delineated by four to five concentric, annular type rings 7.5 to 10.0 microns wide, central body finely granulate; saccus attached to central body, laevigate to finely granular on the surface, infrareticulate.

This genus bears a vague resemblance to Spencerisporites Chaloner, 1951, but differs in many respects. The central body of Spencerisporites measures from 100.0 to 200.0 microns, bears a triradiate ridge, and the edge of the saccus is continued by a single thin layer of cuticle. Genus D has a much smaller central body (65.0 microns) and neither a triradiate ridge nor a cuticle layer. No other known genus bears a closer resemblance to this form.

Genus D sp. A was not encountered in the assemblage study.

Figured specimen: Slide No. OPC 906G-7-1, Coal County, Oklahoma.

GENUS E SP. A

Plate 4, figure 2

Spores radial, trilete; outline roundly triangular; overall dimensions 64.0 by 64.0 microns; trilete obscured by thickened lips that are 1.0 to 2.5 microns wide, trilete reaches equatorial thickening; spore surface covered by papillae 0.5 to 2.5 microns in height, papillae 2.0 to 3.5 microns apart, area between papillae laevigate to finely granular; equatorial thickening varies from

5.0 to 10.0 microns in width.

This form is rare in the McAlester coals, occurring only in the seat earth of section OPC 906. It does not appear in the assemblage counts.

Figured specimen: Slide No. OPC 906A-1-12, Coal County, Oklahoma.

GENUS F SP. A

Plate 1, figure 16

Spores radial, trilete; convex triangular in equatorial view, with well-rounded apices; overall dimensions 33.0 by 33.0 microns; trilete rays reach apices and are bordered by thickened lips 2.0 to 2.5 microns wide on either side of ray, lips appear to terminate at equator; spore coat laevigate to finely granular under oil immersiom.

This genus may be congeneric with the form described as Leiotriletes ornatus Ishchenko, 1956. If this is the case it may be inferred that Ishchenko's assignment is in error because it does not agree with the generic diagnosis of Leiotriletes. Leiotriletes ornatus has been reported from the Donetz Basin of Russia, from Scotland, and from Spitzbergen. The number of specimens recorded from these three localities appears to preclude the 'exinal folding' due to compression as reported by Love (1960, p. 122) and lend credence to thickened lips on either side of the trilete.

In addition to the figured specimen two others were observed during the assemblage study from level OPC 906E.

Figured specimen: Slide No. OPC 906C-5-1, Coal County, Oklahoma.

GENUS G SP. A

Plate 6, figures 7, 8

Spores radial, trilete; saccus and central body circular to subcircular in outline; overall dimensions 51.0 by 40.8 microns, central body 30.6 microns; trilete simple, distinct, rays reach equator of central body; central body distinct, laevigate on the surface, coarsely infrareticulate; saccus surface laevigate, finely infrareticulate.

Several specimens of this form were observed during earlier phases of this study. In the McAlester forms the saccus and central body appear to be in contact with each other in a zone measuring about 2.0 microns at the edges of the central body. This contact zone is undoubtedly the point of attachment of the saccus to the central body. This form resembles Schulzospora Kosanke, 1950, but differs in the mode of saccus attachment and all observed specimens were much smaller than in Kosanke's genus.

Davis (1961, pl. 11, fig. 5) and Urban (1962, pl. 6, figs. 9, 11) figured specimens from the Rowe and Mineral coals respectively that may prove to be congeneric with Genus G from the McAlester coals.

This form is rare in the examined sections and was observed only in levels OPC 906C and OPC 906H.

Figured specimen: Slide No. OPC 906H-5-4, Coal County, Oklahoma.

GENUS H SP. A

Plate 6, figure 11

Spores radial, zonate, apparently alete; almost circular in outline; overall dimensions 51.0 microns, central body 30.6 microns; central body with almost opaque inner body 17.9 microns in diameter, radially striped with projections 5.0 to 8.0 microns long reaching almost to equator of central body proper; saccus laevigate, finely infrareticulate; central body laevigate to finely granular.

This species is rare in the McAlester coals.

Figured specimen: Slide No. OPC 906D-3-1, Coal County, Oklahoma.

GENUS I SP. A

Plate 6, figures 13, 14

Pollen radial, zonate, apparently alete; subcircular to elliptical in outline; overall dimensions 84.2 by 63.8 microns, central body circular, 51.0 microns; saccus lobulate, radially striped due to minor folding, finely granular; saccus varies from 7.7 to 17.9 microns in width; saccus attached at equator of central body, thickens at contact area; central body coarsely granular, grana 1.0 to 3.5 microns wide.

Genus I may be congeneric with Latensina Luber (year ?) but the validity of Latensina is, at present, in doubt. Should Latensina prove to be valid then perhaps the McAlester specimens should be assigned to this genus. A detailed discussion of the generic epithets Latensina and Cordaitina may be seen in Bordeau (1964, p. 137-

138).

Figured specimens: Slides No. OPC 906A-7-1 and OPC 906C-1-10, Coal County, Oklahoma.

MEGASPORES

Anteturma Sporites H. Potonié, 1893

Turma Triletes Reinsch, 1881 (non 1884) Potonié and Kremp, 1955

Subturma Lagenotriletes Potonié and Kremp, 1955

Genus TRILETES (Bennie and Kidston, 1886)

ex Zerndt, 1930 (sensu Dijkstra, 1946)

Type Species: Triletes glabratus Zerndt, 1930

1946 Triletes glabratus Zerndt, Dijkstra, Netherlands Geol. Stichting Meded., ser. C-3-1, no. 1, p. 26-28, pl. 1, figs. 1-3, 5-8; pl. 4, fig. 35. (for synonymy see Dijkstra, 1946, p. 26-27.)

Numerous specimens of megaspores assignable to the genus Triletes are found in the McAlester coals but no special effort was made to isolate large numbers of them. Specimens observed during the assemblage study are not included in the counts because it is not believed that a representative sample was obtained. Three species are illustrated as examples of some megaspore types observed.

TRILETES cf. T. LEVIS (Zerndt, 1937)

S., W., and B., 1944

Plate 8, figures 8, 10, 11

1937 Lagenicula levis Zerndt, Acad. Polonaise Sci. Lettr., Bull., ser. A, p. 587-588, pl. 15, figs. 1-11.

1944 Triletes levis (Zerndt) S., W., and B., Ill. Geol. Survey, Rept. Inv. 91, p. 23.

Figured specimens: Slides No. OPC 907F-5-2 and OPC 907G-12-1, Latimer County, Oklahoma.

TRILETES RUGOSUS (Loose, 1932) Schopf, 1938

Plate 8, figures 1-7

1932 Sporonites rugosus Loose, in Potonié, Ibrahim, and Loose, Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beil.-Band, vol. 67, Abt. B, p. 452, pl. 20, fig. 59.

1946 Triletes rugosus (Loose) Dijkstra, Netherlands Geol. Stichting Meded., ser. C-3-1, no. 1, p. 47-48, pl. 9, figs. 83-99; pl. 10, figs. 100-114; pl. 11, fig. 115.

Figured specimens: Slides No. OPC 906I-7-1, OPC 906I-7-3, and OPC 906I-7-5, Coal County, Oklahoma.

TRILETES SP. A

Plate 8, figures 9, 12

Spores large, trilete; oval, slightly elongated as a result of lateral compression; overall dimensions 497.5 by 483.5 microns; trilete obscure due to compression; surface appears laevigate to finely matte under low power (35X), finely granular under oil immersion; spore coat 8.0 to 10.0 microns thick, translucent; several, randomly oriented, compression folds on several specimens.

This species resembles Triletes translucens Kosanke, 1938, but is smaller and the spore wall is thinner.

Figured specimen: Slide No. OPC 908C-8-1, Latimer County, Oklahoma.

DISCUSSION

Fossil spore and pollen data employed in this study have been obtained in two ways: 1) by the identification of generic and specific palynomorphs in the coals and related sediments and 2) by relative assemblage counts plotted as segment and channel histograms. The latter technique involved counting 200 specimens from each fossiliferous level, computing these counts as relative percentages, and plotting these data as histograms.

Analysis of channel histograms indicates that plant succession took place during deposition of the McAlester coals and that this succession was interrupted during different stages at different localities prior to the final inundation of the coal swamp. Fifteen spore and pollen groups were chosen to illustrate plant distribution and succession as it developed in each level and from each sampled locality (Table 1).

The histograms are presented in their relative southwest to northeast geographic positions with the lower four representing Lower McAlester (Lehigh) localities and the uppermost representing an Upper McAlester (Stigler) locality. This graphic technique is utilized to illustrate floral changes resulting from ecological shifts both in time and in space.

