PALYNOLOGICAL CORRELATION OF THE BEVIER

AND VERDIGRIS COALS

STATE GEOLOGICAL SURVEY OF KANSAS

by

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ABSTRACT

Histograms of fossil spore genera correlate what has been considered the Bevier coal in southeastern Kansas with the Bevier coal in southwestern Missouri. The histograms of the thick two-bench "Bevier" coal in north-central Missouri are almost identical, and these benches cannot be distinguished palynologically. The Bevier coal in Kansas and southwestern Missouri correlates palynologically with both benches of the "Bevier" coal in north-central Missouri.

The spores of 27 samples collected from seven Bevier and two Wheeler localities were studied in order to determine whether the Bevier coal in Kansas correlates palynologically with the Bevier or Wheeler coal in southwestern Missouri. Spores from the thick "Bevier" coal in northern Missouri were also studied to determine with which coal either or both benches correlate.

Twenty-two genera and 61 species are described. Two new species, Calamospora hornbakeri Habib and Cirratriradites schmiegi Habib, and five probably new species are described. Some species are useful in differentiating the Bevier and Wheeler coals.

INTRODUCTION

This study was undertaken with the intention of using fossil spore assemblages to correlate two stratigraphic units in the Pennsylvanian System.

Fossil spores are found in coals, shales, sandstones, and have been reported from limestones. In recent years, the value of relative spore abundance for correlating stratigraphic units has been realized. Wilson (1946, p. 111) supported their correlative powers on the basis of three assumptions, which are "(1) the evolution of floras, (2) the geographic distribution and migration of floras, and (3) the edaphic ecological relations of plants."

Problem

Whether the coal that has been called Bevier in Kansas is correctly named or is actually the Wheeler coal is a problem that has recently been brought to the attention of those interested in the Pennsylvanian stratigraphy of the Midcontinent area. There are two schools of thought. One school would rename the Kansas coal Wheeler, correlating it with the lower bench of the "Bevier" coal in northern Missouri. The other school prefers to have the Kansas seam remain Bevier, correlating it with the upper bench of the "Bevier" coal in northern Missouri.

Two previous studies have prompted the writer to attempt to solve this problem. The first is the work of Hover (unpublished thesis, 1958) who located the Bevier and Wheeler coals

in Henry County, Missouri. The second is the work of Schmieg (unpublished thesis, 1959) who zoned the two coals palynologically.

Purpose of Investigation

The aims of this study are two-fold. The first is the comparison of spore assemblages at a number of localities in Kansas where the Bevier coal is present. This first aim is to determine if palynology can be used to correlate the Bevier coal in Kansas. The second and more important aim is the comparison of the spore assemblages in the Kansas Bevier coal with the spore assemblages of the Bevier and Wheeler coals in western Missouri to determine with which coal the Kansas Bevier correlates palynologically.

Location

The studied area includes the localities in Kansas and Missouri where the Bevier and Wheeler coals crop out (Pl. 1). Samples were collected from Bourbon, Crawford, Allen, and Anderson counties, Kansas, and Henry and Boone counties, Missouri.

Acknowledgements

The writer is deeply indebted to A. L. Hornbaker of the State Geological Survey of Kansas for bringing this problem to his attention; for accompanying him in the collection of samples; for acting as a consistent aid in solving difficulties in procedure; for providing all facilities necessary for this study.

Appreciation is extended to the Mack Colt Oil Company for supplying cores of the Bevier coal, and to the independent drillers who freely permitted use of cable tool samples. Thanks are extended to Dr. W. Schoewe of the State Geological Survey of Kansas and to Dr. W. V. Searight of the Missouri Geological Survey for suggesting localities where the studied coals could be collected. Thanks are also extended to Dr. H. H. Benson of the Department of Geology at the University of Kansas for aiding in taxonomy and critically reviewing this paper.

Previous Work

Palynological studies are reviewed in this section with emphasis placed on the more recent investigations. Those papers with pertinent reference to the present study are reviewed with greater detail.

Fossil plant spores were probably first observed by Witham (1833, p. 50) while studying thin sections of coal. He did not identify the spores as such, but he thought they might be remains of monocotyledonous plant vessels. Bennie and Kidston (1886) recognized these fossils as megaspores in reviewing Witham s work. They credited Morris (1840) as being the first to identify isolated fossil spores (Kosanke, 1950, p. 7-8).

In 1885, Franz Schulze developed a method whereby botanical ingredients could be chemically separated from coal without being damaged. The maceration method used in this study is essentially the same as that introduced by Schulze.

Ibrahim (1933) is considered the first person to attempt a classification of fossil spores. Before this attempt, all microspores were given the generic name Sporites. He classified fossil microspores into three categories: (1) those spores that did not possess an attachment scar were given names with an a separating the prefix and suffix, (2) those spores that possessed a single linear attachment scar were given names with an o separating the prefix and suffix, and (3) those spores that possessed a three-rayed linear attachment scar were given names with an i separating the prefix and suffix. This is illustrated by the names of the genera Punctat(a)sporites, Punctat(o)sporites, and Punctat(i)sporites. The a, o, and i are placed in parentheses for emphasis. The prefix of the generic name describes the ornamentation of the genus and the suffix of the generic name signifies the genus as a member of Sporites.

Schopf, Wilson, and Bentall (1944) re-evaluated the previous literature in an effort to clarify the material, and they also described some new genera. Excellent drawings of some common genera were presented.

In 1952, and again in 1958, Guennel correlated various Pennsylvanian coals in Indiana and described new species that were found in them.

Potonie and Kremp (1954-1956) designed a more complete classification of spores. Except for a few changes made by Bharadwaj (1957a), their classification is used in this study.

Kosanke (1950) published what is considered a major work in Paleozoic spores in the United States. He listed 19 genera and 130 species of which 5 genera and 100 species were described as new. He also proved the value of small spores in zonation and correlation.

Recent work in Oklahoma has been done by Morgan (1955), and Wilson and Hoffmeister (1956). Morgan described some genera in the McAlester coals. Wilson and Hoffmeister correlated the Croweburg coal (Cherokee Group) using spore histograms in comparison of the distribution through nine localities.

Beginning in 1958, a series of catalogue volumes were prepared by Kremp, Ames, and Grebe at The Pennsylvania State University for the purpose of listing previously described spore species in one central reference. Volumes six and seven contain descriptions of Pennsylvanian species.

Information concerning the palynology of the Bevier or Wheeler coal has not been published. Two Master's theses written for the University of Missouri have described the small spores of Missouri coals. Schmieg (unpublished thesis, 1959) described the palynology of the Cabaniss coals in Henry County, Missouri. His work was extremely useful as he was able to zone the coal beds of the Cabaniss. Jones (unpublished thesis, 1957) described the palynology of the Bevier coal in Macon and Boone counties, Missouri.

STRATIGRAPHY

The coals studied in this report are stratigraphically located in the Cherokee Group (Desmoinesian Stage, Pennsylvanian System), which in the area studied is bounded above by the Marmaton Group and below by Mississippian limestones. The Cherokee consists of two formations: the Krebs, which is lower Cherokee; and the Cabaniss (Fig. 1), which is upper Cherokee, and contains the Bevier and Wheeler coals. Cherokee rocks crop out in southwestern and north-central Missouri, and in southeastern Kansas where they strike north-northeast. Only a portion of the Cherokee Group is considered in this report.

The Cabaniss Formation is represented by basinal facies in the McAlester basin at its type locality near Cabaniss, Oklahoma. Oakes (1953, p. 1525) defined the Cabaniss there as those "rocks that crop out above the Krebs group and below the base of the Marmaton group, which is the highest part of the Des Moines series." He considered the Krebs and the Cabaniss as separate groups, thereby replacing the former term, Cherokee, named by Haworth and Kirk (1894, p. 104-115). Searight and others (1953, p. 2747-2748) at a conference held in Nevada, Missouri, adopted Oakes' proposal, but at a meeting held in Lawrence, Kansas in October, 1955, the name Cherokee was readopted to group status with Krebs and Cabaniss being relegated as subgroup terms (Howe, 1956, p. 21).

CABANISS FORMATION
SHOWING STRATIGRAPHIC POSITION
OF THE
BEVIER AND WHEELER COALS

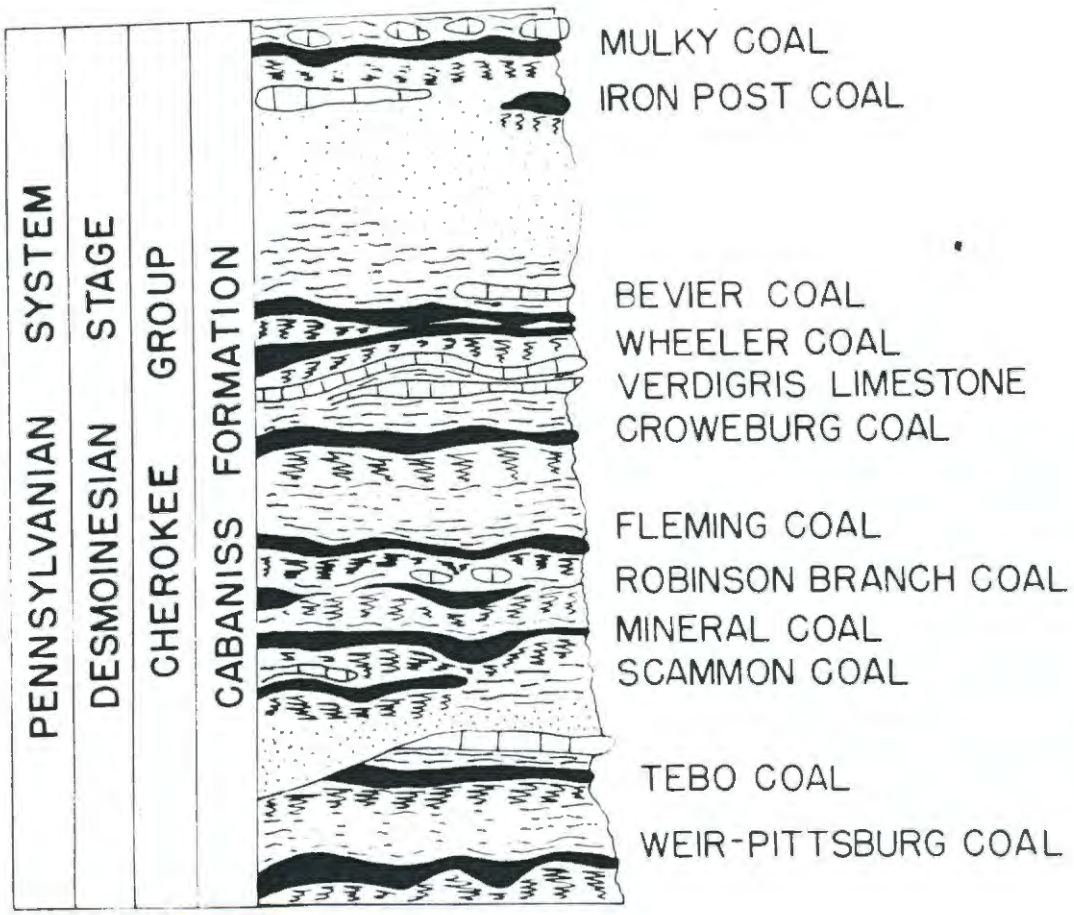

FIGURE 1

The State Geological Survey of Kansas (Jewett, 1959) has reclassified the Krebs and Cabaniss in Kansas as formations. The first coal stratigraphically situated above the Verdigris limestone in the state has questionably been named Wheeler. The Cabaniss and Krebs are considered formations in this report.

The platform facies of the Cabaniss are present in southeastern Kansas and western Missouri (Howe, 1956). In this area, the sequence averages 200 feet in thickness as opposed to 1000 feet reported by Oakes at the type locality. Oakes (1953) recognized a thinning of the formation both to the northeast and southwest, stating it was due to overlap of lower units by higher units and thinning within the individual units.

Cabaniss sediments were deposited in a cyclic sequence in Kansas and Missouri. The stratigraphic succession extending from the top of one coal bed to the top of the next higher coal bed represents a cycle of sedimentation. Howe (1956) recognized five distinct lithologic units found in a southeastern Kansas cycle and listed them from the base upward as: dark shale and dark irregular limestone, gray shale, underlimestone and sandstone, underclay, coal. Hover (unpublished thesis, 1958) reported essentially the same sequence in his study of the geology of Henry County, Missouri.

Bevier Coal

Bevier is the name originally given by McGee (1888, p. 328-336) to a thick coal unit cropping out near the town of

Bevier, Missouri. In this area, the coal is composed of two distinct seams separated by a shale or sandstone parting. Since the time of its definition, this sequence has been recognized as representing two cyclothems. Hence, at the Nevada conference, the name Bevier was restricted to the thicker, upper coal seam, and the name Wheeler was adopted for the lower coal seam (Fig. 2).

STRATIGRAPHIC SECTIONS IN KANSAS AND MISSOURI
SHOWING RELATIVE POSITIONS
OF THE BEVIER AND WHEELER COALS
WITH THE VERDIGRIS LIMESTONE

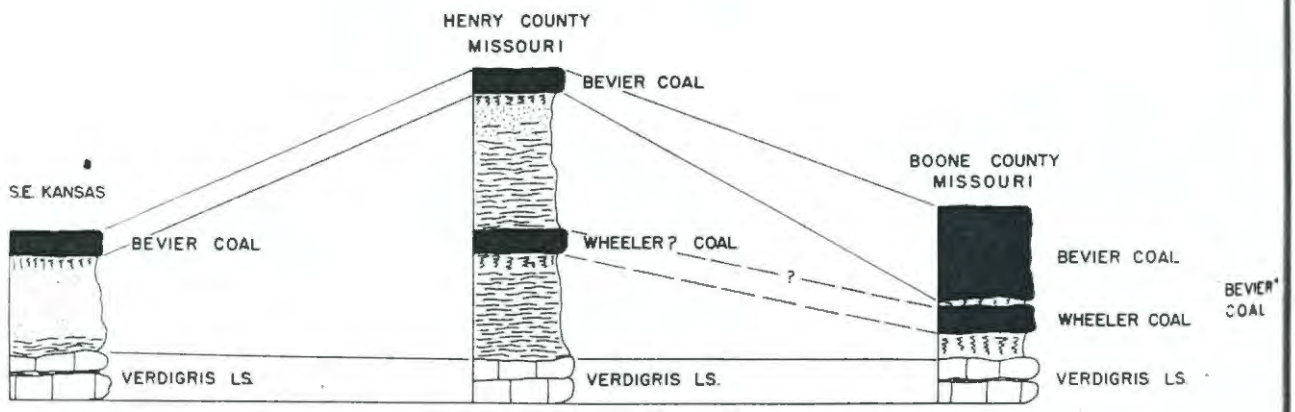

FIGURE 2

The first coal bed present above the Verdigris (Ardmore) Limestone in southeastern Kansas was named Bevier by Pierce and Courtier (1937, p. 76). They did not believe that this unit was physically continuous with the Bevier of northern Missouri. However, they stated that both beds occur at approximately the same stratigraphic interval. Howe (1956, p. 78) correlated the Kansas Bevier coal with the upper

Bevier cycle in northern Missouri, giving two reasons: (1) similarity of the succession above the redefined Bevier coal in northern Missouri and the single bed called Bevier in southeastern Kansas; (2) widespread distribution of the Bevier bed in north-central Missouri.

At all localities in which the Bevier coal was sampled, it is shiny black, the cleavage is blocky, and it contains cleats of pyrite and calcite. The thickness of the coal ranges from 0.85 to 1.95 feet, averaging 1.3 feet.

Wheeler Coal

The Wheeler coal, where present, is the uppermost unit of the Verdigris cyclothem. In parts of northern Missouri, the full sequence is present. Schmieg (unpublished thesis, 1959) reported one locality in Henry County, Missouri where the Wheeler crops out. Howe (1956) did not recognize the coal in southeastern Kansas.

The Wheeler coal and its underclay rest on the Verdigris Limestone. Where the Wheeler is absent, the Verdigris cyclothem is limited above by the top of the Verdigris Limestone.

The Wheeler coal was sampled from two localities, one of which, the name of the coal is questionable, in Henry County, Missouri. At locality 8, the coal is partially weathered and is one foot thick. At locality 9, the coal is shiny black and the cleavage is blocky. This coal is tentatively considered Wheeler on the basis of its spore assemblage and the presence of some species that were found at locality 8 but not in the Bevier coal.