The spore and pollen flora of the McAlester coals consists

of our dominant genera whose species comprise 71.9 percent of the Lower McAlester (Lehigh) coal and 73.4 percent of the Upper McAlester (Stigler) coal. These genera, in descending order of abundance, are: Laevigatosporites, Lycospora, Endosporites, and Calamospora. Principal successional trends are shown by these four genera.

Laevigatosporites appears to have been a pioneer element of the palynological succession. Species of this genus occurred in all examined levels and a relative percentage increase may be noted from the southernmost locality to the northernmost locality (Figure 2). Ecologic conditions for the parent plant of Laevigatosporites must have been somewhat better during the period of coal swamp deposition of the Upper McAlester (Stigler) coal as the highest relative percentages of Laevigatosporites are found in OPC 907.

Lycospora shows a complementary distributional pattern with Laevigatosporites, i. e., as Laevigatosporites increases in number, to the northeast, Lycospora decreases.

Two other genera which show a complementary distributional pattern with Lycospora are Florinites and Wilsonites.

Endosporites is more abundant near the center of the Lower McAlester (Lehigh) outcrop area in Pittsburg County. The Coal and Latimer County localities, which lie at the extreme ends of the sampled area, have a flora reduced only slightly in number of Endosporites specimens. The Upper McAlester (Stigler) section, in Latimer County, has less than one-sixth the number of specimens of Endosporites as was observed in the Lower McAlester coal section immediately underlying it. This marked reduction in occurrence of Endo-

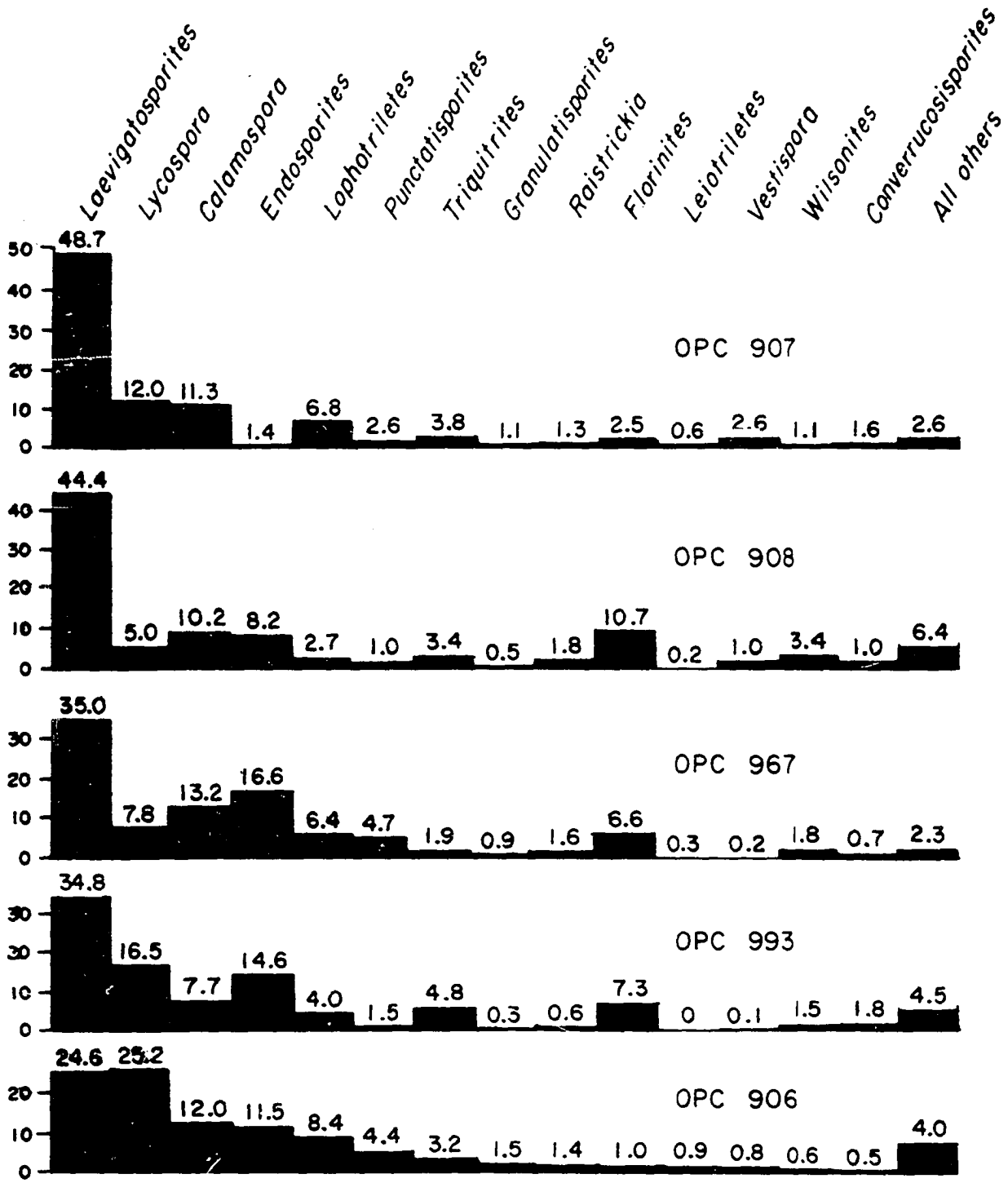


FIGURE 3. CHANNEL HISTOGRAMS ILLUSTRATING RELATIVE PERCENTAGES OF SPORE GENERA IN FIVE SECTIONS OF McALESTER COALS.

sporites, coupled with the high percentages of Laevigatosporites, may be of stratigraphic importance in separating Lower from Upper McAlester coals.

Calamospora does not indicate a definite successional trend in the channel histograms, which are composite histograms for all levels in one seam. The segment histograms, however, show a distinct successional history for each sampled locality (see discussion for each OPC locality).

OPC 906

COAL COUNTY, OKLAHOMA

Section OPC 906 is near the southern limits of the Lower McAlester (Lehigh) coal outcrops. In this locality several floral elements (Ahrensisporites, Grandispora, and, possibly Genus A) in the seat earth appear to have been reworked from older sediments.

Lycospora brevijuga is the dominant species in the coal of OPC 906 and indicates a marked bimodal occurrence. In level H it comprises 50.0 percent of the relative palynological flora. Levels C, D, and E decrease steadily to 5.0 percent at level F. Dominance is again shown in level G where L. brevijuga reaches 44.5 percent then decreases again in the next two levels to 15.0 percent in level I, the topmost coal level.

Laevigatosporites ovalis and Lophotriletes microsaetosus reach their maximum development in the middle part of the seam, at the level where Lycospora brevijuga is greatly diminished.

The six species of Laevigatosporites, combined as a group,

indicate two distinct stages of abundance. This group increases steadily from 11.0 percent in level B to 34.5 percent in level F and then shows a marked drop in level G. They increase again in the next level to 30.0 percent and are replaced by an increase in species of Calamospora and Triquitrites in the topmost level, level I.

Endosporites angulatus and E. ornatus have two maxima, one in level C and the other in level I. Absence of all species of Calamospora in level G is difficult to explain. This is the level in which Lycospora brevijuga reaches its second 'peak' but this abundance is not considered sufficient to mask out Calamospora.

Florinites and Wilsonites, both rare in the lower half of of the coal, are minor floral elements in the upper half (levels F, G, and H) and are missing from the topmost level. The presence of several different species of saccate pollen may indicate proximity to a nearby upland flora. It should be noted that this hypothetical upland was some distance away, and much nearer to the northern portions of the outcrop area, because those sections show a greater number of saccate specimens in the samples.

Triquitrites increases upward from the lowermost coal level to level G where it is reduced slightly in number and reaches a maximum of 8.0 percent in the topmost coal sample.

Section OPC 906 is dominated by species of the genera Lycospora and Laevigatosporites. These genera contributed 51.0 percent of the spore and pollen flora and, in general, where one increases the other decreases sharply, displaying a complementary

distributional pattern within the coal seam.

OPC 993

Section OPC 993, located on the southwestern flank of the Savanna anticline, is characterized by complementary distributional patterns involving species of Calamospora, Florinites, Endosporites, and Laevigatosporites ovalis. As Calamospora and Laevigatosporites ovalis decrease upward in the coal sections both Endosporites and Florinites increase sharply. Endosporites is the dominant spore element in the top one-third of the seam. The lower two-thirds of the coal is dominated by Lycospora brevijuga and species of Laevigatosporites. The marked increase in saccate forms is interpreted as indicative of this section being closer to a nearby upland flora than was section OPC 906. The latter lies approximately 26 miles to the southwest.

Wilsonites, Triquitrites, and Lophotriletes, although present, are minor floral elements at this locality. Triquitrites and Lophotriletes microsaetosus display, in a broad sense, a complementary pattern, as one increases the other decreases.