Collecting localities

Bevier coal

1. NW/4 SE/4 sec. 30, T. 24 S., R. 20 E., Allen County, Kansas. Core sample from Mack Colt Oil Company, No. 140, Snell. The core sample is 0.7 feet long and was extracted from a depth of 803.4 feet.
2. NW/4 SW/4 sec. 9, T. 23 S., R. 19 E., Anderson County, Kansas. Core sample from Mack Colt Oil Company, No. 184, Colt Alexander. The core sample is 1.35 feet long, and was extracted from a depth of 994.35 feet.
3. CBL, SW/4, sec. 10, T. 31 S., R. 22 E., Crawford County, Kansas. Coal outcrop, 1.40 feet thick, in the Apex Compton strip pit 2 miles east of McCune, Kansas.
4. SW/4 SW/4 sec. 20, T. 28 S., R. 22 E., Crawford County, Kansas. Cable tool sample, one foot long, from city of Walnut, Kansas. Extracted from a water well at a depth of 270 feet.
5. SWC, NE/4 SE/4 sec. 9, T. 30 S., R. 24 E., Crawford County, Kansas. Coal outcrop, 1.21 feet thick, in the west bank of Second Cow Creek, approximately 150 yards north of the bend in the stream.
6. NE/4 SE/4 sec. 34, T. 25 S., R. 25 E., Bourbon County, Kansas. Coal outcrop, 1.35 feet thick, in operating local strip pit.
7. NW/4 NE/4 NE/4 sec. 5, T. 41 N., R. 28 W., Henry County, Missouri. Coal outcrop, 1.25 feet thick, in a gully about 100 feet south of the county road.

Wheeler coal

8. NW/4 SE/4 SW/4 sec. 18, T. 42 N., R. 28 W., Henry County, Missouri. Coal outcrop, one foot thick, in a dry exposed gully approximately 500 yards north of county road.

9.? SW/4 SW/4 SE/4 sec. 17, T. 40 N., R. 28 W., Henry County, Missouri. Coal outcrop, 1.15 feet thick, in gully of Davis Branch Creek, about 100 yards north of county road.

"Bevier" coal

10. SE/4 NW/4 sec. 7, T. 51 N., R. 13 W., Boone County, Missouri. Coal outcrop, 4.15 feet thick, in Hussy strip pit. Upper bench measures 3.25 feet thick; lower bench measures 0.9 feet thick.

FIELD AND LABORATORY PROCEDURES

Sampling technique in the field

Outcrop samples were prepared for collection by clearing the rock above the seam to expose the coal in a bench-like fashion. The face of the bench was cleaned to provide a fresh surface. Particular care was taken to assure that the samples would not be contaminated.

Each seam was then vertically divided into three equal portions. The samples were collected from the face of the coal, from the top of the seam, downward. After the uppermost portion was collected, the newly exposed next lower surface was cleaned. This portion was then collected and the process was repeated for the lowest portion.

As each sample was collected, it was placed in a large, cloth sample bag on which was recorded the geographic location of the seam and the vertical position from which it was taken. Samples weighed from 100 to 1000 grams approximately, dependent on the thickness of the seam.

Laboratory Preparation of Material

Mechanical preparation

Each of the collected outcrop samples was washed in running water to remove any contamination. The wet sample was then placed in an oven to dry. After drying, the sample was crushed in a miniature jaw crusher and then split in a Precision Scientific Company splitter. A portion was saved for

future reference. That fraction of the sample which passed through a 16-mesh Tyler Standard screen and caught by a 32-mesh Tyler Standard screen was saved for future treatment. The plus 16 fraction was recrushed with mortar and pestle until nearly all the material passed through the 16-mesh screen. The rest of the sample was discarded. The final sample ready for chemical treatment weighed approximately 50 grams.

Core samples were cut lengthwise and one-third was retained for treatment. Each core was divided vertically into three equal samples so that the upper, middle, and lower portions could subsequently be examined separately. The samples were then treated as the outcrop samples were.

Spores obtained from the cable tool sample were treated as a composite population because there were no means of separating the different portions of the coal seam from which they were extracted. The sample was washed vigorously to remove fine clays and drilling mud that were present. The sample was then dried in an oven after which it was poured into a container containing carbon tetrachloride (sp. gr. 1.58) in order to separate the coal from sand and shale fragments. The coal was collected, weighed, and a 50 gram sample, or as large a sample as could be obtained if less than 50 grams, was saved for chemical treatment.

Chemical preparation

Samples were placed in 1000 ml. polyethylene beakers and put into a chemical air hood preparatory to maceration. Except

for a few minor variations, Kosanke's (1950, p. 8-11) method of maceration was used.

Liberation of spores and other resistant plant material from coal requires two main phases of maceration. The first stage of the treatment with Schulze's solution serves to partially oxidize the coal. The second stage, using potassium hydroxide, breaks down the remaining coal into: (1) the salts of its contained humic acids, and (2) the botanical ingredients (Kosanke, 1950, p. 10).

Partial oxidation with Schulze's solution consisted of mixing the coal sample with an equal portion of granular potassium chlorate to two parts by volume concentrated nitric acid. Kosanke (1950, p. 9) describes the chemical reaction in detail. The reaction was completed when the color of the solution in which the coal was immersed turned a reddish brown due to nitrous oxide. The reaction was immediately active for all the samples treated, but each sample was left in the air hood for one day to ensure completion. Following the first phase, each sample was washed in water and allowed to settle for three or four hours. The supernatant liquid was then siphoned out. Washing, settling, and siphoning were repeated until the solution was normal (ph 7).

The second phase included treating the partially oxidized coal with a 5 percent solution of potassium hydroxide. When the solution was added, its color turned very dark to black, indicating a reaction was taking place. The sample was then left in the hood for one day to ensure completion of the reaction. Following the second phase, the sample was bathed

in water and siphoned repeatedly until the liquid in which the sample was immersed was clear.

Occasionally, an abundance of mineral matter was present in a sample. The mineral matter was a hindrance as it obscured the view of many of the small spores. The sample was therefore treated with hydrofluoric acid and then with hydrochloric acid. The hydrofluoric acid combined with any silica that was present, and formed a residue of a silica-fluoride gel. After a period of three days, the sample was again washed with water, which was then siphoned and the process repeated until the acid was eliminated. A 75 percent solution of hydrochloric acid was subsequently added to dissolve the gel. Washing with water and siphoning was again repeated until the solution was normal. The sample was then ready for sieving.

Sieving

The sample, now consisting of a residue of spores and plant cuticle, was sieved through a 70-mesh U. S. Standard screen which separated those spores that were larger than 210 microns from those that were smaller than 210 microns. The plus 70-mesh fraction was stored in 3-ounce glass bottles filled with 25 percent alcohol and several drops of glycerine. The minus 70-mesh fraction was placed in a 50 ml. glass beaker filled with distilled water.

Staining and dehydration

Staining was necessary to determine the morphology of some of the small, light-colored spores. Consequently, all

the spores were stained by adding a few drops of saturated aqueous Safranin O solution to each glass beaker containing spores. Dehydration with alcohol was necessary in order that the stained sample be miscible in diaphane mounting medium. Alcohol dehydration also served to partially destain the overstained spores.

To prevent damage to the individual spore in the residue, dehydration was accomplished by adding alcohol in steps to the solution. A 5 percent alcohol solution was added first. The sample settled and the solution was siphoned. Then a 25, 50, 95 and finally a 100 percent solution was added. After each addition, the sample was allowed to settle and the solution was siphoned.

Mounting procedure

Mounting the spores on slides consisted essentially of two phases. In the first phase, the spores were fixed on coverslips and in the second, the coverslips were mounted on glass slides.

In the first phase, the residue in the 50 ml. glass beaker was transferred to a two dram glass vial for permanent storage. This was done by thoroughly stirring the spore slurry and pouring quickly into the vial. A portion of the spore residue, after thorough mixing, was then transferred with an eye dropper to a watchglass containing diaphane mounting medium. The slurry of spores and diaphane was thinned with as many drops of 100 percent alcohol as each case warranted. Using a wooden toothpick, the spore material was dispersed by gently stirring the slurry. A few drops of

the spore slurry was then transferred onto a coverslip and spread evenly with the wooden toothpick. The coverslip, spores up, was then placed on a hot plate for three hours at a constant temperature of 110°F. The alcohol evaporated, congealing the diaphane, and leaving the spores firmly attached to the surface of the coverslip.

The second phase consisted of removing the coverslip from the hot plate after the allotted time, and mounting it on a glass slide with canada balsam dissolved in xylene. The slide was then heated to a temperature of 110°F. for three days. Then the slide was removed from the hot plate and was ready for examination. A minimum of four slides were made for each sample.

Counting methods

Two hundred specimens were counted from each sample to determine the relative spore abundance in each portion of the coal. Only genera were counted as species could not be identified in all cases due to poor preservation or over-maceration. Fifty specimens were counted from each of four slides per sample to minimize any human error in preparing the slides. A microscope with a magnification of 430X was needed for accurate counting.

The counting procedure was standardized by starting at the upper right corner of each coverslip and working toward the left. When the opposite corner was reached, the slide was moved down to the distance of one field of observation. Counting then continued toward the right. This sequence was

followed on each slide until the required fifty specimens were recorded.

Every specimen that was identified, at least to generic rank, was counted. Each of a group of spores in a tetrad or cluster was counted where possible. It was impossible to determine the genus of some specimens and these were passed without a count.

Photomicrography

A Bausch and Lomb binocular microscope with interchangeable binocular-monocular system was used in this study. Equipment for photography included a Graflex "22" Graphic camera mounted above an E. Leitz-Wetzlar (Model 11472) Aristophot bellows assembly. The bellows were connected to the monocular system. Adox and Kodak 120 mm. film was used in the camera producing 2½ by 2½ inch negatives. Exposures of different magnifications were taken by varying the length of the bellows in combination with various microscope oculars. Specimens were measured with a steel millimeter rule by magnifying their images 1000 times onto a ground glass. The true dimensions of each spore were then calculated by merely reducing millimeters to microns (i.e. 2.2 millimeters equals 22 microns). Measurements less than 0.5 microns were estimated.

Exposures were taken at one-fifth and one-tenth seconds, depending on the thickness of the spore. A 5.5 ampere light source was used and the light diaphragm was closed to 43X objective magnification. At least one photograph of each identified species is illustrated in this report.

Designation and storage of specimens

Each slide was labeled according to the state from which a particular coal was sampled, the coal bed from which the spores were extracted, location number of the sampled coal, portion of the coal from which the spores were extracted, and the number of the slide in the collection. An example is KB-1A-2, where K represents Kansas, B represents the Bevier coal, 1 represents locality one, A represents the uppermost portion of the coal sampled at locality one, and 2 represents the second slide studied of sample A.

Specimens are located on a particular slide by their vernier position. The first group of numbers represent the horizontal position of a specimen in a slide. The second group of numbers represent the vertical position of a specimen. An example is 2.45-3.67.

All slides used in this study are in the Palynology Laboratory in the State Geological Survey of Kansas.

Construction of histograms

Histograms are used in this report to illustrate similarities and differences in the relative generic populations from one locality to the next. Each bar represents the percentage of a particular genus counted at a particular locality.

RESULTS OF INVESTIGATION

Histograms present on Plate 1 illustrate the relative distribution of the various genera found in the samples of the Bevier and Wheeler coals. The histograms indicate correlation of what has been considered the Bevier coal in Kansas with the Bevier coal in Henry County, Missouri. The spore histograms of the coal bed in southeastern Kansas and western Missouri are very similar to the composite spore histogram of both benches of the "Bevier" coal in north-central Missouri.

Discussion

Significant vertical stratigraphic changes in generic population in the Bevier and Wheeler coals permitted their correlation and zonation within the Kansas bed with the forms contained within the Missouri beds.

Twenty-two genera and 61 species, of which two new species and five probable new species, were used in this investigation to correlate the coal in Kansas with the Bevier coal in southwestern Missouri. Several species were useful as they were restricted either to one coal bed or the other. Leiotriletes sphaerotriangulus ? (Loose), Raistrickia crocea Kosanke, and Cirratriradites schmiegi Habib n. sp. were found to occur only in the Wheeler coal. Lophotriletes commissuralis (Kosanke), Apiculatisporis setulosus ? (Kosanke), Granulatisporites minutus Potonie & Kremp, and Calamospora hornbakeri Habib, n.sp. were found to occur only in the Bevier coal. Other species

were found only in one bed but these could not be used as they were represented by single specimens. Caution is advised in using these restricted species as index fossils as they may be present in both coals elsewhere under a slightly different paleoecology.

Spore histograms of the upper bench (Bevier) and lower bench (Wheeler) of the thick "Bevier" coal in north-central Missouri are very similar and could not be differentiated palynologically. The spore population of the lower bench is markedly different from that of the Wheeler coal in southwestern Missouri, raising doubts as to the validity of their correlation. On the other hand, the composite spore histogram of the two bench coal is very similar to that of the Bevier coal in southwestern Missouri and southeastern Kansas. The full Bevier sequence in north-central Missouri correlates palynologically with the Bevier coal in the area to the southwest.

Comparison of Histograms

Lycospora is clearly the dominant genus in the Bevier coal. Its abundance ranges from a low of 34.8 percent at locality 5 (Crawford County, Kansas) to a high of 56.4 percent at locality 1 (Allen County, Kansas). Punctatosporites is invariably the secondmost abundant genus. Laevigatosporites is usually thirdmost abundant, being replaced by Calamospora at locality 6 (Bourbon County, Kansas).

Lycospora, Punctatosporites, Punctatisporites, Florinites, and Laevigatosporites are the common genera in the

Wheeler coal of southwestern Missouri. No one genus is predominant.

Areal Distribution

The distribution of species is variable at different localities in the Bevier coal. Lophotriletes sp. B was found only at locality 10 (Boone County, Missouri), and is replaced by L. commissuralis & L. sp. A, which are present at the western localities. Endosporites was not found in north-central Missouri but three species were found to the southwest. Verrucososporites is common at almost all the localities but V. thiessani was not found in southwestern Missouri (locality 7, Henry County, Missouri). Foveolatisporites was found only at locality 10 (Boone County, Missouri).

The distribution of various species discussed in the previous paragraph indicates slight ecologic differences in the studied area. Either different plants existed in different areas or these areas were more readily accessible to the areas from which these spores were borne. Only a few plants of different nature in each area could conceivably contribute to and slightly alter the total relative population.

Another factor to be considered is that the classification of fossil spores used in this report is artificial and somewhat limited, genetically. Different species, and even different genera, have been found in sporangia of the same fossil plant.

Trends in the Bevier coal

The studied coals were collected in a series of three samples with the intention of determining any significant

trend in the spore population of the Bevier coal from its base upward. A secondary purpose for this sampling was to determine any difference in these trends that might further contribute to the zonation and correlation of the Bevier coal. These trends are compared with those reported by Wilson and Hoffmeister (1956) in the Croweburg coal.

	Lycospora	Punctato-sporites	Laevigat-osporites	Florinites	Triquitrites
Upper Third	45%	9.6%	8.1%	6.7%	3.6%
Middle Third	446%	17.8%	7.4%	2.2%	4.1%
Lower Third	403%	23.7%	7.7%	4.9%	2.7%

Table 1. Trends of some common fossil spore genera in different portions of the Bevier coal in southeastern Kansas and southwestern Missouri.

No significant trends are present within the Bevier coal of southeastern Kansas and southwestern Missouri (Table 1). Lycospora increases toward the top of the coal, but only to the magnitude of 4.7 percent. Punctatosporites decreases from 23.7 percent at the base of the coal to 9.6 percent at the top. Wilson and Hoffmeister (1956) reported Punctatosporites reaching its maximum percentage in the

middle third of the Crowsburg coal. No significant trends were found in Laevigatosporites, Florinites, or Triquitrites. Wilson and Hoffmeister (1956) reported Florinites as reaching its maximum percentage in the upper third of the Crowsburg coal. The maximum percentage of Florinites is reached in the upper third of the Bevier coal also, but the difference in magnitude measures only 1.8 percent.

Conclusions

The following conclusions are drawn from this study:

1. What has been considered the Bevier coal in southeastern Kansas correlates palynologically with the Bevier coal in western Missouri.
2. The Bevier coal in southeastern Kansas and southwestern Missouri correlates palynologically with either and both benches of the thick two-bench "Bevier" coal in north-central Missouri. The histogram of each bench and the composite histogram of both benches are almost identical to the histograms of the Bevier coal to the southwest.
3. The Wheeler coal in southwestern Missouri is markedly different palynologically than the lower bench of the "Bevier" coal in north-central Missouri.
4. Lophotriletes commissuralis, Apiculatisporis setulosus?, Granulatisporites minutus, and Calamospora hornbekeri are helpful in distinguishing the Bevier coal in the southeastern Kansas-southwestern Missouri area.
5. Leiotriletes sphaerotriangulus?, Cirratriradites schaleni, and Raistrickia crossa are helpful in distinguishing the

Wheeler coal in the southeastern Kansas-southwestern Missouri area.

6. Two newly described species are present in the studied coals; Calamospora hornbakeri and Cirratriradites schmiegi.
7. There is no distinct change in the generic population from the lower portion of the Bevier coal in southeastern Kansas and southwestern Missouri to the uppermost portion of the coal.

SYSTEMATIC PALYNOLOGY

The taxonomic classification used in this study is adopted from Potonie and Kremp (1954-1956) and Bhardwaj (1957a). Only those species which were found in this study are listed.

Super-division SPORITES Potonie, 1893

Division TRILETES (Reinsch), 1881

Subdivision AZONOTRILETES Luber, 1935

Series LAEVIGATI (Bennie & Kidston), 1886

Genus Leiotriletes (Naumova), 1937
Genus Punctatisporites (Ibrahim), 1933
Genus Calamospora Schopf, Wilson, & Bentall, 1944
Genus Granulatisporites (Ibrahim), 1933

Series APICULATI (Bennie & Kidston), 1886

Genus Schopfites Kosanke, 1950
Genus Lophotriletes (Naumova), 1937
Genus Apiculatisporis (Ibrahim), 1933
Genus Anapiculatisporites Potonie & Kremp, 1954
Genus Kaistrickia (Schopf, Wilson, & Bentall), 1944

Series MURORNATI Potonie & Kremp, 1954

Genus Foveolatisporites Bhardwaj, 1955
Genus Vestispora (Wilson & Hoffmeister), 1956

Division ZONALES (Bennie & Kidston), 1886

Subdivision AURITOTRILETES Potonie & Kremp, 1954

Series AURICULATI (Schopf), 1938

Genus Triquitrites (Wilson & Coe), 1940

Subdivision ZONOTRILETES Waltz, 1935

Series CINGULATI Potonie & Kremp, 1954

Genus Cirratriradites Wilson & Coe, 1940
Genus Lycospora Schopf, Wilson, & Bentall, 1944

Division MONOLETES Ibrahim, 1933

Subdivision AZONOMONOLETES Luber, 1935

Genus Laevigatosporites Ibrahim, 1933
Genus Latosporites Potonie & Kremp, 1954
Genus Punctatosporites Ibrahim, 1933
Genus Verrucososporites (Knox), 1950

Super-division POLLENITES Potonie, 1931

Division SACCITES Erdtman, 1947

Subdivision MONOSACCITES Chitaley, 1951

Genus Florinites Schopf, Wilson, & Bentall, 1944
Genus Cheilosporites Wilson & Coe, 1940

Series TRILITES (Fast), 1954

Genus Wilsonia Kosanke, 1950

Subdivision DISACCITES Cookson, 1947

Genus Vesicaspora Schemel, 1951

Super-division SPORITES Potonie, 1893

Division TRILETES (Reinsch), 1881

Subdivision AZONOTRILETES Luber, 1935

Series LAEVIGATI (Dennie & Kidston), 1886

Genus Leiotriletes (Naumova), 1937

Leiotriletes NAUMOVA, 1937, p. 357, fig. 1; POTONIE & KREMP, 1954, p. 120; 1955, pp. 36-37; BHARDWAJ, 1957, p. 113.

Type species. Leiotriletes sphaerotriangulus (Loose), 1932.

Diagnosis. Shape subtriangular with smooth outline; trilete; ornamentation levigate, infrapunctate, or infragranulate.

Occurrence. This genus totals 0.24 percent of the composite spore population of the Bevier coal in southeastern Kansas and western Missouri. It composes 0.8 per-

cent of the spore population in the Wheeler coal in western Missouri.

Range. Basal Tournasian through Lower Permian.

LEIOTRILETES SPHAEROTRIANGULUS? (Loose), 1932

Pl. 2, Figs. 3-4

Leiotriletes sphaerotriangulus Loose, in POTONIE, IBRAHIM, & LOOSE, 1932, pl. 18, fig. 45; POTONIE & KREMP, 1954, p. 120.

Laevigati-sporites sphaerotriangulus LOOSE, 1934, p. 145.

Diagnosis. Recognized by its roundly triangular shape and smooth outline; trilete extending more than halfway to periphery; relatively large size.

Dimensions. About 46 microns in longest diameter and 41 microns in the diameter perpendicular to the longest diameter.

Material. Five specimens were examined.

Occurrence. Found only at both localities from which the Wheeler coal was studied.

Remarks. One specimen found in the Wheeler coal contains an extension at one of its apices which could be interpreted as a node, which would place it in the genus Triquitrites. Because this "node" is not present at all the apices and is not darker than the rest of the spore, the writer is of the opinion that this specimen has been described correctly. The extension at the apex is most

likely a folding out of the broken exine of the distal face.

LEIOTRILETES ADNATUS (Kosanke), 1950

Pl. 2, Fig. 1

Granulati-sporites adnatus KOSANKE, 1950, p. 20, pl. 3, fig. 9.

Leiotriletes adnatus (Kosanke) POTONIE & KREMP, 1955, p. 39, pl. 11, fig. 11.

Diagnosis. Recognized by area contagionis; concave interapex areas; trilete extending at least three-fourths distance to spore wall.

Dimensions. Ranges from 32 to 39 microns in diameter.

Material. Two specimens were examined.

Occurrence. Found only at locality 9.

Remarks. This species was readily identified by the presence of an area contagionis.

LEIOTRILETES ADNATOIDES Potonie & Kremp, 1955

Pl. 2, Fig. 2

Leiotriletes adnatoides POTONIE & KREMP, 1955, p. 38, pl. 11, figs. 112-115.

Diagnosis. Recognized by convex interapex areas; relatively small size; trilete extending three-fourths distance to spore wall but not reaching it.

Dimensions. Ranges from 30 to 40 microns in diameter.

Material. Three specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. Potonie & Kremp (1955) noted that the attachment scar is commonly open in this species. Forms with and without open scars were found.

Genus PUNCTATISPORITES (Ibrahim), 1933

Punctati-sporites IBRAHIM, 1933, p. 21; SCHOPF, WILSON & BENTALL, 1944, pp. 29-30; KOSANKE, 1950, p. 14; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 13.

Punctatisporites (Ibrahim) POTONIE & KREMP, 1954, p. 120; 1955, pp. 41-42; BHARDWAJ, 1957, p. 113.

Type species. Punctatisporites punctatus IBRAHIM, 1933, p. 21, pl. 2, fig. 18.

Diagnosis. Recognized by its circular shape approaching a triangular form; outline smooth; trilete usually more than halfway to spore outline; ornamentation punctate to infragranulate to infrareticulate; usually no contact area present.

Occurrence. Punctatisporites is abundant in the Bevier and Wheeler coals of southeastern Kansas and western Missouri. It totals 6.79 percent of the composite spore population in the Bevier coal and 10.1 percent of the spore population in the Wheeler coal.

Range. Basal Tournasian to Lower Permian.

PUNCTATISPORITES OBLIQUUS Kosanke, 1950

Pl. 2, Fig. 5

Punctatisporites obliquus KOSANKE, 1950, p. 16, pl. 2, fig. 5.

Diagnosis. Recognized by its frequently obliquely compressed outline; minutely punctate exine; distinct trilete scar with lips and commissure.

Dimensions. Known size ranges from 31 to 46 microns in diameter.

Material. Over 300 specimens were examined.

Occurrence. Found at all the localities that were studied and is the most abundant species of *Punctatisporites*.

Remarks. It was difficult to separate some specimens of this species from *Latosporites globosus* because the third ray of the attachment scar was very short. These specimens could be identified only after careful focusing up and down to determine whether the third ray was present or not.

PUNCTATISPORITES sp. A

Pl. 2, Fig. 7

Diagnosis. Recognized by its circular shape; broadly punctate to microreticulate ornamentation; relatively large size; relatively short trilete attachment scar.

Description. Spore radially symmetrical; shape circular in transverse view; outline smooth; ornamentation broadly punctate to microreticulate; trilete distinct, measuring from 10 to 14 microns; lips are present but

indistinct; commissure not present; normal diameters of spore measure 72 by 73.5 microns.

Remarks. Only one specimen was found at locality 5. This specimen is very similar to P. sp. A described by Schmieg (1959) and both may be members of a new species. He found his specimen in the Weir-Pittsburg coal and this specimen was found in the Bevier coal. If these two specimens represent the same species, its range is then extended from the Weir-Pittsburg coal to the Bevier coal.

PUNCTATISPORITES ? STRAMINEUS (Wilson & Kosanke), 1944

Pl. 2, Fig. 6

Calamospora straminea WILSON & KOSANKE, 1944, p. 329, pl. 1, fig. 1.

Punctatisporites straminеus (Wilson & Kosanke) GUENNEL, 1958, p. 68, pl. 4, figs. 5-8.

Diagnosis. Recognized by its thick exine; compression folds; relatively small size.

Dimensions. Ranges in size from 30 to 45 microns in diameter; thickness of spore coat about 3 microns.

Material. Over 20 specimens were examined.

Occurrence. Found at all localities of the studied coals.

Remarks. Guennel (1958) identified this species as a member of Punctatisporites on the basis of its thicker spore coat and the presence of compression-type folds. Specimens of this species encountered in this study were

found to contain an area contagionis, which seems to place the species closer to Calamospora.

Genus CALAMOSPORA Schopf, Wilson, & Bentall, 1944

Calamospora SCHOPF, WILSON, & BENTALL, 1944, pp. 49-51, text-fig. 1; WILSON & KOSANKE, 1944, p. 329; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 13, pl. 1, fig. 11; POTONIÉ & KREMP, 1955, pp. 46-47, text-fig. 6.

Type species. Calamospora hartungiana SCHOPF, WILSON, & BENTALL, 1944, p. 51, text-fig. 1.

Diagnosis. Recognized by spherical or near-spherical shape; ornamentation smooth or nearly smooth; trilete attachment scar; characteristically folded spore coat; contact area (area contagionis) usually present.

Occurrence. Calamospora totals 4.52 percent of the composite spore population in the Bevier coal of southeastern Kansas and southwestern Missouri. It totals 3.2 percent in the Wheeler coal.

Range. Basal Tournasian through Lower Permian.

CALAMOSPORA HARTUNGIANA Schopf, 1944

Pl. 2, Fig. 10

Calamospora hartungiana Schopf, in SCHOPF, WILSON, & BENTALL, 1944, p. 51, text-fig. 1.

Diagnosis. Recognized by trilete rays approximately one-fourth diameter of spore; smooth ornamentation, large size.

Dimensions. Diameter from 80 to 100 microns.

Material. About ten specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals at almost all the studied localities.

CALAMOSPORA BREVIRADIATA Kosanke, 1950

Pl. 2, Fig. 9

Calamospora breviradiata KOSANKE, 1950, p. 41, pl. 9, fig. 4.

Diagnosis. Recognized by its relatively short trilete rays and developed lips.

Dimensions. Ranges from 52 to 71 microns in diameter.

Material. Over 100 specimens were examined.

Occurrence. This species appears to be the most common representative of Calamospora. It was found at almost all the localities.

Remarks. Unfolded, as well as folded specimens were found.

CALAMOSPORA PEDATA Kosanke, 1950

Pl. 2, Fig. 11

Calamospora pedata KOSANKE, 1950, p. 42, pl. 9, fig. 3.

Diagnosis. Recognized by its relatively long trilete rays and single folded spore coat.

Dimensions. Ranges from 41 to 75 microns in diameter.

Material. Only a few specimens were examined.

Occurrence. This species is rare in the studied coals, but was found at localities 7, 8, and 9 (Henry County, Missouri).

CALAMOSPORA SP. A

Pl. 2, Fig. 8

Diagnosis. Characterized by its triangular folded shape; long distinct trilete attachment scar; contact area.

Description. Shape radially symmetrical; outline roundly triangular; ornamentation distinctly levigate; spore coat very thin, translucent, less than one micron thick; trilete attachment scar is distinct, extending to folds; lips distinct and raised slightly; commissure distinct; folds are present and circumscribe the outline of the spore; contact area distinct, represented by dark circular area near junction of each trilete ray; maximum diameter measures 46.5 microns; normal diameter measures 44 microns.

Remarks. Only one specimen was found at locality 7 (Henry County, Missouri). This specimen may represent a compressed form of a known species but the presence of the unusual contact area seems to distinguish it.

CALAMOSPORA HORNBAKERI Rabib, n. sp.

Pl. 2, Figs. 12-14

Diagnosis. Recognized by its large size; long broad folds; relatively short trilete attachment scar.

Description. Shape radially symmetrical; originally round in outline; trilete attachment scar distinct but may be obscured by folds in some specimens; trilete rays measure up to 24 microns in length but most are about 14 microns; commissure is indistinct; lips are raised slightly; contact area is distinct and notably darker than rest of spore; ornamentation is levigate; long, broad folds are present; species ranges from 114 to 150 microns in its longest diameter.

Material. Nine specimens were examined.

Occurrence. Most abundant at locality 6 (Bourbon Co., Kansas) and rare at other localities. Found only in the Bevier coal.

Remarks. This species is similar to C. hartungiana but is consistently larger. Schopf, Wilson, and Bentall (1944) limited a size of 80 to 100 microns to unfolded forms of the type species. Unfolded forms of this species would seem to exceed 150 microns in diameter.

C. hornbakeri is distinguished from C. breviradiata by its larger size.

Genus GRANULATISPORITES (Ibrahim), 1933

Granulati-sporites IBRAHIM, 1933, p. 21; SCHOPF, WILSON, & BENTALL, 1944, p. 32; KOSANKE, 1950, p. 19; HOFFMEISTER, STAPLIN & MALLOY, 1955, p. 13.

Granulatisporites (Ibrahim) POTONIE & KREMP, 1954, p. 58; 1955, p. 56-57; BHARDWAJ, 1957, p. 114.

Type species. Granulatisporites granulatus IBRAHIM, 1933, p. 22, pl. 6, fig. 51.

Diagnosis. Recognized by its subtriangular outline; trilete attachment scar; granulose exine.

Occurrence. This genus totals 4.57 percent of the composite spore population of the Bevier coal in southeastern Kansas and southwestern Missouri. It appears to be more common in Kansas than in Missouri. It measures about 0.1 percent of the spore population in the Wheeler coal.

Range. Basal Tournasian through Lower Permian.

GRANULATISPORITES GRANULATUS Ibrahim, 1933

Pl. 3, Fig. 1

Granulatisporites granulatus IBRAHIM, 1933, p. 22, pl. 6, fig. 51.

Diagnosis. Recognized by its finely granulate to punctate exine; trilete extending about two-thirds radius of spore; distinct trilete.

Dimensions. Ranges from 28 to 34 microns in diameter.

Material. About ten specimens were examined.

Occurrence. Found at most of the studied localities.

Remarks. Specimens were observed with its trilete rays extending more than two-thirds the distance to the spore wall but not reaching it.

GRANULATISPORITES PARVUS (Ibrahim), 1932

Pl. 3, Fig. 2

Sporonites parvus Ibrahim, in POTONIE, IBRAHIM, & LOOSE, 1932, p. , pl. 18, fig. 45.

Punctati-sporites parvus IBRAHIM, 1933, p. 21, pl. 2, fig. 21.

Granulatisporites pallidus KOSANKE, 1950, p. 21, pl. 3, fig. 3.

Granulatisporites parvus (Ibrahim) POTONIE & KREMP, 1955, p. 59, pl. 12, figs. 161-171.