OPC 967

PITTSBURG COUNTY, OKLAHOMA

Dominant genera in the coal of section OPC 967 are Laevigatosporites and Endosporites, with species of Calamospora, Florinites, and Lycospora as subdominant floral elements. The species of Laevigatosporites are abundant (54.5 percent) at the base of the

coal. Laevigatosporites minutus closely approximates this successional pattern, the major deviation being that level H contains the lowest percentage of the species. Laevigatosporites ovalis increases steadily upward in the section to level H (24.0 percent) and decreases from this point upward to 11.5 percent in level I.

Lycospora brevijuga and Endosporites display a complementary distributional pattern. Endosporites, missing in the lowermost coal level, increases from 2.5 percent in level C to 38.0 percent in level J, then decreases in the two uppermost levels to 10.5 percent in level L. Lycospora brevijuga has its maximum development in level B, decreases, more or less steadily, to 1.0 percent in level J, and is missing from levels K and L. These two levels may present an anomalous condition with respect to an abundance of Lophotriletes microsaetosus which makes up approximately 20.0 percent of levels K and L. In these two levels species of Laevigatosporites are at their lowest relative percentages, Lycospora brevijuga is absent, and Endosporites has again become reduced in number.

Calamospora shows a steady, if somewhat sporadic, increase from 4.0 percent in level B to 17.5 percent in level L. Wilsonites and Florinites follow this same general pattern except that both are conspicuous in their absence from the two lowermost coal levels.

Endosporites is absent from level B and represented by 2.5 percent in level C. These three saccate genera, Wilsonites, Florinites, and Endosporites may be indicative of an upland flora which, at the time of deposition corresponding to levels B and C, was not being transported to the depositional site in the coal swamp. By the time

level D and succeeding levels were being deposited a transportational medium developed, which may account for their steady increase in the upper portions of the coal seam. An alternative thesis is that the plant community, of the upland type, had not developed prior to the time level D was deposited.

OPC 908

LATIMER COUNTY, OKLAHOMA

The flora of the Latimer County section, OPC 908, is dominated by Laevigatosporites, which comprises almost 35.0 percent of the relative spore and pollen count in all but the two uppermost levels of the coal. These two levels are both in excess of 25.0 percent species of Laevigatosporites. Laevigatosporites displays a bimodal distributional pattern at this locality. Its relative abundance is 62.5 percent in level B, decreasing slowly to 34.5 percent in level E, increasing sharply in levels F anf G, and finally decreasing again to 27.5 percent in level I. The two lowermost levels, B and C, are low in abundance of Laevigatosporites and are replaced by a corresponding increase in percentages of Endosporites. Laevigatosporites minutus decreases more or less regularly toward the upper portion of the coal while L. ovalis maintains a fairly constant distributional pattern, varying between 9.0 and 18.5 percent of the relative spore and pollen assemblage.

Lycospora brevijuga is greatly reduced in abundance, being replaced by both Laevigatosporites and Florinites. The maximum occurrence of Lycospora brevijuga in OPC 908C corresponds to the

minimum occurrence of Endosporites. Two maxima are reached by Endosporites, one in level E (27.0 percent) and the other in level H (19.0 percent). Endosporites would display a bimodal occurrence except for the two lowermost levels which decrease from level B to level D. These resurgent abundances are not well enough developed to warrant interpretation as a trimodal distributional pattern. A comparison of the distributional pattern of Endosporites with that of Laevigatosporites ovalis shows the two to be similar in that there is a distinct series of increases and decreases in number of specimens within the coal interval.

Florinites may be considered with Endosporites and Calamospora as subdominant floral elements in section OPC 908. There is a steady increase of Florinites from 0.5 percent in level B to 26.5 percent in level H, then a sharp decline to 11.0 percent in the uppermost coal level. The upper five levels are noteworthy in that a maximum abundance of Florinites occurs in these levels. Although a minor floral element in the McAlester coals, the appearance of Florinites persistently in five levels may be of ecologic importance when considered in conjunction with the abundance of Wilsonites in the same levels. Parent plants of these two spore genera are considered to be upland floral elements and a sudden increase of these genera may be interpreted as indicative of later phases of the coal swamp continuum.

Lophotriletes microsaetosus and Triquitrites are minor floral elements in this section. The former increases slowly toward the top of the coal to a maximum of 8.5 percent in the top level and the lat-

ter displays a rather sporadic pattern varying from 1.0 to 6.4 percent of the relative assemblage counts. Both were present in all levels of OPC 908.

OPC 907

LATIMER COUNTY, OKLAHOMA

Section OPC 907 is the only fossiliferous locality of Upper McAlester (Stigler) coal studied. Section OPC 909, from Haskell County, is also an Upper McAlester (Stigler) coal but proved to be sterile due to incipient metamorphism which the coal had been subjected to some time after deposition.

A comparison of the histograms of the McAlester coals (Figure 4) indicates anomalous distributional patterns are present in OPC 907 and it may be that these anomalies are of value in determining the Upper McAlester (Stigler) coal. Inasmuch as only one section was examined caution in applying these data must be employed until such time as other Upper McAlester (Stigler) sections are examined for their palynological content.

Laevigatosporites is the dominant spore element in this section and the subdominant elements are Calamospora, Lophotriletes, and Lycospora.

Laevigatosporites is present in every level in excess of 47.0 percent and varies between 47.5 and 53.5 percent of the relative assemblage counts. This almost constant assemblage pattern may be interpreted as indicating that the coal swamp remained in an early stage of ecological development throughout its entire history.

Segment histograms of L. ovalis and L. minutus show little change except that the former increases slightly toward the top of the coal seam and decreases in the topmost level and that the latter decreases slightly toward the top of the seam.

Lycospora brevijuga reverses the pattern set in the four Lower McAlester (Lehigh) sections by increasing upward in the seam to a maximum of 32.0 percent in the topmost level. There is a minor increase of L. brevijuga in levels C and D but not enough to interpret a bimodal distributional pattern.

Calamospora is in excess of 11.0 percent relative abundance in levels C, D, E, and F and is greatly reduced in the lowermost and topmost levels.

Lophotriletes microsaetosus, like Lycospora brevijuga, reverses its distributional pattern. In the Lower McAlester (Lehigh) coal sections Lophotriletes microsaetosus is most abundant at, or near, the top of the seam. In OPC 907 its maximum occurrence (20.0 percent) is in the lowermost coal level and it gradually decreases in abundance to 2.5 percent in the topmost level.

Triquitrites, Florinites, Endosporites, and Wilsonites are well represented but are minor floral elements in this section.

Most of the spores and pollen recovered from the five fossiliferous localities of the McAlester coals were probably deposited in situ, or transported but a short distance because numerous tetrads of Calamospora, Laevigatosporites, Lycospora, Granulatisporites, and Triquitrites were observed which is indicative that little or no transport took place. The saccate forms such as Wilsonites, Endo-

sporites, *Florinites*, etc. were probably wind-borne and their presence may be the result of several miles transport to the depositional sites. Dominance, or high percentage occurrence, of one or more of these saccate forms is highly suggestive of a local concentration of the parent plants from which the spores were derived.

FIGURE 4

Segment sample histograms reflecting relative percentages of 25 species in five McAlester coal sections. The two fossiliferous seat earths are indicated by oblique lines. Sections, from top to bottom, are northeast to southwest geographically. The uppermost histogram (OPC 907) is the Upper McAlester (Stigler) and the lower four histograms represent the Lower McAlester (Lehigh) coal.

Species combinations are indicated by numbers as listed below:

1. Composite of six species of Laevigatosporites; L. minutus, L. ovalis, L. desmoinesensis, L. medius, L. minimus, and L. punctatus
2. Laevigatosporites minutus
3. Laevigatosporites ovalis
4. Lycospora brevijuga
5. Endosporites angulatus and E. ornatus
6. Calamospora breviradiata and C. flexilis
7. Florinites pellucidus, F. parvus, and F. sp. A
8. Lophotriletes microsaetosus
9. Wilsonites delicatus and W. vesicatus
10. Triquitrites bransonii, T. crassus, T. exiguus, T. praetextus, T. protensus, T. sp. A, T. sp. B, and T. sp. C

FIGURE 4. SEGMENT SAMPLE HISTOGRAMS REFLECTING RELATIVE PERCENTAGES OF 25 SPECIES IN FIVE McALESTER COAL SECTIONS (REFER NUMBERS TO PREVIOUS PAGE)

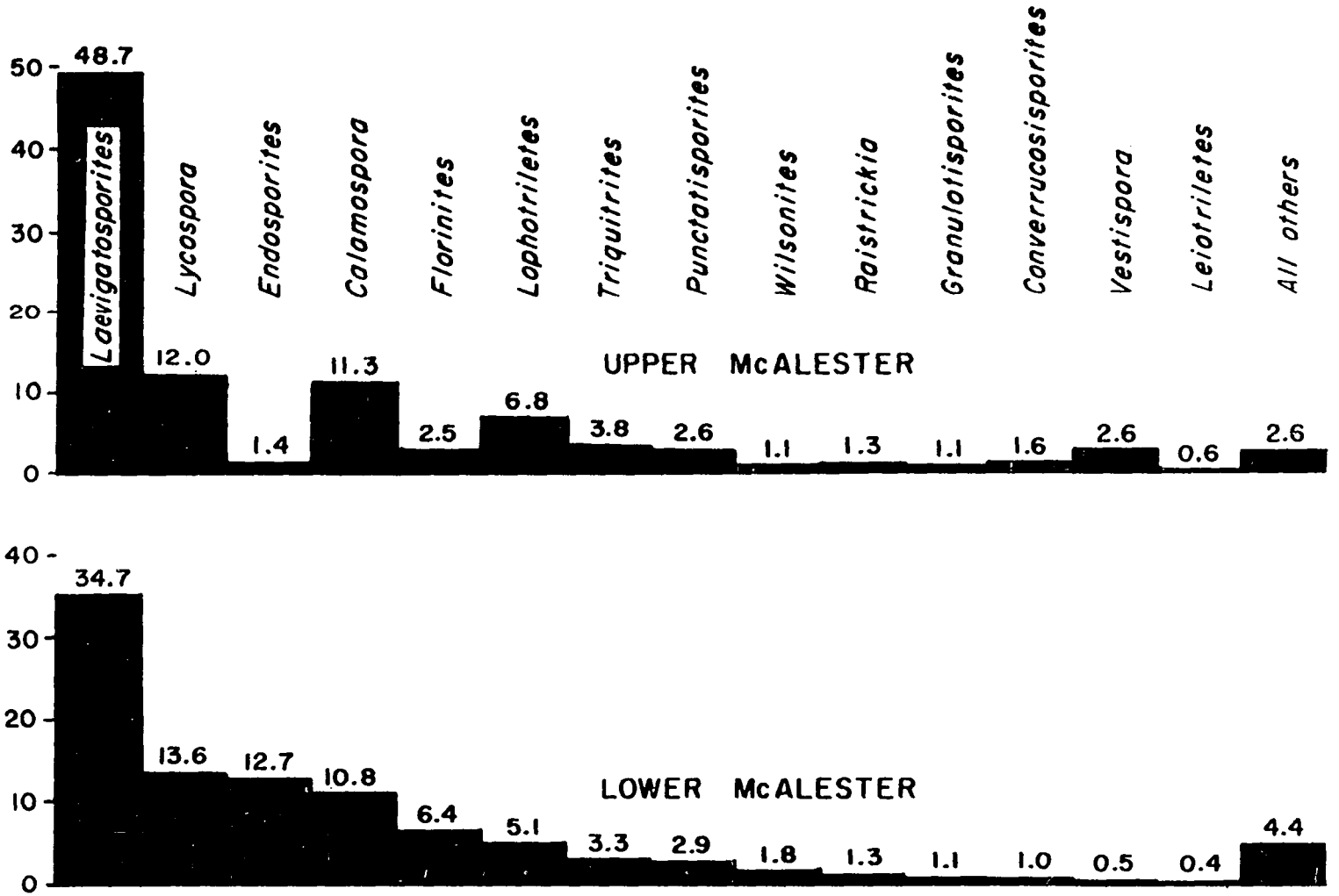


FIGURE 5. COMPOSITE AVERAGE PERCENTAGES FOR FIVE SECTIONS OF McALESTER COALS.

STRATIGRAPHIC CORRELATION OF THE McALESTER COALS

The McAlester coals have a wide distribution in southeastern Oklahoma and western Arkansas. In Oklahoma most of the known outcrops of the McAlester coals are restricted to the Arkoma Basin (Figure 1).

Fossil spores and pollen have been found to be valuable in stratigraphic studies. Palynological assemblages, successional trends, and the distributional relationships of these can be graphically illustrated as histograms and may be used in stratigraphic and paleoecologic correlations.

The McAlester coals in the western part of the Arkoma Basin contain an abundance of fossil spores and pollen but eastward into the areas of low volatile coals the palynological fossils have been destroyed by low-grade metamorphism. All McAlester coals of western Arkansas are also in the low volatile class and do not contain fossil spores and pollen.

An attempt has been made to compare the approximately contemporaneous coals of Illinois with the McAlester seams. In this effort the palynological work of Kosanke (1950) has been used as a source of comparison with the McAlester coals. His list of species from the Reynoldsburg, Sub-Babylon, Babylon, and Tartar-Willis coals

is used in this comparison of spore floras (Table 2). These four Illinois seams do not appear to correlate with the McAlester coals because the number of species in common with any one of these four coals does not exceed 27.2 percent (see Table 2) and this percentage is probably too small to be significant for correlation purposes.

The Rowe coal in Oklahoma was studied by Davis (1961) and has 35.4 percent of the species in common with the McAlester coals and the Rowe coal is higher in the Oklahoma Pennsylvanian section, yet it has more species in common with the McAlester coals than the Illinois coal seams listed above. One explanation of these differences and similarities could be the geographic proximity of the Rowe coal to the McAlester and the status of palynological knowledge at the present time.

Two genera present in the Rowe coal but missing from the McAlester coals are Reinschospora and Alatisporites. Densosporites is absent in the Rowe coal and is rare in the McAlester coals. Only 21 specimens of Densosporites were observed during the present study.

Wilson (1964, personal communication) stated that, in a 10½ foot section of the Hartshorne coal in Latimer County, Oklahoma, Laevigatosporites and Cirratriradites dominate the lower portion of the coal. Higher in the section these two genera are replaced by Florinites, Endosporites, and Densosporites and the top of the coal is dominated by Densosporites. Both Densosporites and Cirratriradites are rare in the McAlester coals and Reinschospora and Alatisporites are absent.

TABLE 2

SUMMARY OF SPORE DISTRIBUTION IN FOUR ILLINOIS COALS AND THE ROWE AND McALESTER COALS

Comparison	Illinois				Oklahoma	
	Re*	SB	Ba	TW	Ro	Mc
Number of species reported	19	17	19	33	78	91
Species in common with McAlester coals	5	4	5	9	29	--
Percentage in common with McAlester coals	26.3	23.5	26.3	27.2	35.4	--

*Re-Reynoldsburg coal (Kosanke, 1950)
SB-Sub-Babylon coal (Kosanke, 1950)
Ba-Babylon coal (Kosanke, 1950)
TW-Tartar and Willis coals (Kosanke, 1950)
Ro-Rowe coal (Davis, 1961)
Mc-McAlester coals (Dempsey, 1964)

BIBLIOGRAPHY

Bhardwaj, D. C., 1957a, The palynological investigations of the Saar coals (Part I--morphography of Sporae dispersae): Palaeontographica, Abt. B, vol. 101, p. 73-125, pls. 22-31, 7 figs., 1 table.

_____ 1957b, The spore flora of Velener Schichten (Lower Westphalian D) in the Ruhr Coal Measures: Palaeontographica, Abt. B, vol. 102, p. 110-138, pls. 23-26, 9 figs., 3 tables.

_____ and Venkatachala, B. S., 1961 [1962], Spore assemblage out of a Lower Carboniferous shale from Spitzbergen: Palaeobotanist, vol. 10, p. 18-47, 10 pls., 5 figs.

Bond, T. A., 1963, Palynology of the Weir-Pittsburg coal (Pennsylvanian) of Oklahoma and Kansas: unpublished Master of Science thesis, The University of Oklahoma, 103 p., 5 pls.

Bordeau, K. V., 1964, Palynology of the Drywood coal (Pennsylvanian) of Oklahoma: unpublished Master of Science thesis, The University of Oklahoma, 207 p., 11 pls.

Branson, C. C., 1954a, Field Conference on Desmoinesian rocks of northeastern Oklahoma: Okla. Geol. Survey Guide Book 2, 41 p., 17 figs., 6 maps.

_____ 1954b, Names of Oklahoma coal beds: Okla. Geol. Survey, The Hopper, vol. 14, no. 8, p. 123-132.

_____ 1961, in Doerr, Coal mining and landscape modification: Okla. Geol. Survey, Circ. 54, 48 p., 13 figs.

_____ 1962, Pennsylvanian System of the Mid-Continent, in Branson, C. C. [ed], Pennsylvanian System in the United States, a symposium: Amer. Assoc. Petroleum Geologists, p. 431-460, 10 figs., 8 tables.

Chaloner, W. G., 1951, On Spencerisporites, gen. nov. and S. karczewskii (Zerndt), the isolated spore of Spencerites insignis Scott: Annals Mag. Nat. History, ser. 12, vol. 4, p. 861-873, 10 text figs.