Diagnosis. Recognized by its straight to slightly convex outline; granulations about one-half micron in diameter.

Dimensions. Ranges from 35 to 50 microns in diameter.

Material. Three specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. The identified specimens of this species coincide with the description given by Potonie & Kremp (1955) and are tentatively placed in G. parvus. Granulations on the exine are not as numerous as on the illustrated representatives of this species.

GRANULATISPORITES MINUTUS Potonie & Kremp, 1955

Pl. 3, Fig. 3.

Granulatisporites minutus POTONIE & KREMP, 1955, p. 59, pl. 12, figs. 147-148.

Diagnosis. Recognized by its small size; granulose exine; rounded triangular outline in transverse plane.

Dimensions. Ranges from 20 to 25 microns in diameter.

Material. Five specimens were examined.

Occurrence. Found only in the Bevier coal.

Remarks. Specimens of this species found in the Bevier coal resemble Anapiculatisporites spinosus but are readily distinguished by lack of spines and presence of distinct granulose exine. A contact area was observed in all the specimens but this was found to be present in the specimens illustrated by Potonie and Kremp (1955) also.

Series APICULATI (Bennie & Kidston), 1886

Genus SCHOPFITES Kosanke, 1950

Schopfites KOSANKE, 1950, p. 52; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 18; POTONIE & KREMP, 1955, p. 69-70.

Type species. Schopfites dimorphus KOSANKE, 1950, p. 52-53, pl. 13, figs. 1-3.

Diagnosis. Recognized by its circular to round outline; trilete attachment scar; proximal surface levigate for most of its area; distal surface covered with blunt projections.

Occurrence. Schopfites is distinctly present at all localities where the collected coals were studied. It totals 0.21 percent of the composite spore population in the Bevier coal of southeastern Kansas and southwestern Missouri and is present in the Wheeler coal.

Range. Desmoinesian (Pennsylvanian).

SCHOPFITES COLCHESTERENSIS Kosanke, 1950

Pl. 3, Fig. 10

Schopfites colemasterensis KOSANKE, 1950, p. 53, pl. 13, fig. 4.

Diagnosis. Recognized by its smaller size; distal projections being smaller and not as closely spaced.

Dimensions. Maximum diameter measures about 91 microns.

Material. Over 20 specimens were examined.

Occurrence. This species was found at every studied locality.

SCHOPFITES DIMORPHUS Kosanke, 1950

Pl. 3, Fig. 9

Schopfites dimorphus KOSANKE, 1950, p. 52-53, pl. 13, figs. 1-3.

Diagnosis. Recognized by its larger size and more closely spaced projections.

Dimensions. Ranges in size from 78 to 115 microns.

Material. Over 10 specimens were examined.

Occurrence. Found at several localities.

Genus LOPHOTRILETES (Naumova), 1937

Lophotriletes NAUMOVA, 1937, p. 357; POTONIE & KREMP, 1954, p. 129; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 13; POTONIE & KREMP, 1955, p. 72, BHARDWAJ, 1957, p. 114.

Type species. Lophotriletes gibbosus (IBRAHIM), 1933, p. 25, pl. 6, fig. 49.

Diagnosis. Recognized by its roundly triangular outline; concave or convex interapex areas; trilete attachment scar; surface ornamented with broad based coni.

Occurrence. This genus totals less than 0.1 percent of the composite spore population in the Bevier coal. It was not found in the Wheeler coal.

Range. Basal Tournasian through Lower Permian.

LOPHOTRILETES COMMISSURALIS (Kosanke), 1950

Pl. 3, Figs. 4-5

Granulatisporites commissuralis KOSANKE, 1950, p. 20, pl. 3, fig. 1.

Lophotriletes commissuralis (Kosanke) POTONIE & KREMP, 1955, p. 73, pl. 10, figs. 222-223.

Diagnosis. Recognized by its coni being slightly longer; triangular outline with concave interapex areas; small size.

Dimensions. Maximum diameter about 34 microns.

Material. Six specimens were examined.

Occurrence. Found at localities 2, 3, and 7.

Remarks. Two specimens are slightly smaller than the species given by Kosanke (1950).

LOPHOTRILETES SP. A

Pl. 3, Fig. 6

Diagnosis. This species is distinguished by its more triangular shape and shorter coni.

Description. Shape is radially symmetrical; outline triangular with rounded apices; outline interrupted by short,

broad-based coni, giving an irregular appearance; interapex areas are straight to slightly concave; trilete attachment scar open at junction of rays and extends approximately halfway to edge of spore; lips slightly elevated; commissure not observed; spore coat is covered by a profuse array of short, broad-based coni; spore measures 23.5 by 24.5 microns for normal diameters.

Occurrence. A single specimen was found at locality 1 (Anderson County, Kansas).

Remarks. The shape and distinct presence of coni place this specimen in Lophotriletes. It is very similar to L. sp. A described by Schulze (1959) and these two specimens may be members of a new species.

LOPHOTRILETES SP. B

Pl. 3, Fig. 7

Diagnosis. Recognized by its sparingly located coni.

Description. Spore radially symmetrical; shape triangular in transverse view with rounded apices; outline interrupted by coni; coni sparingly located on spore coat; trilete distinct, extending about three-fourths distance to margin of spore; lips are present and slightly raised; normal diameters of spore measure 46 by 46.5 microns.

Remarks. The one specimen found is identical to Granulatisporites saetosus described by Jones (unpublished thesis, 1957) but is somewhat smaller. Jones restricted the size range of G. saetosus to 56-60 microns. The described speci-

men is smaller but is most likely a member of the same species described by Jones.

Genus APICULATISPORIS (Ibrahim), 1933

Apiculati-sporites IBRAHIM, 1933, p. 23.

Apiculatisporites (Ibrahim) POTONIE & KREMP, 1954, p. 130; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 13; POTONIE & KREMP, 1955, p. 76-81.

Apiculatisporis (Ibrahim) POTONIE & KREMP, 1956, p. 94.

Type species. Apiculatisporis aculeatus IBRAHIM, 1933, p. 23, pl. 6, fig. 57.

Diagnosis. Recognized by its circular outline in transverse plane; trilete attachment scar; exine covered with numerous coni very closely spaced.

Occurrence. Apiculatisporis is rare in the studied coals, totaling less than 0.1 percent of the composite spore population.

Range. Basal Tournasian through Lower Permian.

APICULATISPORIS LATIGRANIFER (Loose), 1932

Pl. 3, Fig. 12

Sporonites latigranifer Loose, in POTONIE, IBRAHIM, & LOOSE, 1932, p. 452, pl. 19, fig. 54.

Granulati-sporites latigranifer LOOSE, 1934, p. 147.

Punctati-sporites latigranifer (Loose) KOSANKE, 1950, p. 95, pl. 1, fig. 5.

Apiculatisporis latigranifer (Loose) POTONIE & KREMP, 1955, p. 79, pl. 14, figs. 244-245.

Diagnosis. Recognized by its trilete scar extending over one-half the distance to the spore wall; cont distantly spaced.

Dimensions. Size ranges from 55 to 90 microns in diameter.

Material. Eight specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. Only one well preserved specimen was found.

APICULATISPORIS SETULOSUS ? (Kosanke), 1950

Pl. 3, Fig. 13

Punctati-sporites setulosus KOSANKE, 1950, p. 15, pl. 2, fig. 1.

Apiculatisporis setulosus (Kosanke) POTONIE & KREMP, 1955, p. 79-80, pl. 14, figs. 246-248.

Diagnosis. Recognized by its trilete scar extending about half the distance to the margin of the spore; between 40 and 50 coni present in equatorial view.

Dimensions. Ranges from 60 to 80 microns in diameter.

Material. Four specimens were examined.

Occurrence. Found only in the Bevier coal.

Remarks. Coni examined in these specimens appear to be slightly longer than wide proportionally than that given by Potonie and Kremp (1955). The longer coni resemble spines which would place the found specimens close to Raistrickia.

APICULATISPORIS SP. A

Pl. 3, Fig. 11

Diagnosis. Distinguished by its subtriangular oblate shape; ornamentation.

Description. Shape radially symmetrical; subtriangular oblate; outline interrupted by broad-based blunt projections; ornamentation consists of broad, short, blunt projections arising from a levigate spore coat, two or three of these projections appear to be interconnected; trilete attachment scar distinct and rays measure from 9 to 11 microns in length; lips distinct and elevated; commissure faintly discernible; equatorial thickening measures about 2.5 microns in width and is widest at apices; size 44 by 46 microns.

Remarks. This specimen, the only one found, is tentatively placed in Apiculatisporis because of the closely spaced blunted projections. It was recovered from the middle third of the Bevier coal at locality 2 (Allen County, Kansas).

Genus ANAPICULATISPORITES Potonie & Kremp, 1954

Anapiculatisporites POTONIE & KREMP, 1954, p. 130; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 13; POTONIE & KREMP, 1955, p. 81.

Type species. Anapiculatisporites isselburgensis POTONIE & KREMP, 1954, p. 133, pl. 20, fig. 97.

Diagnosis. Recognized by its circular to convexly subtriangular outline; smooth proximal surface; distal surface covered with cones or spines.

Occurrence. This genus totals 0.4 percent of the composite spore population of the Bevier coal in southeastern Kansas and southwestern Missouri, being most common at locality 3. It is present at the Wheeler localities but was not entered into the count.

Range. Uppermost Westphalian A through Westphalian C.

ANAPICULATISPORITES SPINOSUS (Kosanke), 1950

Pl. 3, Fig. 8

Granulati-sporites spinosus KOSANKE, 1950, p. 22, pl. 3, fig. 7.

Anapiculatisporites spinosus (Kosanke) POTONIE & KREMP, 1955, p. 82, pl. 14, figs. 253-255.

Diagnosis. Recognized by its spore coat being spiny on proximal and distal surfaces except around trilete scar.

Dimensions. Ranges from 26 to 38 microns in diameter.

Material. Over 40 specimens were examined.

Occurrence. Found in both coals.

Genus RAISTRICKIA (Schopf, Wilson, & Bentall), 1944

Raistrickia SCHOPF, WILSON, & BENTALL, 1944, p. 55; WILSON & KOSANKE, 1944, p. 331; KOSANKE, 1950, p. 45-46; POTONIE & KREMP, 1954, p. 129; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 18; POTONIE & KREMP, 1955, p. 85-86; BHARDWAJ, 1957, p. 88, 114.

Type species. Raistrickia grovensis Schopf, in SCHOPF, WILSON, & BENTALL, 1944, p. 55-56, text-fig. 3.

Diagnosis. Recognized by its trilete attachment scar; numerous spines which essentially are not broader at the base than at the tip.

Occurrence. Raistrickia totals 3.3% percent of the composite spore population in the Bevier coal of southeastern Kansas and southwestern Missouri. It is present at the Wheeler localities but composes less than 0.1 percent of the spore population.

Range. Basal Namurian through Westphalian B.

RAISTRICKIA CRINITA Kosanke, 1950

Pl. 4, Fig. 12

Raistrickia crinita KOSANKE, 1950, p. 46-47, pl. 11, fig. 7.

Diagnosis. Recognized by its long trilete rays; roundly triangular outline in transverse plane; numerous spines which taper to a blunt point.

Dimensions. Ranges from 54 to 67 microns in diameter. Spines range in length from 7.7 to 9.5 microns.

Material. Over ten specimens were examined.

Occurrence. Found infrequently in the studied coals but appears to be the most common species of Raistrickia.

Remarks. Outline varied in some specimens from roundly triangular to convexotriangular.

RAISTRICKIA SASTOSA r (loose), 1932

Pl. 4, Fig. 13

Sporonites saetosus Loose, in POTONIÉ, ZERLANG, & LOOSE, 1932, p. 458, pl. 19, fig. 56.

Setosi-sporites saetosus (Loose) ZERLANG, 1933, p. 27.

Raistrickia saetosus SCHOPF, WILSON, & BENTALL, 1944, p. 56.

Raistrickia saetosa POTONIÉ & KREMP, 1955, p. 87-88, pl. 15, figs. 264-266.

Diagnosis. Recognized by its trilete extending two-thirds distance to margin of spore; spines extending outward up to 14 microns; lacerated spines.

Dimensions. Ranges from 60 to 90 microns in diameter.

Material. Two specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. The two specimens that were found were badly folded and identification could only be made through examination of the spines.

RAISTRICKIA SOLARIA Wilson & Hoffmeister, 1956

Pl. 4, Fig. 11

Raistrickia solaria WILSON & HOFFMEISTER, 1956, p. 22, pl. 1, figs. 18-19.

Diagnosis. Recognized by its circular outline; long simple trilete rays; simple slender spines.

Dimensions. Ranges from 51 to 63.5 microns in diameter; rays 19 to 21 microns long; spines 7 to 12 microns long.

Material. One specimen was examined.

Occurrence. Found in middle third of coal at locality 3 (Crawford County, Kansas).

Remarks. Most of the spines on the studied specimen fit within the size range given by Wilson and Hoffmeister (1956) but a few fell short of the lower limit i.e. 7 microns.

RAISTRICKIA PROTENSA ? Kosanke, 1950

Pl. 4, Fig. 10

Raistrickia protensa KOSANKE, 1950, p. 46, pl. 11, figs. 1-3.

Diagnosis. Recognized by its bifurcating spines; spines that are narrowest at their base and broaden outward; spines that are terminated by a lacerated surface; stems of spines that are finely partate; club shaped spines.

Dimensions. Ranges from 54.5 to 63.8 microns in diameter; spines range from 12.5 to 17.9 microns in length.

Material. Four specimens were examined.

Occurrence. Present in the Bevier and Wheeler coals.

Remarks. Specimens discussed here are tentatively placed in R. protensa as they fell short of the given size range i.e. 47.5 microns, exclusive of spines. Their description otherwise fits the description given by Kosanke (1950).

RAISTRICKIA CROCEA Kosanke, 1950

Pl. 4, Fig. 9

Raistrickia crocea KOSANKE, 1950, p. 47, pl. 11, fig. 6.

Diagnosis. Recognized by its spines being ribbon-like in appearance.

Dimensions. Ranges from 63 to 77 microns in diameter.

Material. Four specimens were examined.

Occurrence. Found in the Wheeler coal.

Series MURORNATI Potonie & Kremp, 1954

Genus FOVEOLATISPORITES Bhardwaj, 1955

Foveolatisporites BHARDWAJ, 1955, p. 125-126; 1957, p. 119-120.

Type species. Foveolatisporites fenestratus

Diagnosis. Recognized by its circular outline; outline that may be interrupted by low, smooth muri; presence of foveoli; undiscernible trilete scar but thickenings of it; thick exine.

Occurrence. Only two species of Foveolatisporites were recovered from the Bevier coal in north-central Missouri.

Range. Westphalian D through Lower Stephanian.

FOVEOLATISPORITES FENESTRATUS (Kosanke & Brokaw), 1950

Pl. 4, Fig. 8

Punctati-sporites fenestratus Kosanke & Brokaw, in KOSANKE, 1950, p. 15, pl. 2, fig. 10.

Microreticulatisporites fenestratus BUTTERWORTH & WILLIAMS, 1954, p. 755.

Foveolatisporites fenestratus (Kosanke & Brokaw) BHARDWAJ, 1955, p. 125-127, pl. 1, fig. 4.

Diagnosis. Recognized by its foveoli measuring 2 to 3 microns in diameter; muri 1.5 microns high with rounded apices; circular outline.

Dimensions. Ranges from 68 to 90 microns in diameter.

Material. Three specimens were examined.

Occurrence. This species was found only at locality 10 (Boone County, Missouri).

Remarks. The foveoli are slightly smaller than the size described by Bhardwaj (1955).

FOVEOLATISPORITES FOVEATUS (Kosanke), 1950

Pl. 4, Fig. 7

Punctati-sporites foveatus KOSANKE, 1950, p. 17, pl. 1, fig. 6.

Microreticulatisporites foveatus (Kosanke) POTONIE & KREMP, 1955, p. 98.

Foveolatisporites foveatus (Kosanke) BHARDWAJ, 1955, p. 126.

Diagnosis. Recognized by its common obliquely compressed circular outline; spore surrounded by a ridge; folds usually present.

Dimensions. Ranges in diameter from 67 to 84 microns.

Material. Two specimens were examined.

Occurrence. Two specimens were found only at locality 10 (Boone County, Missouri).