Clarke, R. T., 1961, Palynology of the Secor coal (Pennsylvanian) of Oklahoma: unpublished Master of Science thesis, The University of Oklahoma, 131 p., 12 pls.

Couper, R. A., 1953, British Mesozoic microspores and pollen grains: Palaeontographica, Abt. B, vol. 103, p. 75-179, pls. 15-31, 11 text figs., 12 tables.

Dane, C. H., Rothrock, H. E., and Williams, J. S., 1938, Geology and fuel resources of the southern part of the Oklahoma coal field, pt. 3, The Quinton-Scipio district: U. S. Geol. Survey, Bull. 874C, p. 151-253, pls. 12-26, figs. 8-11.

Davis, P. N., 1961, Palynology of the Rowe coal (Pennsylvanian) of Oklahoma: unpublished Master of Science thesis, The University of Oklahoma, 153 p., 11 pls.

Dijkstra, S. J., 1946, Eine monographische Bearbeitung der karbonischen Megasporen: Netherlands Geol. Stichting Meded., ser. C-3-1, no. 1, p. 1-101, 16 pls., 1 fig., 8 tables.

Doerr, A. H., 1961, Coal mining and landscape modification: Okla. Geol. Survey, Circ. 54, 48 p., 13 figs.

Dott, R. H., 1942, Geology of the McAlester bed coal, in Davis, J. D., and Reynolds, D. A., Carbonizing properties of McAlester bed coal from Dow No. 10 Mine, Dow, Pittsburg County, Okla.: Okla. Geol. Survey, Mineral Rept. 15.

Frezon, S. E., 1962, Correlation of Paleozoic rocks from Coal County, Oklahoma, to Sebastian County, Arkansas; Okla. Geol. Survey, Circ. 58, 53 p., 2 pls.

Gibson, L. B., 1961, Palynology and paleoecology of the Iron Post coal (Pennsylvanian) of Oklahoma: unpublished Ph. D. dissertation, The University of Oklahoma, 239 p., 8 pls.

Guennel, G. K., 1958, Miospore analysis of the Pottsville coals of Indiana: Ind. Dept. Conserv., Ind. Geol. Survey, Bull. 13, 101 p., 6 pls., 20 figs.

Hendricks, T. A., 1937, Geology and fuel resources of the southern part of the Oklahoma coal field, pt. 1, The McAlester district: U. S. Geol. Survey, Bull. 874A, p. 1-90, pls. 1-10, figs. 1-5.

_____ 1939, idem, pt. 4, The Howe-Wilburton district: U. S. Geol. Survey, Bull. 874D, p. 255-300, pls. 27-35, figs. 12-17.

Higgins, M. J., 1961, Stratigraphic position of the coal seam near Porter, Wagoner County, Oklahoma: unpublished Master of Science thesis, The University of Oklahoma, 83 p., 6 pls.

Hoffmeister, W. S., Staplin, F. L., and Malloy, R. E., 1955, Mississippian plant spores from the Hardinsburg Formation of Illinois and Kentucky: Jour. Paleontology, vol. 29, p. 372-399, pls. 36-39, 4 figs.

Ibrahim, A., 1933, Sporenformen des Aegirhorizonts des Ruhr-Reviers: Dissert. Tech. Hochschule Berlin, Würzburg, Triltsch, 48 p., 8 pls., 2 figs.

Imgrund, R., 1960, Sporae dispersae des Kaipingbeckens, ihre paläontologische und stratigraphische Bearbeitung im Hinblick auf eine Parallelisierung mit dem Ruhrkarbon und dem Pennsylvanian von Illinois: Geol. Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 77, p. 143-204, pls. 13-16, 7 figs., 4 tables.

Ishchenko, A. M., 1956, Spory i pyltsa nizhnekamennougolnykh osadkov zapadnogo prodolzheniya Donbassa i ikh znachenie dyla stratigrafii: Akademiya Nauk Ukrainskoy SSR, Trudy Instityta Geologisheskikh Nauk, Seriya Stratigrafii i Paleontologii, vypusk 11, 184 p., 20 pls., 3 tables.

Knechtel, M. M., 1937, Geology and fuel resources of the southern part of the Oklahoma coal field, pt. 2, The Lehigh district: U. S. Geol. Survey, Bull 874B, p. 91-149, pl. 11, figs. 6-7.

_____ 1949, Geology and coal and natural gas resources of northern LeFlore County, Oklahoma: Okla. Geol. Survey, Bull. 68, 76 p., 3 tables.

Knox, E. M., 1948, The microspores of the Limestone Coal Group in Scotland: Inst. Mining Engineers, Trans., vol. 107, pt. 3, p. 1-9, 45 text figs., 2 tables.

_____ 1950, The spores of Lycopodium, Phylloglossum, Selaginella, and Isoetes and their value in the study of microfossils of Palaeozoic age: Bot. Soc. Edinburgh, Trans., vol. 35, p. 209-357, pls. 8-19.

Kosanke, R. M., 1950, Pennsylvanian spores of Illinois and their use in correlation: Ill. State Geol. Survey, Bull. 74, 128 p., 18 pls., 7 figs.

_____, et al., 1960, Classification of the Pennsylvanian strata of Illinois: Ill. State Geol. Survey, Rept. Inv. 214, 84 p., 1 pl., 4 figs., 3 tables.

Love, L. G., 1960, Assemblages of small spores from the Lower Oil-shale Group of Scotland: Roy. Soc. Edinburgh, Proc., vol. 67, pt. 2, p. 99-126, 2 pls., 15 text figs.

Moose, J. E., and Searle, V. C., 1929, A chemical study of Oklahoma coals: Okla. Geol. Survey, Bull. 51, 112 p., 7 pls., 1 fig.

Morgan, J. L., 1955, Spores of McAlester-Stigler coal: Okla. Geol. Survey, Circ. 36, 52 p., 3 pls., 2 figs.

Oakes, M. C., and Knechtel, M. M., 1948, Geology and mineral resources of Haskell County, Oklahoma: Okla. Geol. Survey, Bull. 67, 134 p., 8 pls., 6 figs., 4 tables.

Potonié, R., 1954, Stellung der paläozoischen Sporengattungen im natürlichen System: Paläontologische Zeitschrift, vol. 28, nos. 3/4, p. 103-139, pls. 9-13.

_____ 1956, Synopsis der Gattungen der Sporae dispersae. Teil I: Geologischen Landesanstalten Bundesrepublik Deutschland, Amt für Bodenforschung, Beihefte Geol. Jahrb., vol. 23, 103 p., 11 pls.

_____ 1958, idem, Teil II: vol. 31, 114 p., 11 pls.

_____ 1960, idem, Teil III: vol. 39, 189 p., 9 pls.

Potonié, R., Ibrahim, A., and Loose, F., 1932, Sporenformen aus den Flözen Aegir und Bismarck des Ruhrgebietes: Neues Jahrb. für Mineralogie, Geologie, und Paläontologie, Beilage-Band, vol. 67, Abt. B, p. 438-454, pls. 14-20, 1 fig.

Potonié, R., and Klaus, W., 1954, Einige Sporengattungen des alpinen Salzebirges: Geologischen Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 68, p. 517-546, pl. 10, 11 text figs.

Potonié, R, and Kremp, G., 1955a, Die Gattungen der paläozoischen Sporae dispersae und ihre Stratigraphie: Geologischen Landesanstalten Bundesrepublik Deutschland, Geol. Jahrb., vol. 69, p. 111-194, pls. 4-20, 5 figs.

_____ 1955b, Die Sporae dispersae des Ruhrkarbons ihre Morphographie und Stratigraphie mit Ausblicken Arten anderer Gebiete und Zeitabschnitte, Teil I: Palaeontographica, Abt. B. vol. 98, p. 1-136, 16 pls., 37 figs.

_____ 1956a, idem, Teil II: vol. 99, p. 85-191, pls. 17-22, figs. 38-88.

_____ 1956b, idem, Teil III: vol. 100, p. 65-121, 3 tables.

Ruffin, J. H., 1961, Palynology of the Tebo coal (Pennsylvanian) of Oklahoma: unpublished Master of Science thesis, The University of Oklahoma, 124 p., 7 pls.

Russell, D. T., 1960, Geology of northern Latimer County, Oklahoma; Okla. Geol. Survey, Circ. 50, 56 p., 1 pl., 12 figs.

Schemel, M. P., 1950, Carboniferous plant spores from Daggett County, Utah: Jour. Paleontology, vol. 24, p. 232-244, pls. 39-40, 3 figs.

Schopf, J. M., Wilson, L. R., and Bentall, R., 1944, An annotated synopsis of Paleozoic fossil spores and the definition of generic groups: Ill. State Geol. Survey, Rept. Inv. 91, 73 p., 3 pls., 5 figs.