Genus VESTISPORA (Wilson & Hoffmeister), 1956

Vestispora WILSON & HOFFMEISTER, 1956, p. 27; BHARDWAJ, 1957, p. 115-118.

Type species. Vestispora profunda WILSON & HOFFMEISTER, 1956, p. 28, text-fig. 1, pl. 2, figs. 16-19.

Diagnosis. Recognized by circular outline; spore consisting of bladder and inner body; inner body circular and thin-walled; bladder ornamented with thin muri; infragranulose to levigate exine; trilete scar.

Occurrence. Vestispora totals 0.18 percent of the composite spore population in the Bevier coal of southeastern Kansas and southwestern Missouri. It composes approximately 0.1 percent of the spore population in the Wheeler coal.

Range. Desmoinesian. (Pennsylvanian).

VESTISPORA PROFUNDA Wilson & Hoffmeister, 1956

Pl. 5, Fig. 14

Vestispora profunda WILSON & HOFFMEISTER, 1956, p. 28, pl. 2, figs. 16-19.

Diagnosis. Recognized by its reticulations on the bladder being equiangular to linear.

Dimensions. Ranges from 64 to 96 microns in diameter; central spore body from 32 to 35 microns; trilete rays measure from 18 to 20 microns in length; walls measure from 1.5 to 2 microns thick.

Material. About 10 specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. In some specimens, the trilete rays are indistinct and could only be observed by careful focusing.

VESTISPORA COSTATA ? (Balme), 1952

Pl. 5, Fig. 13

Endosporites costatus BALME, 1952, p. 179, pl. 1, fig. f; BALME & BUTTERWORTH, 1952, p. 873; BUTTERWORTH & MILLOT, 1954-1955, p. 504.

Vestispora costata (Balme) BHARDWAJ, 1957, p. 118-119, pl. 24, figs. 36-42.

Diagnosis. Recognized by its uneven equatorial outline due to the presence of muri; muri run obliquely on the spore surface forming a coarse network; meshes 6 to 10 microns wide.

Dimensions. Ranges from 60 to 104 microns in diameter; muri 2 microns high and 2 to 3 microns wide.

Occurrence. One specimen was found at locality 7.

Remarks. The one specimen that was found is rather poorly preserved but shows the mesh network and muri distinctly. No trilete scar was discernible but Bhardwaj (1957) describes it as being faintly observable in this species.

Division ZONALES (Bennie & Kidston), 1886

Subdivision AURITOTRILETES Potonie & Kremp, 1954

Series AURICULATI (Schopf), 1938

Genus TRIQUITRITES (Wilson & Coe), 1940

Triquitrites WILSON & COE, 1940, p. 194; WILSON & KOSANKE, 1944, p. 331-332; SCHOPF, WILSON, & BENTALL, 1944, p. 46-47; KOSANKE, 1950, p. 37-38; POTONIE & KREMP, 1954, p. 133; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 18; POTONIE & KREMP, 1956, p. 86-87; BHARDWAJ, 1957, p. 122.

Type species. Triquitrites arculatus WILSON & COE, 1940, p. 185, pl. 1, fig. 8.

Diagnosis. Recognized by its subtriangular outline in transverse plane; trilete attachment scar; auriculae present at each of the three apices; auriculae thickened and darker than remainder of spore coal.

Occurrence. Triquitrites varies slightly in some localities but is always present. It totals 3.35 percent of the composite spore population in the Bevier coal.

Range. Upper Tournasian through Lower Permian.

TRIQUITRITES BRANSONII Wilson & Hoffmeister, 1956

Pl. 4, Fig. 5

Triquitrite bransonii WILSON & HOFFMEISTER, 1956, p. 24-25, pl. 3, figs. 1-5.

Diagnosis. Recognized by its triangular-oblate outline; levigate ornamentation; trilete extending almost to the margin of the spore; relative large size.

Dimensions. Ranges from 30 to 42 microns in diameter.

Material. Over 40 specimens were examined.

Occurrence. It appears to be the most abundant species of Triquitrites found in the studied coals.

Remarks. This species was readily identified by its size and shape.

TRIQUITRITES SPINOSUS Kosanke, 1943

Pl. 4, Fig. 6

Triquitrites spinosus KOSANKE, 1943, p. 128, pl. 3, figs. 2-2b.

Dimensions. Measures from 43 to 55 microns in maximum diameter.

Material. Five specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. It was difficult at times to distinguish this species from T. additus. Kosanke (1943) described T. spinosus as containing spines that protrude from a levigate spore coat. His illustration of the species contains just a few spines. Wilson & Hoffmeister (1956) described T. additus as containing tubular or lobed projections that extend from a levigate spore coat. The writer placed those specimens in which a few distinct distinguishable slender spines were found, in T. spinosus.

TRIQUITRITES ADDITUS Wilson & Hoffmeister, 1956

Pl. 4, Fig. 4

Triquitrites additus WILSON & HOFFMEISTER, 1956, p. 24, pl. 3, figs. 6-9.

Diagnosis. Recognized by its tubular or lobed projections usually being present; partial secondary wall layers frequently present on distal surface; relative small size.

Dimensions. Ranges in diameter from 35 to 45 microns.

Material. Over 10 specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. Specimens were placed in this species when the projections were found to be irregular and not spine-like. Size was also useful in determining this species but there were instances when specimens exceeded the upper size limit by a few microns. (Note Remarks under T. spinosus).

TRIQUITRITES DELTIFORMIS ? (Wilson & Coe), 1940

Pl. 4, Figs. 1-2

Triquitrites deltoides WILSON & COE, 1940, p. 185, fig. 9.

Granulati-sporites deltiformis SCHOPF, WILSON, & BENTALL, 1944, p. 32.

Triquitrites deltiformis (Wilson & Coe) POTONIE & KREMP, 1956, p. 87.

Diagnosis. Recognized by its distinctly concave inter-apex areas; levigate ornamentation; relatively small size.

Dimensions. Measures from 26 to 30 microns in diameter.

Material. About 5 specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. Specimens tentatively placed in this species contain a thin equatorial thickening at each apex. Wilson and Coe (1940) distinguished this species from T. arculatus by noting that there is no equatorial flange whereas T. arculatus has an equatorial flange. However, the equatorial flange of T. arculatus completely surrounds the spore body.

Other than this problem, the specimens discussed here are the same as the species described and illustrated by Wilson and Coe.

TRIQUITRITES EXIGUUS Wilson & Kosanke, 1944

Pl. 4, Fig. 3

Triquitrites exiguus WILSON & KOSANKE, 1944, p. 332, fig. 2.

Diagnosis. Recognized by its straight to slightly concave interapex areas; thick arcuate thickenings; small size.

Dimensions. Ranges in diameter from 22 to 30 microns; width of thickenings from 3 to 6 microns; width from 9 to 15 microns.

Material. Over 15 specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Subdivision ZONOTRILETES Waltz, 1935

Series CINGULATI Potonie & Klaus, 1954

Genus CIRRATRIRADITES Wilson & Coe, 1940

Cirratriradites WILSON & COE, 1940, p. 183; SCHOPF, WILSON, & BENTALL, 1944, p. 43; WILSON & KOSANKE, 1944, p. 329-330; KOSANKE, 1950, p. 34; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 20; POTONIE & KREMP, 1956, p. 125.

Type species. Cirratriradites sacculatus WILSON & COE, 1940, p. 183, pl. 1, fig. 3.

Diagnosis. Recognized by its subtriangular to round outline in transverse plane; presence of equatorial flange; trilete

attachment scar; trilete extending to periphery of flange; partly grooved or striate flange; size greater than 60 microns.

Occurrence. This genus is rare in the Bevier and Wheeler coals, constituting about 0.1 percent of the composite spore population.

Range. Upper Devonian through the Permian.

CIRRATRIRADITES CRASSUS Wilson & Hoffmeister, 1956

Pl. 5, Fig. 12

Cirratriradites crassus WILSON & HOFFMEISTER, 1956, p. 14, pl. 2, fig. 6.

Diagnosis. Distinguished by its relatively wide ridges bordering the trilete rays; oblate to subtriangular outline.

Dimensions. Maximum diameter measures 93 microns; spore body measures about 86 microns in diameter; maximum width of flange measures 7.7 microns.

Material. Only one well preserved specimen was examined, which was found at locality 3 (Crawford County, Kansas).

Occurrence. Wilson and Hoffmeister (1956), and Schmieg (1959) have reported finding this species in the Croweburg coal. As this specimen was found in the Bevier coal, the range of C. crassus is extended from the Croweburg coal to the Bevier coal.

CIRRATRIRADITES FLABELLIFORMIS Wilson & Kosanke, 1944

Pl. 5, Fig. 10

Cirratriradites flabelliformis WILSON & KOSANKE, 1944, p. 330, fig. 6.

Diagnosis. Recognized by its rugose ornamentation; thick wavy flange.

Dimensions. Ranges from 75 to 80 microns in diameter; flange from 10 to 15 microns thick; spore body 42 to 45 microns in diameter.

Material. Two specimens were examined.

Occurrence. Found only at locality 10 (Boone County, Missouri).

CIRRATRIRADITES ANNULATUS Kosanke & Brokaw, 1950

Pl. 5, Fig. 11

Cirratriradites annulatus Kosanke & Brokaw, in KOSANKE, 1950, p. 35, pl. 7, fig. 4.

Diagnosis. Distinguished by its sharply punctate exine; minutely radially striate flange; thin flange.

Dimensions. Maximum diameter up to 102 microns; central spore body of holotype measures 67.2 microns in diameter.

Material. Three specimens were examined.

Occurrence. Found in the Bevier and Wheeler coal. Kosanke (1950) reported this species from the No. 5 and No. 6 coal beds of the McLeansboro Group in Illinois.

Remarks. The exine of this species was observed to be sharply punctate in part only. Portions of the exine were found to be levigate.

CIRRATRIRADITES SCHMIEGI Habib, n. sp.

Pl. 5, Figs. 7-9

Diagnosis. Recognized by its distinct triangular outline in transverse plane.

Description. Shape radially symmetrical; outline triangular in transverse plane; apices slightly rounded; contains relatively thick equatorial flange; trilete rays are distinct and extend to the periphery of the flange; flange radially striate to serrate in part, being smooth otherwise; commissure present and may be distinct or indistinct; lips slightly elevate; central spore body bordered by distinct ridge measuring about 5 to 7 microns in width; ornamentation varies from levigate to punctate; arcuate thickenings at junction of trilete rays may or may not be present.

Dimensions. Maximum length of species is 82 microns; maximum width is 74 microns; maximum length of spore body is 67 microns and maximum width is 61 microns.

Material. Four specimens were examined.

Occurrence. Found only at locality 9 (Henry County, Missouri).

Remarks. C. schmiegi is the same species as C. sp. A described by Schmieg (1959).

C. schmiegi is distinguished from the type species of Cirratriradites because the flange is serrated, at least in part, and the outline is distinctly more triangular. It is distinguished from C. annulatus because its ornamentation is not sharply punctate and the flange is serrated, at least in part.

Genus LYCOSPORA Schopf, Wilson, & Bentall, 1944

Lycospora SCHOPF, WILSON, & BENTALL, 1944, p. 54; KOSANKE, 1950, p. 44; POTONIE & KREMP, 1954, p. 156; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 19; POTONIE & KREMP, 1956, p. 98-99; BHARDWAJ, 1957, p. 127.

Type species. Lycospora micropapillata (Wilson & Coe), 1940, p. 184, pl. 1, fig. 6.

Diagnosis. Recognized by its round to subtriangular outline; presence of equatorial ridge; trilete attachment scar; levigate to rugose ornamentation; size range from 18 to 60 microns.

Occurrence. Lycospora is the most abundant genus in the Bevier coal. It constitutes 44.3 percent of the composite spore population, reaching a high of 56.4 percent at locality 1 (Anderson County, Kansas) and a low of 34.8 percent at locality 5 (Crawford County, Kansas). It represents 18.5 percent of the spore population in the Wheeler coal.

Range. Upper Devonian through Desmoinesian.

LYCOSPORA PUNCTATA Kosanke, 1950

Pl. 5, Fig. 1

Lycospora punctata KOSANKE, 1950, p. 45, pl. 10, fig. 3; POTONIE & KREMP, 1956, p. 103, pl. 17, figs. 347-350.

Cirratriradites punctatus (Kosanke) HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 382.

Diagnosis. Characterized by its punctate exine; subtriangular outline in transverse plane; size range from 30 to 42 microns; equatorial ridge from 2 to 3 microns wide.

Dimensions. Same as in Diagnosis.

Material. Over 2000 specimens were examined.

Occurrence. Found to be abundant in all the studied coals.

Remarks. The similarity of specimens of this species with species of Cirratriradites is remarkable. Actually, the only criterion separating the two groups is size (Bhardwaj, 1957a, p. 101-102). Fossil spores of this shape and structure less than 60 microns were placed in Lycospora, and fossil spores of this shape and structure greater than 60 microns were placed in Cirratriradites.

LYCOSPORA PARVA Kosanke, 1950

Pl. 5, Figs. 2-3

Lycospora parva KOSANKE, 1950, p. 44-45, pl. 16, fig. 5; GUENNEL, 1958, p. 48-49, pl. 1, fig. 10.

Diagnosis. Recognized by its roundly triangular outline; size range of 25 to 32 microns; minutely punctate ornamentation.

Dimensions. Same as in Diagnosis.

Material. About 20 specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. This species is closely related to L. pusillus. Kosanke (1950) separated the two species on the basis of the size of the spore and the width of its equatorial ridge. Guennel (1958) separated the two species on the basis of size alone. He assigned those specimens fitting the description of shape and ornamentation, and measuring between 25 and 32 microns to L. parva, and those specimens fitting the description of shape

and ornamentation, and measuring between 33 and 42 microns to L. pusillus.

LYCOSPORA GRANULATA Kosanke, 1950

Pl. 5, Figs. 5-6

Lycospora granulata KOSANKE, 1950, p. 45, pl. 10, figs. 4,6.

Diagnosis. Recognized by its coarsely granulose ornamentation; greatly developed lips.

Dimensions. Ranges from 30 to 41 microns in diameter.

Material. About 50 specimens were examined.

Occurrence. Occurs in both the Bevier and Wheeler coals.

Remarks. Some specimens of this species could only be separated from L. punctata on the basis of ornamentation.

LYCOSPORA SP. A

Pl. 5, Fig. 4

Diagnosis. Recognized by its broadly punctate exine; length of trilete scar.

Description. Spore radially symmetrical; subtriangular to suboblate; outline interrupted by broad punctations; ornamentation very broadly punctate to microreticulate; trilete attachment scar distinct and rays measure over three-fourths distance to margin of spore; lips well developed and elevated; commissure not present; rays slightly irregular; equatorial ridge measures one and one-half to two microns

wide; spore measures 41 microns in its greatest diameter and 34 microns in the normal diameter.

Remarks. Only one well preserved specimen was found. It was found at locality 7 (Henry County, Missouri).

Division MONOLETES Ibrahim, 1933

Subdivision AZONOMONOLETES Luber, 1935

Genus LAEVIGATOSPORITES Ibrahim, 1933

Laevigato-sporites IBRAHIM, 1933, p. 39-40; SCHOPF, WILSON, & BENTALL, 1944, p. 36-37; KOSANKE, 1950, p. 27-28; POTONIE & KREMP, 1954, p. 165; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 20.

Phaseolites WILSON & COE, 1940, p. 192.

Laevigatosporites POTONIE & KREMP, 1956, p. 137; BHARDWAJ, 1957, p. 122; GUENNEL, 1958, p. 77-79.

Type species. Laevigatosporites vulgaris IBRAHIM, 1933, p. 39-40, pl. 2, fig. 16.

Diagnosis. Recognized by its bilateral symmetry; monlete attachment scar; mostly levigate ornamentation with few exceptions.

Occurrence. Laevigatosporites constitutes 8.9 percent of the composite spore population in the Bevier coal of southeastern Kansas and southwestern Missouri. It is secondmost abundant in the Wheeler coal.

Range. Lampasan (Pennsylvanian) through Permian.

LAEVIGATOSPORITES OVALIS Kosanke, 1950

Pl. 6, Fig. 2

Laevigatosporites ovalis KOSANKE, 1950, p. 29-30, pl. 5, fig. 7.