Shannon, C. W., et al., 1926, Coal in Oklahoma: Okla. Geol. Survey, Bull. 4, 110 p., 23 pls., 12 figs., 7 tables.

Taff, J. A., 1899, Geology of the McAlester-Lehigh coal field, Indian Territory: U. S. Geol. Survey, 19th Ann. Rept., pt. 3, p. 423-456, figs. 77-80.

Trumbull, J. V. A., 1957, Coal resources of Oklahoma: U. S. Geol. Survey, Bull. 1042J, p. 307-382, pls. 16-17, 8 tables.

Urban, J. B., 1962, Palynology of the Mineral coal (Pennsylvanian) of Oklahoma and Kansas: unpublished Ph. D. dissertation, The University of Oklahoma, 146 p., 7 pls.

Wiggins, V. D., 1962, Palynomorph fossils from the Goddard Formation (Mississippian) of southern Oklahoma: unpublished Master of Science thesis, The University of Oklahoma, 123 p., 28 pls.

Wilson, L. R., 1959a, A water-miscible mountant for palynology: Okla. Geol. Survey, Okla. Geology Notes, vol. 19, p. 110-111.

_____ 1959b, The use of fossil spores in the resolution of Mississippian stratigraphic problems: Tulsa Geol. Society Digest, vol. 27, p. 166-171, 1 pl., 1 fig.

_____ 1960, Florinites pelucidus and Endosporites ornatus with observations on their morphology: Okla. Geol. Survey, Okla. Geology Notes, vol. 20, p. 29-33, 1 pl.

_____ 1961, Palynological fossil response to low-grade metamorphism in the Arkoma Basin: Tulsa Geol. Society Digest, vol. 29, p. 131-140, 1 fig., 7 tables.

_____ 1962, Permian plant microfossils from the Flowerpot Formation, Greer County, Oklahoma: Okla. Geol. Survey, Circ. 49, 50 p., 3 pls., 1 table.

_____ 1963, Type species of the Paleozoic pollen genus Florinites Schopf, Wilson, and Bentall, 1944: Okla. Geol. Survey, Okla. Geology Notes, vol. 23, p. 29.

Wilson, L. R., and Hoffmeister, W. S., 1956, Pennsylvanian plant microfossils of the Croweburg coal in Oklahoma: Okla. Geol. Survey, Circ. 32, 57 p., 5 pls., 4 figs.

Wilson, L. R., and Kosanke, R. M., 1944, Seven new species of unassigned plant microfossils from the Des Moines Series of Iowa: Iowa Acad. Science, Proc., vol. 51, p. 329-333, 7 text figs.

Wilson, L. R., and Venkatachala, B. S., 1963, An emendation of Vestispora Wilson and Hoffmeister, 1956: Okla. Geol. Survey, Okla. Geology Notes, vol. 23, p. 94-100, 1 pl.

Winslow, M. R., 1959, Upper Mississippian and Pennsylvanian megaspores and other plant microfossils from Illinois: Ill. State Geol. Survey, Bull. 86, 135 p., 16 pls., 9 text figures, 3 tables.

APPENDIX

PLATE 1

PLATE 1

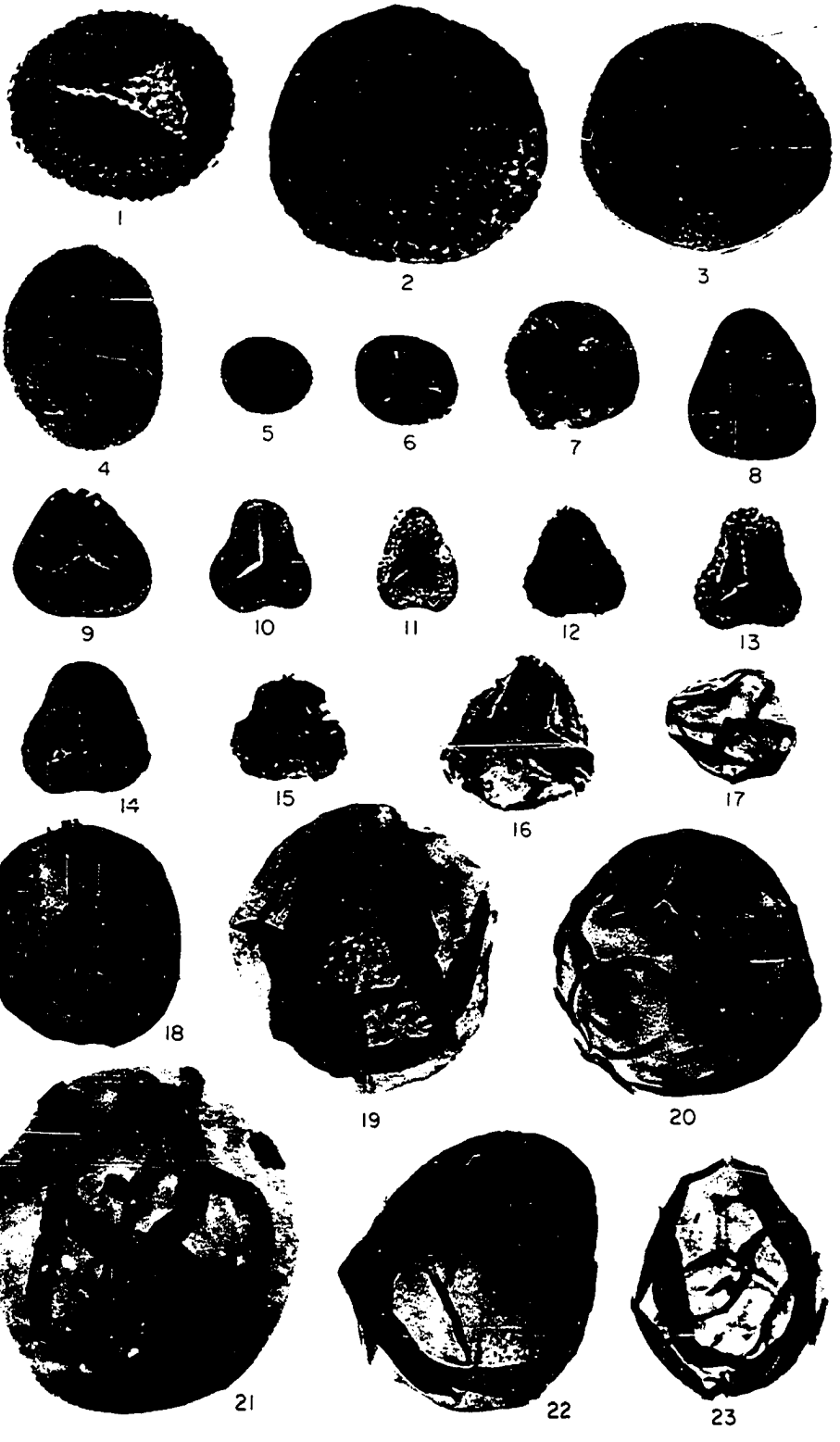


PLATE 2

PLATE 2

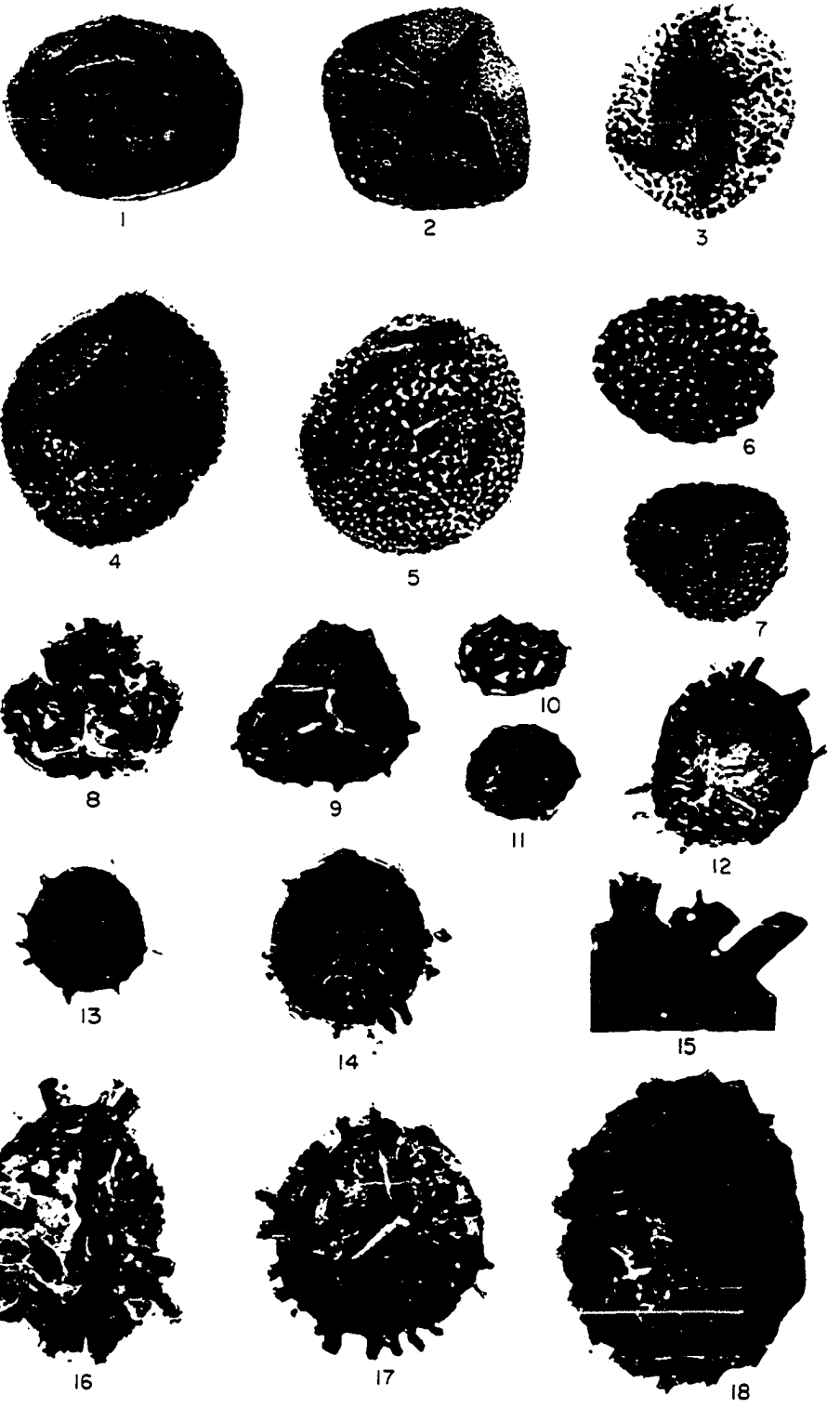


PLATE 3

PLATE 3

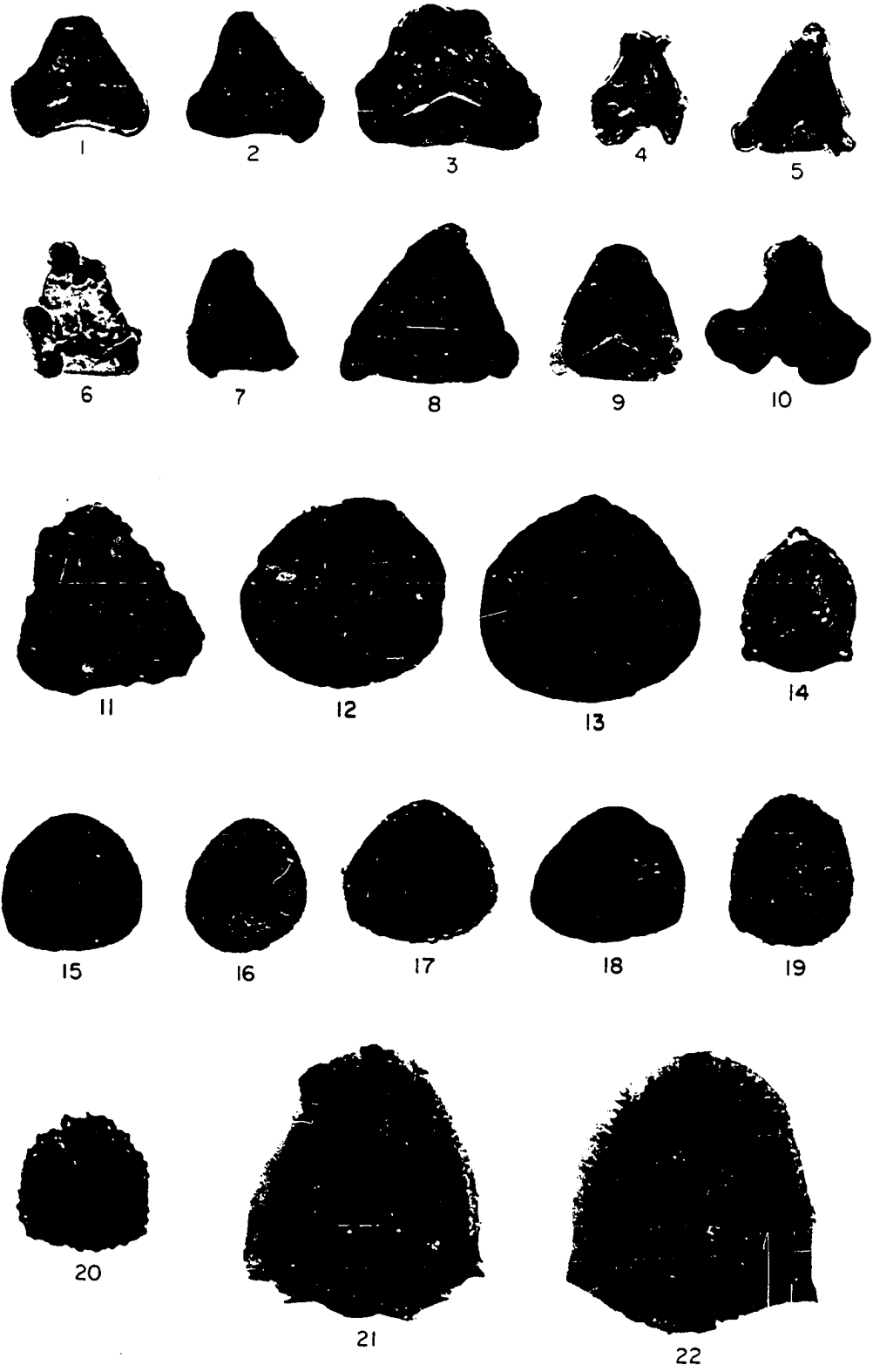


PLATE 4