Diagnosis. Characterized by its width being about three-fourths its length; distinct levigate ornamentation.

Dimensions. Ranges from 45 to 65 microns in diameter; thickness of spore coat from two to two and one-half microns.

Material. Over 500 specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals and appears to be the most abundant species of Laevigatosporites present.

Remarks. Kosanke (1950) separated L. ovalis from other species of Laevigatosporites mainly on the basis of shape configuration. Guennel restricted the size of this species to between 45 and 65 microns. Both criteria were used in identification. When specimens of this genus were found to measure close to the lower or upper size limits, the species could only be determined by shape.

LAEVIGATOSPORITES MEDIUS Kosanke, 1950

Pl. 6, Fig. 1

Laevigatosporites medius KOSANKE, 1950, p. 29, pl. 16, fig. 2; GUENNEL, 1958, p. 78-79, pl. 5, figs. 15-16.

Diagnosis. Characterized by its size range smaller than L. ovalis.

Dimensions. Ranges in size from 36 to 43 microns; width reported by Kosanke (1950) as varying from 25 to 29 microns; thickness of spore coat between two and two and one-half microns.

Material. About 20 specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. Koesmke (1950) reported this species as ranging in width from 25 to 29 microns, or less than three-fourths the length of the species. He also described the ornamentation as being levigate but minutely granular under high focus. Guennel restricted the species to those specimens ranging in size from 36 to 43 microns. In many cases, specimens of this genus were found to be included in the size range between 40 and 50 microns, and roughly approximating the length-width ratio given for L. medius and L. ovalis. These specimens could only be identified then by careful examination of the ornamentation. This was difficult when specimens were poorly preserved or subjected to over-maceration.

LAEVIGATOSPORITES DESMOINENSIS (Wilson & Coe), 1940

Pl. 6, Fig. 3

Phaseolites desmoinensis WILSON & COE, 1940, p. 182-183, pl. 1, fig. 4.

Laevigatosporites desmoinensis (Wilson & Coe), SCHOPF, WILSON, & BENTALL, 1944, p. 37; (Wilson & Coe) in GUENNEL, 1958, p. 73, pl. 5, fig. 18.

Diagnosis. Recognized by its larger size range; levigate ornamentation.

Dimensions. Ranges from 60 to 75 microns in length; 39 to 42 microns in width.

Material. About 30 specimens were examined.

Occurrence. Found in the Bevier coal.

Remarks. Identification of this species was not difficult due to its size.

LAEVIGATOSPORITES MINIMUS (Wilson & Coe), 1940

Pl. 6, Fig. 4

Phaseolites minimus WILSON & COE, 1940, p. 183, pl. 1, fig. 5.

Laevigatosporites minimus (Wilson & Coe) in SCHOPF, WILSON, & BENTALL, 1944, p. 37; GUENNEL, 1958, p. 79, pl. 5, fig. 17.

Diagnosis. Characterized by its smaller size.

Dimensions. Measure between 20 and 35 microns in its maximum diameter.

Material. About 10 specimens were examined.

Occurrence. Rare in the studied coals.

LAEVIGATOSPORITES PUNCTATUS Kosanke, 1950

Pl. 6, Fig. 5

Laevigatosporites punctatus KOSANKE, 1950, p. 30, pl. 5, fig. 3.

Diagnosis. Recognized by its distinctly punctate exine.

Dimensions. Ranges from 35 to 51 microns in its longest diameter; spore coat one and one-quarter to two microns thick.

Material. About five specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Genus LATOSPORITES Potonie & Kremp, 1954

Latosporites POTONIE & KREMP, 1954, p. 165; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 20, POTONIE & KREMP, 1956, p. 140.

Type species. Latosporites latus (KOSANKE), 1950, p. 29, pl. 5, fig. 11.

Diagnosis. Shape is oval to unevenly circular in outline; monolete; ornamentation levigate to infrareticulate.

Occurrence. This genus is common in the studied coals, averaging 2.02 percent of the composite spore population in the Bevier coal of southeastern Kansas and southwestern Missouri.

Range. Namurian C through Lower Permian.

LATOSPORITES ROBUSTUS (Kosanke), 1950

Pl. 6, Fig. 8

Laevigato-sporites robustus KOSANKE, 1950, p. 30, pl. 5, fig. 9.

Latosporites robustus (Kosanke) POTONIE & KREMP, 1956, p. 140.

Diagnosis. Characterized by its broad bean-shaped outline; distinct levigate ornamentation; large size; common folding.

Dimensions. Ranges from 79 to 150 microns in its longest diameter.

Material. About 20 specimens were examined.

Occurrence. More abundant at the southeastern Kansas localities.

Remarks. Only folded forms of this species were found.

LATOSPORITES GLOBOSUS (Schemel), 1951

Pl. 6, Fig. 7

Laevigato-sporites globosus SCHEMEL, 1951, p. 746-747, pl. 1, fig. 2.

Latosporites globosus (Schemel) POTONIE & KREMP, 1956, p. 140.

Diagnosis. Characterized by its circular to subcircular outline in transverse plane; minutely punctate exine.

Dimensions. Ranges in size from 19 to 30 microns, averaging 24 microns.

Material. About 30 specimens were found.

Occurrence. L. globosus is present at all the studied localities and is the most abundant species of Latosporites present.

Remarks. The writer was able to distinguish this species from Punctatisporites obliquus only after careful focusing.

Genus PUNCTATOSPORITES Ibrahim, 1933

Punctato-sporites IBRAHIM, 1933, p. 40; POTONIE & KREMP, 1954, p. 165; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 20; POTONIE & KREMP, 1956, p. 141-142.

Punctatosporites (Ibrahim) BHARDWAJ, 1957, p. 129.

Type species. Punctatosporites minutus IBRAHIM, 1933, p. 40, pl. 5, fig. 33.

Diagnosis. Recognized by its oval to bean-shaped outline; monolete attachment scar; granulose exine.

Occurrence. This genus is secondmost abundant in the Bevier coals that were studied, averaging 15.6 percent of the composite spore population.

Range. Westphalian ? to Lower Permian.

PUNCTATOSPORITES MINUTUS Ibrahim, 1933

Pl. 6, Fig. 6

Laevigato-sporites minutus (Ibrahim) SCHOPF, WILSON, & BENTALL, 1944, p. 37.

Punctatosporites minutus (Ibrahim) IBRAHIM, 1933, p. 40, pl. 5, fig. 33; POTONIE & KREMP, 1956, p. 143, pl. 19, fig. 439.

Diagnosis. Recognized by its bean to oval shape in outline; granulose exine; smaller size.

Dimensions. Ranges from 21 to 28 microns in the longest diameter.

Material. Over 250 specimens were examined.

Occurrence. P. minutus is present and abundant in all the studied coals. This species was the only one found.

Genus VERRUCOSOSPORITES (Knox), 1950

Verrucoso-sporites KNOX, 1950, p. 316-319; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 20.

Verrucososporites (Knox) POTONIE & KREMP, 1954, p. 166; 1956, p. 143; BHARDWAJ, 1957, p. 129.

Type species. Verrucososporites obscurus (KOSANKE), 1950, p. 29, pl. 16, fig. 6.

Diagnosis. Recognized by its monolete attachment scar; verrucose ornamentation.

Occurrence. Verrucososporites is common in most of the studied coals, composing 3.54 percent of the spore population in the southeastern Kansas and southwestern Missouri Bevier bed. Only one specimen was found at locality 1 (Anderson County, Kansas).

Range. Middle Pennsylvanian through Lower Permian.

VERRUCOSOSPORITES PSEUDOTHIESSENI (Kosanke), 1950

Pl. 6, Fig. 9

Laevigato-sporites pseudothiesseni KOSANKE, 1950, p. 30, pl. 5, fig. 10.

Verrucososporites pseudothiesseni (Kosanke) POTONIÉ & KREMP, 1956, p. 144.

Diagnosis. Characterized by its elongate to oval outline; slightly larger size.

Dimensions. Ranges from 26 to 46 microns in its longest diameter; spore coat ranges from 1.5 to 3.5 microns thick.

Material. Over 25 specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals. This species and V. thiessení are useful in distinguishing the Bevier and Wheeler coals from the next underlying coal, the Croweburg. Wilson and Hoffmeister (1956) did not report finding Verrucososporites in their study of the Croweburg coal in Oklahoma.

VERRUCOSOSPORITES THIESSENI (Kosanke), 1943

Pl. 6, Fig. 10

Laevigato-sporites thiesseni KOSANKE, 1943, p. 125, 127, pl. 3, fig. 1.

Verrucososporites thiesseni (Kosanke) BHARDWAJ, 1957, p. 112.

Diagnosis. Recognized by its smaller size; rounded shape; slight variation difference in ornamentation.

Dimensions. Ranges from 14 to 24 microns in diameter; spore coat ranges from one to two microns thick.

Material. About six specimens were examined.

Occurrence. This species is rare in the studied coals. No specimens were found in southwestern Missouri, and only a few were found in southeastern Kansas.

Super-division POLLENITES Potonie, 1931

Division SACCITES Erdtman, 1947

Subdivision MONOSACCITES Cookson, 1947

Genus FLORINITES Schopf, Wilson, & Bentall, 1944

Florinites SCHOPF, WILSON, & BENTALL, 1944, p. 56-58; KOSANKE, 1950, p. 48-49; POTONIE & KREMP, 1956, p. 166-167.

Type species. Florinites antiquus Schopf, in SCHOPF, WILSON, & BENTALL, 1944, p. 58-59, text-fig. 4.

Diagnosis. Recognized by its broadly elliptical outline; central spore body near-spherical to spherical; bladder commonly not folded; folds occurring around central spore body; bladder ornamentation reticulate; vestigial trilete attachment scar.

Occurrence. Florinites is abundant in the Bevier coal of southeastern Kansas and southwestern Missouri, totaling 5.07 percent of the composite spore population. It is abundant in the Wheeler coal, composing about 23.5 percent of the spore population.

Range. Westphalian A to Lower Permian.

FLORINITES ANTIQUUS, Schopf, 1944

Pl. 6, Fig. 11

Florinites antiquus Schopf, in SCHOPF, WILSON, & BENTALL, 1944, p. 58-59, text-fig. 4.

Diagnosis. Recognized by its broadly elliptical bladder with numerous sharp folds encircling the spore body; striations sometimes present in the spore body.

Dimensions. Ranges from 55 to 90 microns in length; 40 to 70 microns in width; spore body measures from 25 to 45 microns in length; 20 to 40 microns in width.

Material. Over 70 specimens were examined.

Occurrence. F. antiquus was found to be present at all the studied localities.

Remarks. This is the only species of Florinites present.

Genus ENDOSPORITES Wilson & Coe, 1940

Endosporites WILSON & COE, 1940, p. 184; SCHOPF, WILSON, & BENTALL, 1944, p. 44-46; KOSANKE, 1950, p. 36; POTONIE & KREMP, 1956, p. 158-159.

Type species. Endosporites ornatus Wilson & Coe, 1940, p. 184, pl. 1, fig. 2.

Diagnosis. Recognized by its spherical to subspherical shape in original outline; central spore body; trilete attachment scar; thin wall.

Occurrence. Endosporites is rare in the studied coals, averaging 0.35 percent of the Bevier bed in southeastern Kansas and southwestern Missouri. It was found to be more common in the Missouri Bevier than in the Kansas Bevier, however. It did not enter into the spore count of the Wheeler coal.

Range. Pennsylvanian.

ENDOSPORITES ORNATUS Wilson & Coe, 1940

Pl. 6, Fig. 13

Endosporites ornatus WILSON & COE, 1940, p. 184, pl. 1, fig. 2.

Diagnosis. Recognized by its granulose bladder and unornamented central spore body.

Dimensions. Greatest diameter measures from 91 to 113 microns; central spore body measures from 47 to 54 microns.

Material. Five specimens were examined for identification.

Occurrence. Found in the Bevier and Wheeler coals.

Remarks. Some specimens of this species were identified with reservation as the central spore body was not completely unornamented in all cases. In these cases, the central spore body was found to be mildly punctate.

ENDOSPORITES VESICATUS ? Kosanke, 1950

Pl. 6, Fig. 12

Endosporites vesicatus KOSANKE, 1950, p. 37, pl. 7, fig. 8.

Diagnosis. Characterized by its folded bladder; presence of apical papillae.

Dimensions. Greatest diameter measured is 148 microns; central spore body of holotype measures 44 by 52.5 microns.

Material. About four specimens were examined for identification.

Occurrence. Found at the Missouri localities.

Remarks. Some of the identified specimens did not contain apical papillae, but instead contained a distinct ridge.

ENDOSPORITES FORMOSUS ? Kosanke, 1950

Pl. 6, Fig. 14

Endosporites formosus KOSANKE, 1950, p. 36-37, pl. 7, fig. 9.

Diagnosis. Recognized by its central spore body being punctate and bladder being coarsely punctate to reticulate; trilete attachment scar extending to periphery of spore body; thickening of bladder wall.

Dimensions. Ranges from 101 to 112 microns in diameter.

Material. Five specimens were examined from localities 1 (Allen County, Kansas), 5 (Crawford County, Kansas) and 7 (Henry County, Missouri).

Occurrence. Found in the Bevier coal and at locality 9 (Henry County, Missouri)- Wheeler coal?

Genus TRIRADITES (Pant), 1954

Genus WILSONIA Kosanke, 1950

Wilsonia KOSANKE, 1950, p. 54; POTONIE & KREMP, 1954, p. 173; HOFFMEISTER, STAPLIN, & MALLOY, 1955, p. 21; POTONIE & KREMP, 1956, p. 164; BHARDWAJ, 1957, pp. 113-115.

Type species. Wilsonia vesicatus KOSANKE, 1950, p. 54, pl. 14, figs. 1-3.

Diagnosis. Recognized by its round outline in transverse plane; bladder covering all of distal surface of spore; bladder covering at least major portion of proximal surface of spore; trilete attachment scar.

Occurrence. This genus is rare in the studied coals, constituting less than 0.1 percent of the spore population of both coal beds. Only one species, W. vesicatus, was found.

Range. Basal Westphalian to Upper Stephanian.

WILSONIA VESICATUS Kosanke, 1950

Pl. 6, Fig. 15

Wilsonia vesicatus KOSANKE, 1950, p. 54, pl. 14, figs. 1-3.

Diagnosis. Recognized by its bladder covering body, both distally and proximally; distinct trilete scar; trilete rays extending to margin of spore; common folding of bladder, usually adjacent to trilete rays.

Dimensions. Maximum diameter about 81 microns; central spore body about 55 microns.

Material. About five specimens were examined.

Occurrence. Found in the Bevier and Wheeler coals.

Subdivision DISACCITES Cookson, 1947

Genus VESICASPORA Schemel, 1951

Vesicaspora SCHEMEL, 1951, p. 748-749; POTONIE & KREMP, 1956, p. 179-180.

Type species. Vesicaspora wilsonii SCHEMEL, 1951, p. 749-750, figs. 1,3.

Diagnosis. Recognized by its bilaterally symmetrical shape; ellipsoidal to variable outline dependent on compression; ellipsoidal outline with triangular body in lateral view.

Occurrence. Vesicaspora is rare in the studied coals, totaling about 0.1 percent of the composite spore count.

Range. Wheeler coal to Uppermost Cabaniss Formation?

VESICASPORA WILSONII Schemel, 1951

Pl. 6, Figs. 16-17

Vesicaspora wilsonii SCHEMEL, 1951, p. 749-750, figs. 1,3.

Diagnosis. Recognized by its body and bladders being ellipsoidal in equatorial view with bladder widest at right angles to the long dimension of body; transverse view in which a slight indentation in the body is present.

Dimensions. Total length of spore ranges from 40 to 50 microns; width from 30 to 35 microns; body length from 25 to 34 microns in equatorial view; width from 13 to 20 microns; body ranges from 27 to 32 microns in equatorial view.

Material. Eight specimens were examined.

Occurrence. Found at most localities of the studied coals.

Remarks. Both equatorial and transverse views of this species were found.

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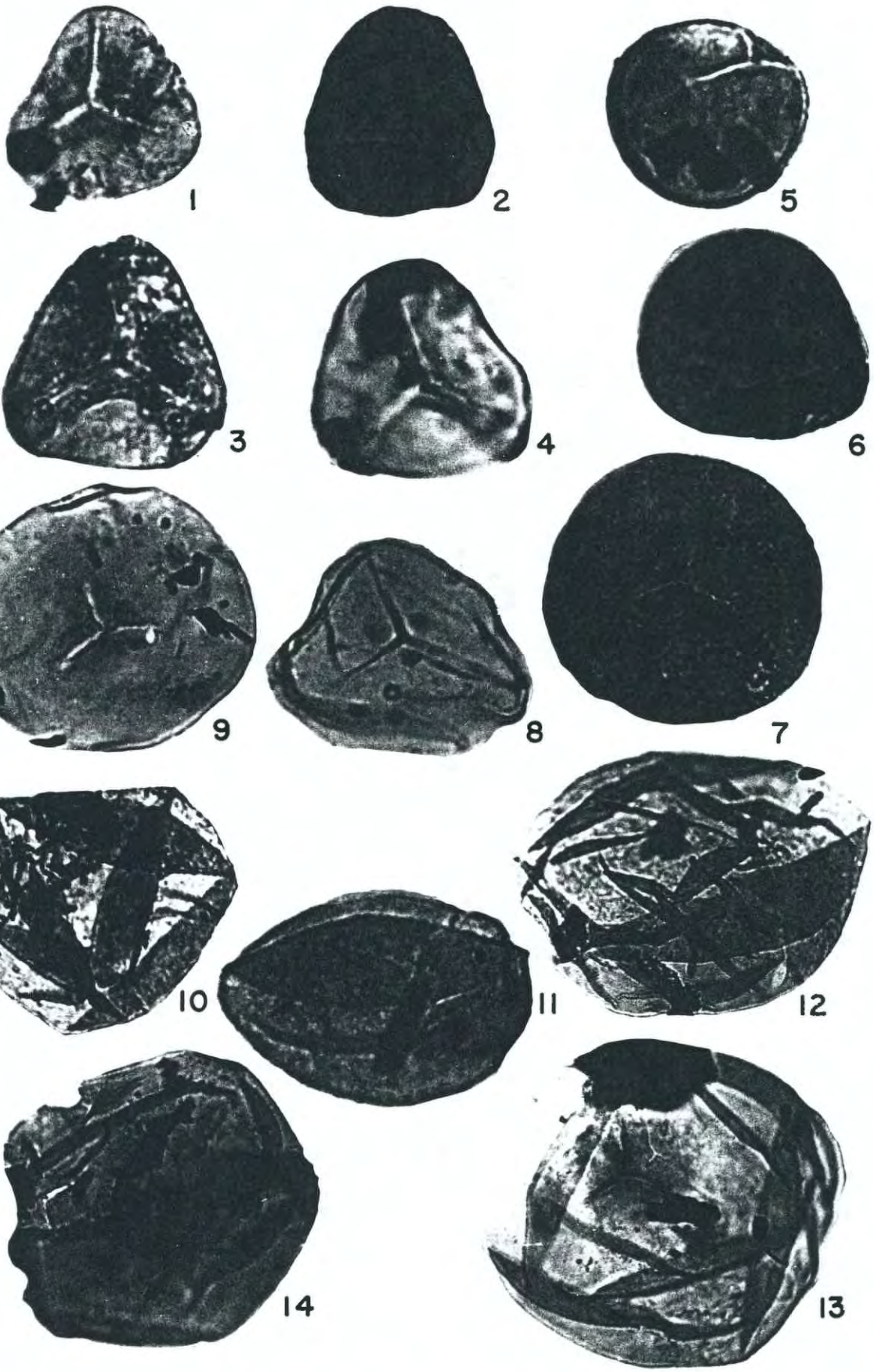
EXPLANATION OF PLATE 2

LEIOTRILETES, PUNCTATISPORITES, CALAMOSPORA

Figure Page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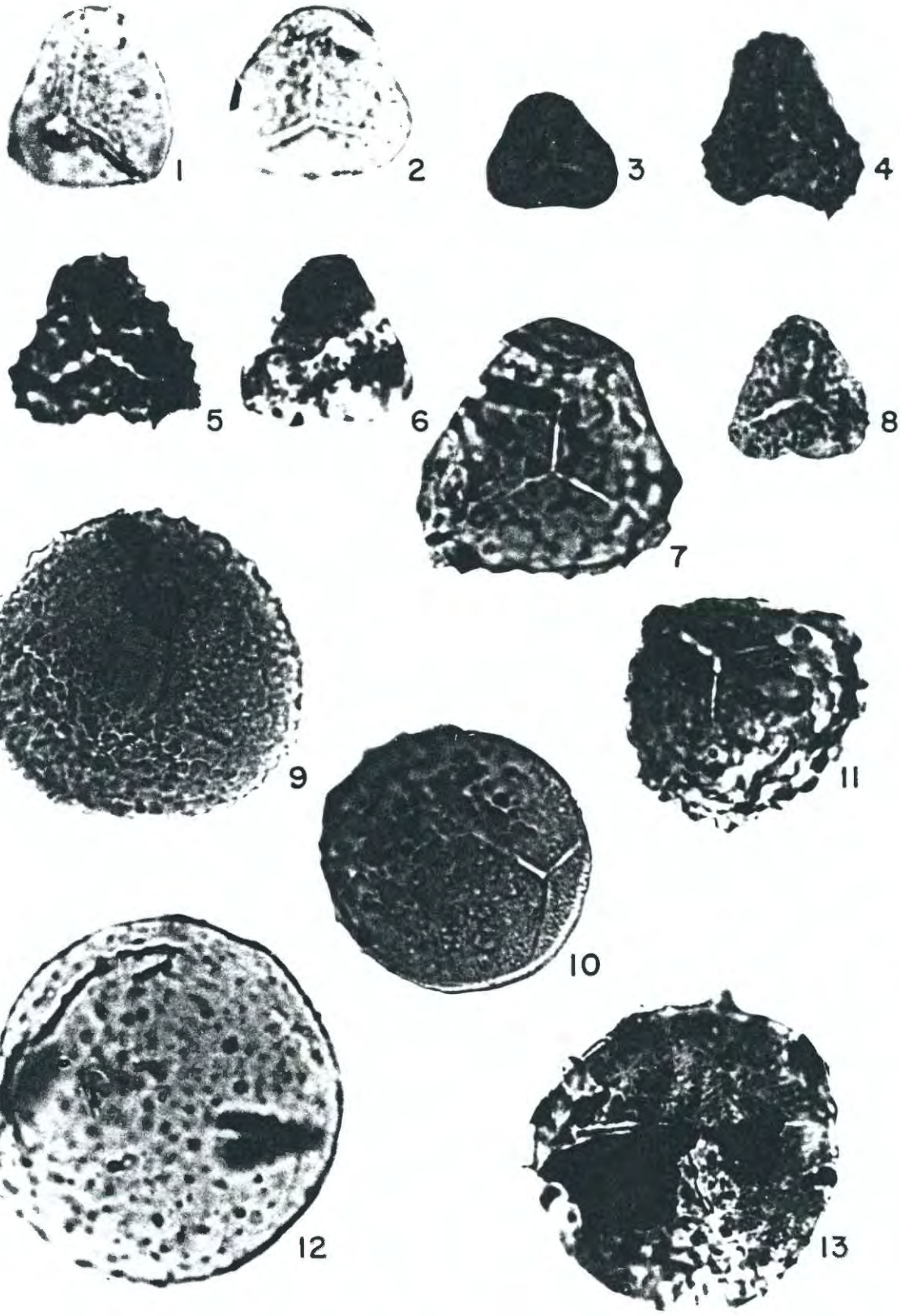
EXPLANATION OF PLATE 3

GRANULATISPORITES, LOPHOTRILETES, ANAPICULATISPORITES, SCHOPFITES, APICULATISPORIS

Figure		Plate
1.	Granulatisporites granulatus (Ibrahim), Size 31 X 34 microns; Slide MW-9C-3 (2.87-12.31); Wheeler coal; 750X.	39
2.	Granulatisporites parvus (Ibrahim), Size 33 X 35 microns; Slide MW-9C-2 (2.86-10.53); Wheeler? coal; 750X.	39
3.	Granulatisporites minutus Potonie & Kremp, Size 18 X 20 microns; Slide KB-3B-4 (2.92-10.78); Bevier coal; 1000X.	40
4.	Lophotriletes commissuralis (Kosanke), Size 29 X 30 microns; Slide KB-3B-4 (2.34-10.78); Bevier coal; 750X.	43
5.	Lophotriletes commissuralis (Kosanke), Size 23 X 26 microns; Slide KB-2C-1 (2.05-12.23); Bevier coal; 750X.	43
6.	Lophotriletes sp. A; Size 23.5 X 24.5 microns; Slide KB-1B-4 (4.80-12.16); Bevier coal; 1000X.	43
7.	Lophotriletes sp. B; Size 46 X 46.5 microns; Slide KB-10A-3 (4.80-10.49); "Bevier" coal; 750X.	44
8.	Anapiculatisporites spinosus (Kosanke), Size 25 X 26.5 microns; Slide KB-3A-1 (4.32-11.00); Bevier coal; 750X.	43
9.	Schopfites dimorphus Kosanke, Size 92 X 94 microns; Slide MW-9B-5 (3.11-11.03); Wheeler coal; 600X.	42
10.	Schopfites colchesterensis Kosanke, Size 62 X 65.5 microns; Slide MW-8B-2 (4.35-12.30); Wheeler coal; 600X.	41
11.	Apiculatisporis sp. A; Size 43 X 44 microns; Slide KB-2B-3 (3.88-12.12); Bevier coal; 750X	47
12.	Apiculatisporis latidentifex (Kosanke), Size 67 X 71 microns; Slide MW-8C-1 (3.21-11.19) Wheeler coal; 750X.	45
13.	Apiculatisporis latidentifex (Kosanke), Size 43 X 45 microns; Slide KB-3B-1 (3.26-12.04); Bevier coal; 750X.	46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EXPLANATION OF PLATE 4

TRIQUITRITES, FOVEOLATISPORITES, RAISTRICKIA

Figure — Page

1. Triquitrites deltiformis? (Wilson & Coe), Size 28 X 29 microns; Slide MW-9B-3 (4.08-12.26); Wheeler coal; 1050X 58

2. Triquitrites deltiformis? (Wilson & Coe), Size 29 X 31 microns; Slide KB-2A-1 (4.49-11.29); Bevier coal; 750X. 58

3. Triquitrites exiguus Wilson & Kosanke, Size 27.5 X 30 microns; Slide KB-3B-1 (3.22-12.19); Bevier coal; 1000 X. 59

4. Triquitrites bransonii Wilson & Hoffmeister, Size 37 X 39 microns; Slide MW-9B-5 (4.11-11.79); Wheeler coal; 750X. 56

5. Triquitrites additus Wilson & Hoffmeister, Size 51 X 51 microns; Slide KB-4B-1 (3.86-10.28); Bevier coal; 750X. 57

6. Triquitrites spinosus Kosanke, Size 50 X 52 microns; Slide MW-9C-3 (3.83-10.60); Wheeler coal; 750X. 57

7. Foveolatisporites foveatus (Kosanke), Size 71.5 X 76.5 microns; Slide MB-10A-2 (2.62-12.18); "Bevier" coal; 600X. 53

8. Foveolatisporites fenestratus (Kosanke), Size 63 X 65 microns; Slide MB-10C-6 (4.15-10.63); "Bevier" coal; 750X. 52

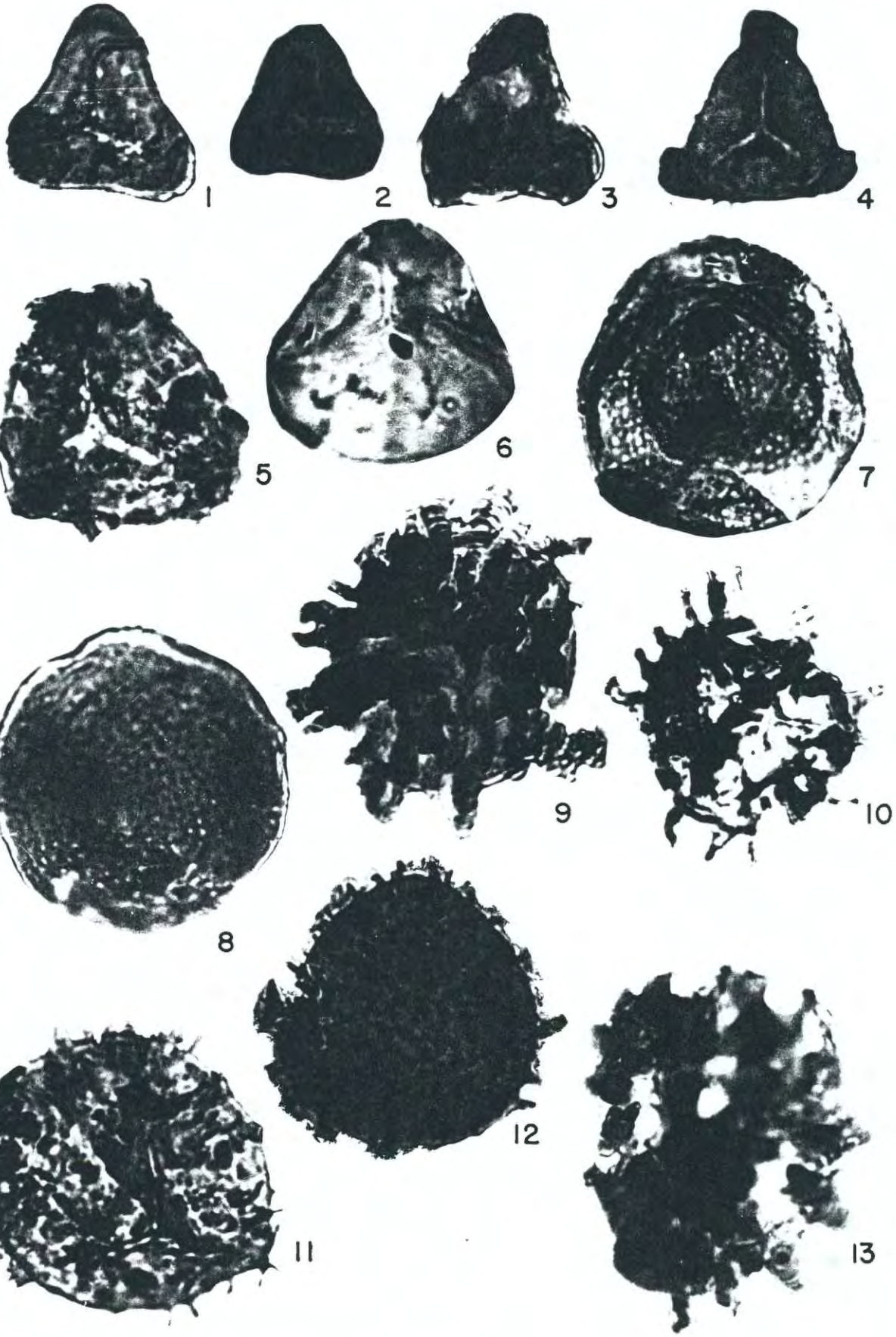
9. Raistrickia crocea Kosanke, Size 62 X 70 microns; Slide MW-9A-4 (2.95-11.69); Wheeler coal; 600X. . . . 51

10. Raistrickia protensa? Kosanke, Size 42 X 46 microns; Slide KB-2C-3 (4.10-12.25); Bevier coal; 750X . 51

11. Raistrickia solaria Wilson & Hoffmeister, Size 58 X 58 microns; Slide KB-3B-1 (3.75-11.23); Bevier coal; 750X. 50

12. Raistrickia crinita Kosanke, Size 65 X 68 microns; Slide MW-9B-1 (3.43-11.38); Wheeler coal; 650X. . . . 49

13. Raistrickia saetosa? (Loose), Size 52 X 69.5 microns; Slide MB-7C-1 (3.43-10.63); Bevier coal; 750X. 49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EXPLANATION OF PLATE 5