PLATE 4

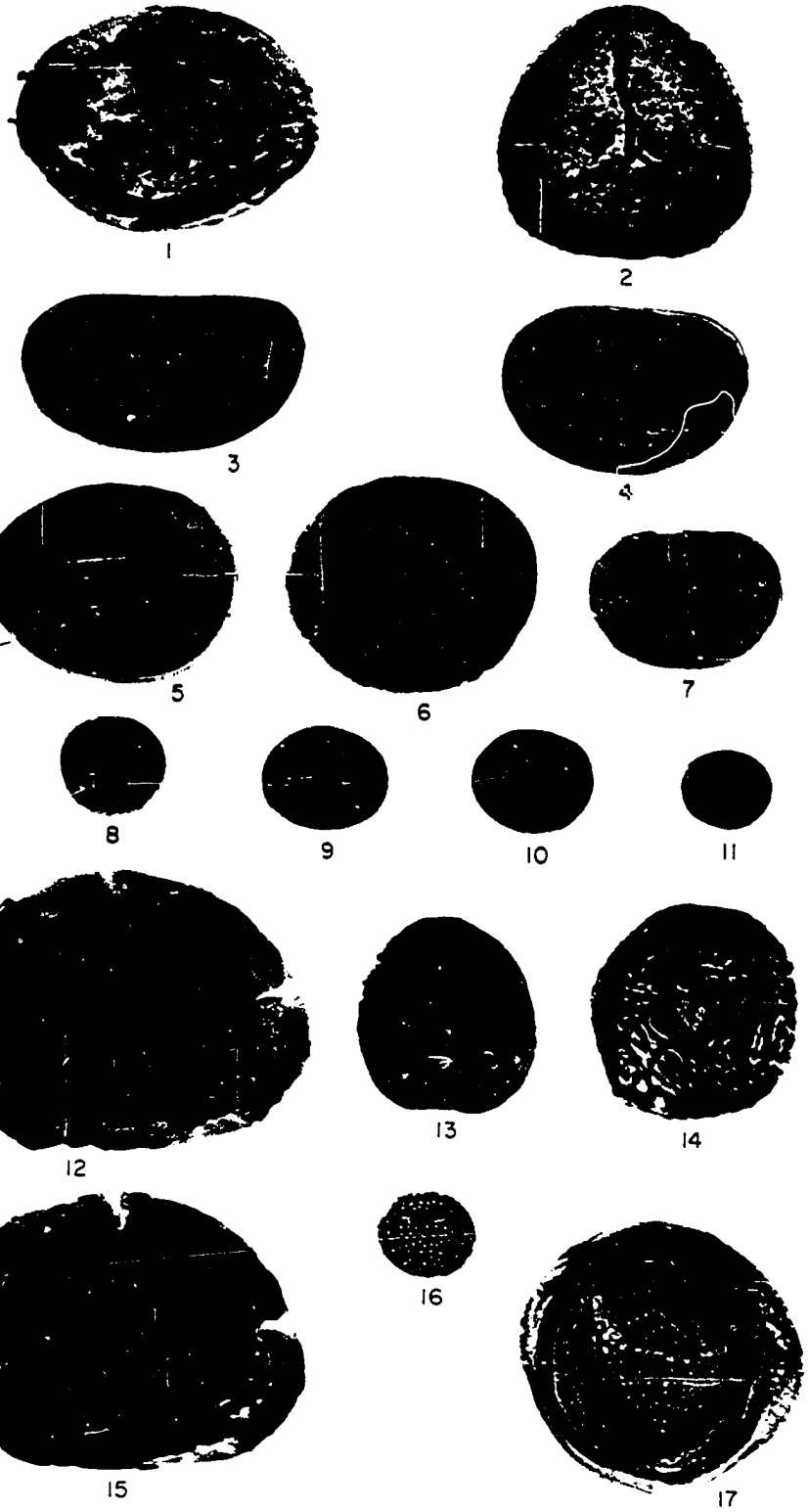


PLATE 5

PLATE 5

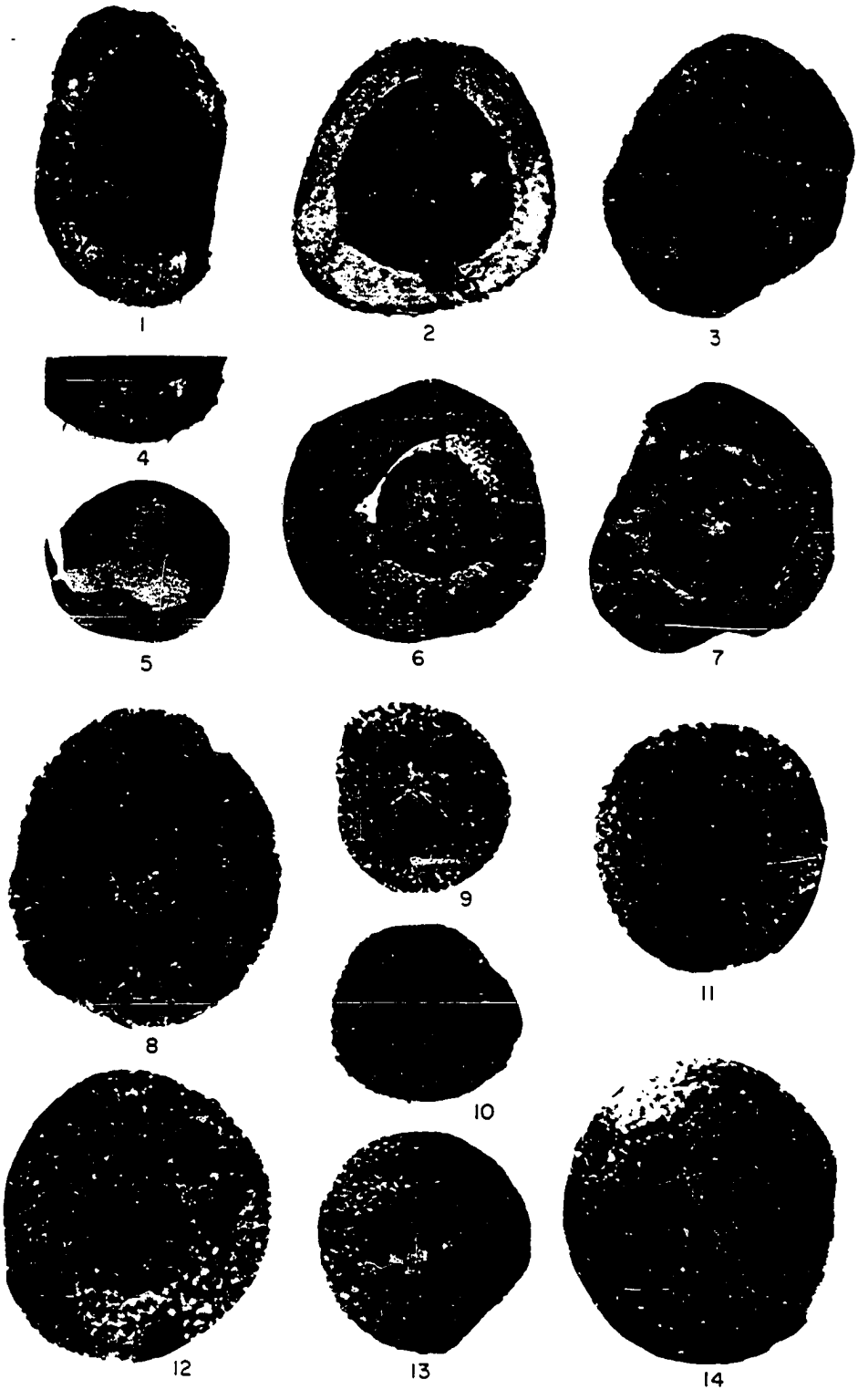


PLATE 6

PLATE 6

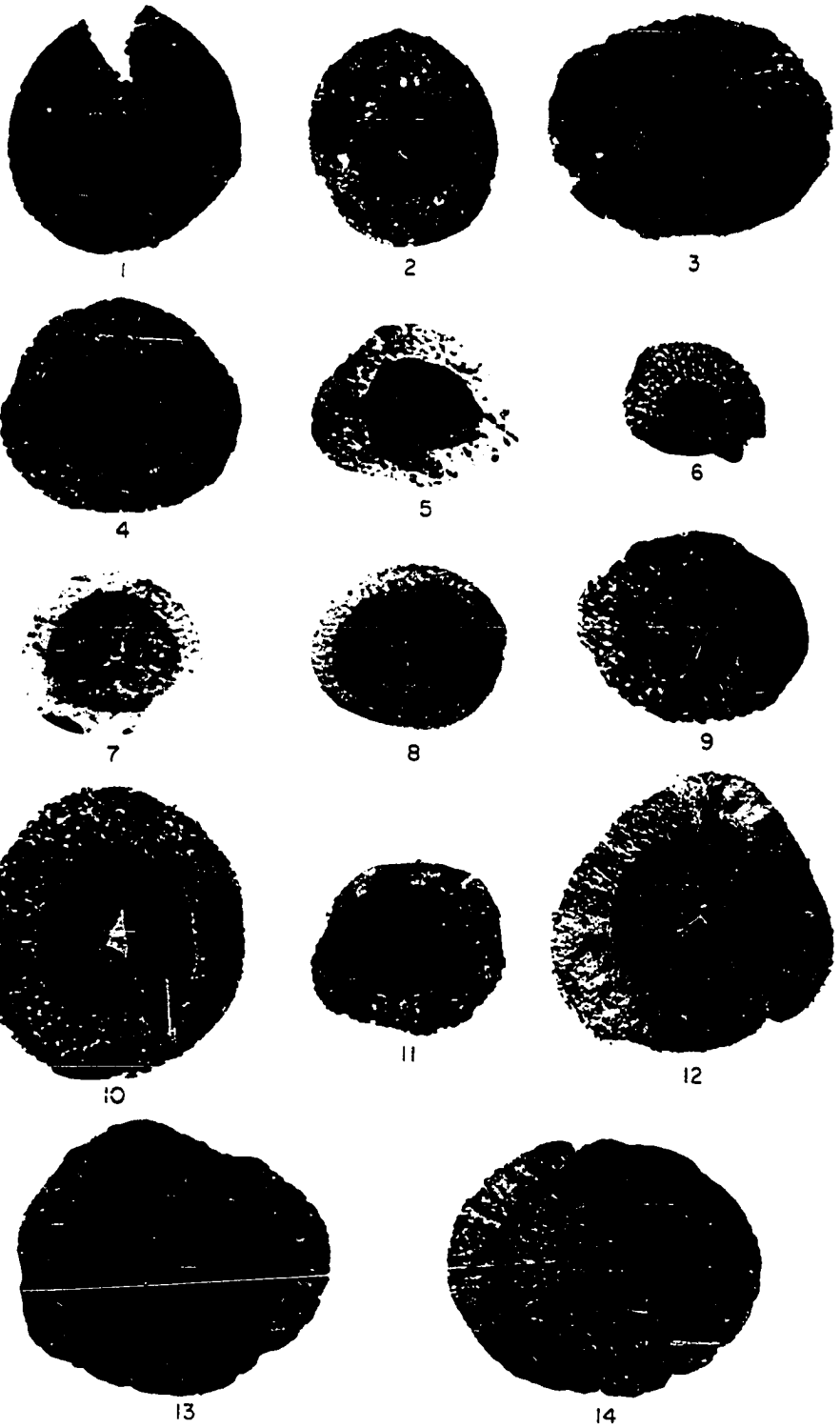


PLATE 7

PLATE 7

PLATE 8

PLATE 8