LYCOSPORA, CIRRATRIRADITES, VESTISPORA

Figure — Page

1. Lycospora punctata Kosanke, Size 30 X 30 microns; Slide MW-9B-3 (4.08-12.26); Wheeler coal; 1000X. . . 63

2. Lycospora parva Kosanke, Size 27 X 32 microns; Slide MB-7A-4 (3.99-11.84); Sevier coal; 750X. . . . 64

3. Lycospora parva Kosanke, Size 25 X 27 microns; Slide MB-2C-1 (2.62-11.87); Sevier coal; 750X. . . . 64

4. Lycospora sp. A; Size 34 X 41 microns; Slide MB-7C-4 (3.73-12.10); Sevier coal; 750X. 65

5. Lycospora granulata Kosanke, Size 31 X 35 microns; Slide MB-2A-7 (4.25-11.78); Sevier coal; 1000X . . . 65

6. Lycospora granulata tetrad; Cluster of four specimens grouped together. 65

7. Cirratriradites schaiegi Habib, n. sp.; Holotype; Size 69 X 79 microns; Slide MW-9C-4 (3.77-11.52); Wheeler coal; 750X. 62

8. Cirratriradites schaiegi Habib, n. sp.; Paratype; Size 74 X 82 microns; Slide MW-9C-7 (4.50-11.40); Wheeler coal; 750X. 62

9. Cirratriradites schaiegi Habib, n. sp.; Cotype; Size 74 X 76 microns; Slide MW-9C-3 (3.55-11.73); Wheeler coal; 750X 62

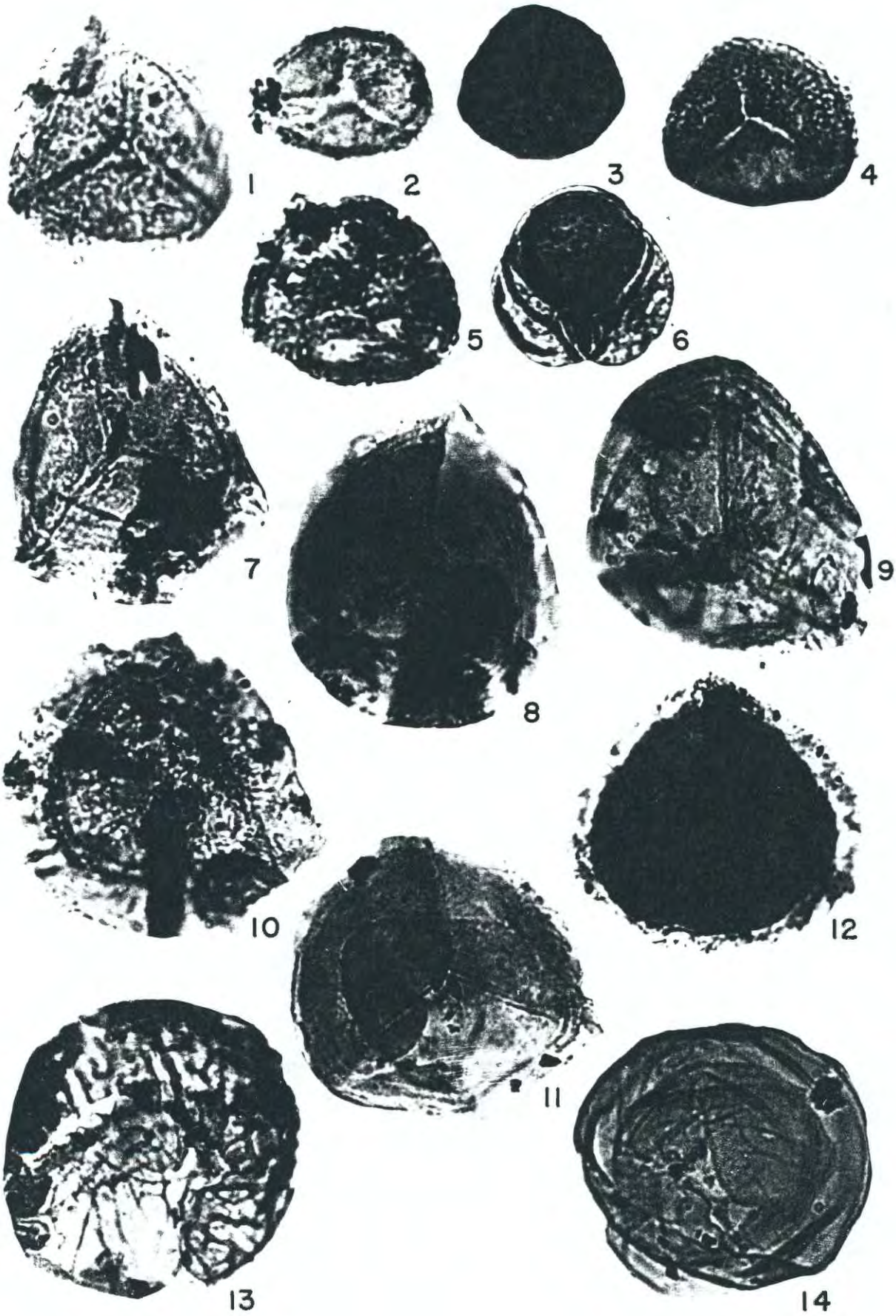
10. Cirratriradites flabelliformis Wilson & Kosanke, Size 73.5 X 81 microns; Slide MB-10A-1 (3.25-12.09); "Sevier" coal; 650X. 60

11. Cirratriradites annulatus Kosanke & Brokaw, Size 74 X 76 microns; Slide MB-4A-8 (3.81-10.36); Sevier coal; 650X. 61

12. Cirratriradites crassus Wilson & Hoffmeister, Size 76 X 77 microns; Slide MB-3B-2 (3.91-12.06); Sevier coal; 650X 60

13. Vestispora costata? (Balme), Size 81.5 x 85.5 microns; Slide MB-7C-3 (4.17-10.86); Sevier coal; 650X. 55

14. Vestispora profunda Wilson & Hoffmeister, Size 67 X 76.5 microns; Slide MB-7B-1 (3.24-12.14); Sevier coal; 750X. 54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EXPLANATION OF PLATE 6

LAEVIGATOSPORITES, PUNCTATOSPORITES, LATOSPORITES, VERRUCOSOSPORITES, FLORINITES, ENDOSPORITES, WILSONIA, VESICASPORA

Figure — Page

1. Laevigatosporites medius Kosanke, Size 29.5 X 44 microns; Slide KB-2A-1 (2.77-11.68); Bevier coal; 650X. 67

2. Laevigatosporites ovalis Kosanke, Size 38.5 X 52.5 microns; Slide MW-9C-2 (4.75-10.28); Wheeler coal; 650X. 66

3. Laevigatosporites desmoinensis (Wilson & Coe), Size 38.5 X 67.5 microns; Slide KB-2B-4 (3.57-11.61); Bevier coal; 650X. 68

4. Laevigatosporites minimus (Wilson & Coe), Size 15 X 23.5 microns; Slide KB-6B-2 (4.57-11.38); Bevier coal; 750X. 69

5. Laevigatosporites punctatus Kosanke, Size 36 X 42 microns; Slide MW-9B-3 (4.19-12.39); Wheeler coal; 1000X. 69

6. Punctatosporites minutus Ibrahim, Size 19 X 21 microns; Slide MW-9A-1 (3.67-12.39); Wheeler coal; 1000X 72

7. Latosporites globosus (Schemel), Size 26 X 27 microns; Slide MW-8B-2 (4.23-12.20); Wheeler coal; 750X. 71

8. Latosporites robustus (Kosanke), Size 76 X 123 microns; Slide KB-6A-1 (4.61-10.48); Bevier coal; 400X. 70

9. Verrucososporites pseudothiesseni (Kosanke), Size 28 X 33.5 microns; Slide MW-9B-1 (4.00-12.11); Wheeler coal; 1000X 73

10. Verrucososporites thiesseni (Kosanke), Size 20 X 21.5 microns; Slide KB-6A-4 (4.25-12.25); Bevier coal; 1000X. 74

11. Florinites antiquus Schopf, Size 56.2 X 70.4 microns; Slide KB-6B-3 (3.45-12.14); Bevier coal; 650X 75

12. Endosporites vesicatus? Kosanke, Size 140 X 150 microns; Slide MW-9B-2 (2.80-11.94); Wheeler coal; 400X. 77

13. Endosporites ornatus Wilson & Coe, Size 87 X 91 microns; Slide MB-7A-3 (3.56-10.36); Bevier coal; 500X. 76

Figure


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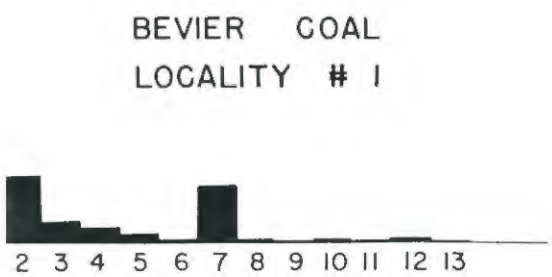
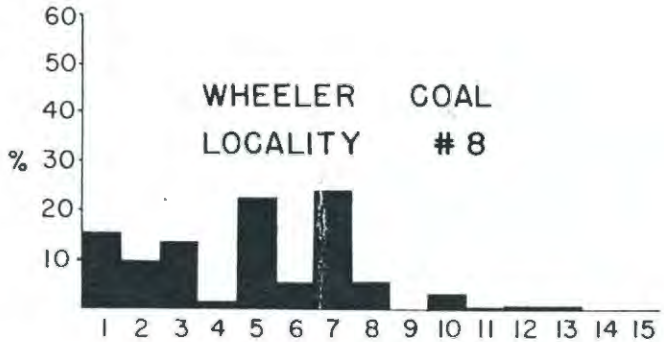
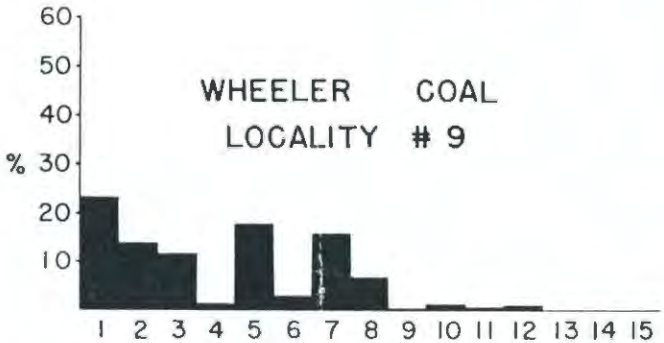
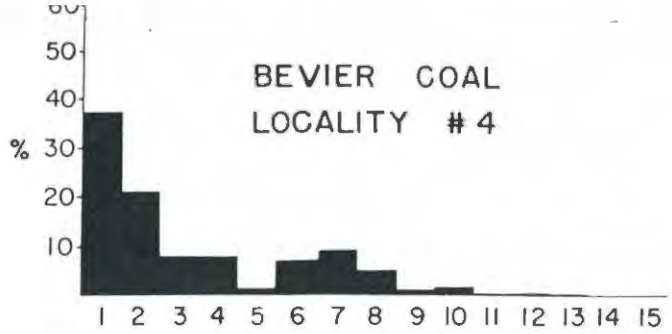
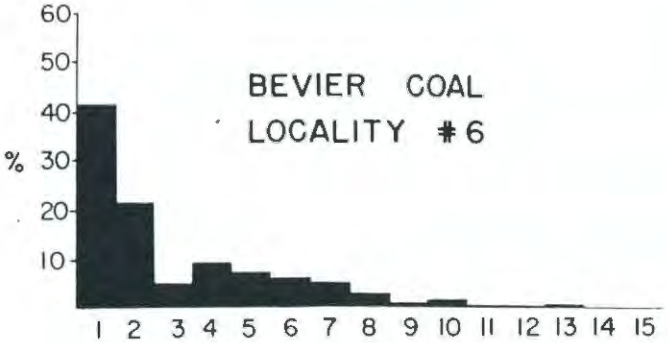
SPORE HISTOGRAMS OF THE BEVIER AND WHEELER COALS

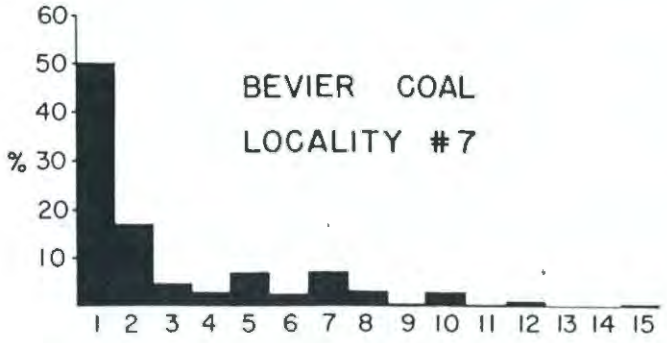


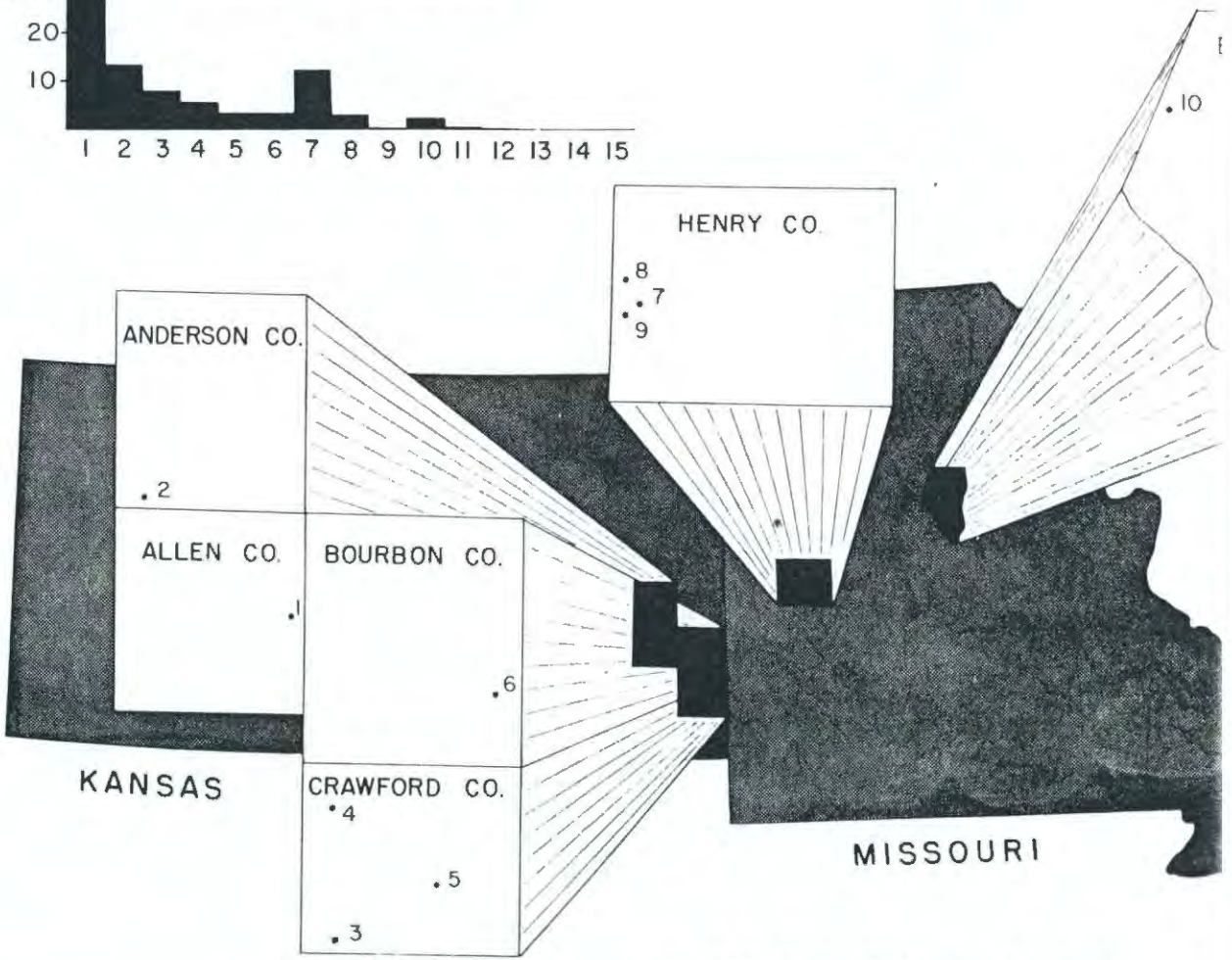












LOCATION MAP