Palynology of Selected Coal Beds in the Proposed Pennsylvanian System Stratotype in West Virginia

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By ROBERT M. KOSANKE

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A description of palynomorph assemblages, range zones, and coal correlations of selected coals from the proposed Pennsylvanian System stratotype of West Virginia and adjacent States

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PALYNOLOGY OF SELECTED COAL BEDS IN THE PROPOSED PENNSYLVANIAN SYSTEM STRATOTYPE IN WEST VIRGINIA

By ROBERT M. KOSANKE

ABSTRACT

The usefulness of Pennsylvanian palynomorphs, spores, and pollen grains, as an aid in coal-correlation investigations in the Appalachians, has been known for many years. However, much of this and subsequent information was scattered in the literature or was not from the proposed stratotype area of West Virginia. Investigation of coals from sections of the proposed Pennsylvanian System stratotype provided the opportunity to examine changes in palynomorph content through a number of coals from the New River Formation to the basal part of the Monongahela Formation.

The rank of most coals of the Pocahontas and New River Formations of West Virginia does not permit extraction of palynomorphs with current laboratory maceration techniques. Because of this, the data of some possibly equivalent lower rank Pennsylvanian coals from adjacent parts of southern Ohio and eastern Kentucky have been included. The coals examined from the Kanawha Formation, Charleston Sandstone, and Monongahela Formations of West Virginia have yielded abundant and well-preserved palynomorphs. Attention has been focused on the Charleston Sandstone, which is a massive, complex unit lacking marine fossils and composed primarily of sandstone. The coal is a significant resource in Pennsylvanian rocks, and the correlation of coals is an important consideration in the area of the stratotype in West Virginia and in adjacent States.

As a result of this preliminary examination, the approximate range zones of some important taxa have been established. These range zones together with abundance data are used to correlate the coals. The range zones of some important taxa from Lower to Upper Pennsylvanian coals are: *Densosporites irregularis* Hacquebard and Barss, *Stenozonotriletes lycosporoides* (Butterworth and Williams) Smith and Butterworth, *Schulzospora rara* Kosanke, *Laevigatosporites* spp., *Radiizonates* spp., *Torispora securis* Balme, *Zosterosporites triangularis* Kosanke, *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala, *Schopfites dimorphus* Kosanke, and *Thymospora thiessenii* (Kosanke) Wilson and Venkatachala. Some of the range zones are relatively short and extremely useful for correlation studies. For example, in the Charleston Sandstone, *T. pseudothiessenii* (Kosanke) Wilson and Venkatachala is present in the Upper No. 5 Block coal (upper bench) and the No. 6 Block coal, whereas *Schopfites dimorphus* Kosanke is restricted to the No. 6 Block coal. *Thymospora thiessenii* (Kosanke) Wilson and Venkatachala is not restricted to the Pittsburgh No. 8 coal, but it is the only coal known in which this taxon is so dominant (more than 70 percent of the palynomorph assemblage).

This preliminary report has provided a framework for the correlation of a selected number of coals occurring in Ohio and eastern Kentucky with those of the proposed Pennsylvanian System stratotype of West Virginia. In other studies, additional samples from the stratotype would be examined for ultimate correlation with rocks of Pennsylvania and in adjacent States and elsewhere.

INTRODUCTION

The need for a stratotype section of Pennsylvanian rocks has been indicated by boundary and correlation problems. Theoretically, an ideal stratotype section would contain a complete depositional sequence of rocks from oldest to youngest. This requirement was met in West Virginia despite the fact that the alternation of marine and nonmarine deposition does not extend throughout the stratotype section. The presence of widespread coals in the stratotype section suggested that palynomorphs have an important role to play in defining the stratotype. Many of the coals in West Virginia are exposed in the rocks of the proposed Pennsylvanian System stratotype (fig. 1). Pennsylvanian rocks of the proposed stratotype section start with the Lower Pennsylvanian Series near Bluefield, W. Va., at the position of the Bramwell Member of the Bluestone Formation, and continue north-northwest through the Middle and Upper Pennsylvanian Series into the Dunkard Basin of northwestern West Virginia, southeastern Ohio, and southwestern Pennsylvania.

Although coal is abundant in West Virginia, not all of the coal is amenable to maceration because it is of high rank. Palynomorphs are altered by coalification from translucent to opaque entities in high-rank coal, so they have little value for palynological studies. Palynomorphs in coals in the Pocahontas Formation and the lower half of the New River Formation generally appear to be in this category.

Figure 2 illustrates some of the Lower Pennsylvanian strata from the stratotype examined for palynomorphs. Lower Pennsylvanian strata that may be in part equivalent to the lower part of the stratotype section occur in adjacent southeastern Ohio and eastern Kentucky. Coal

in these two areas is of lower rank and is readily amenable to maceration, so that excellent assemblages of palynomorphs were recovered. I decided to include some of these data to correlate with the stratotype section. These data are discussed subsequently under palynomorph assemblages from Ohio and Kentucky.

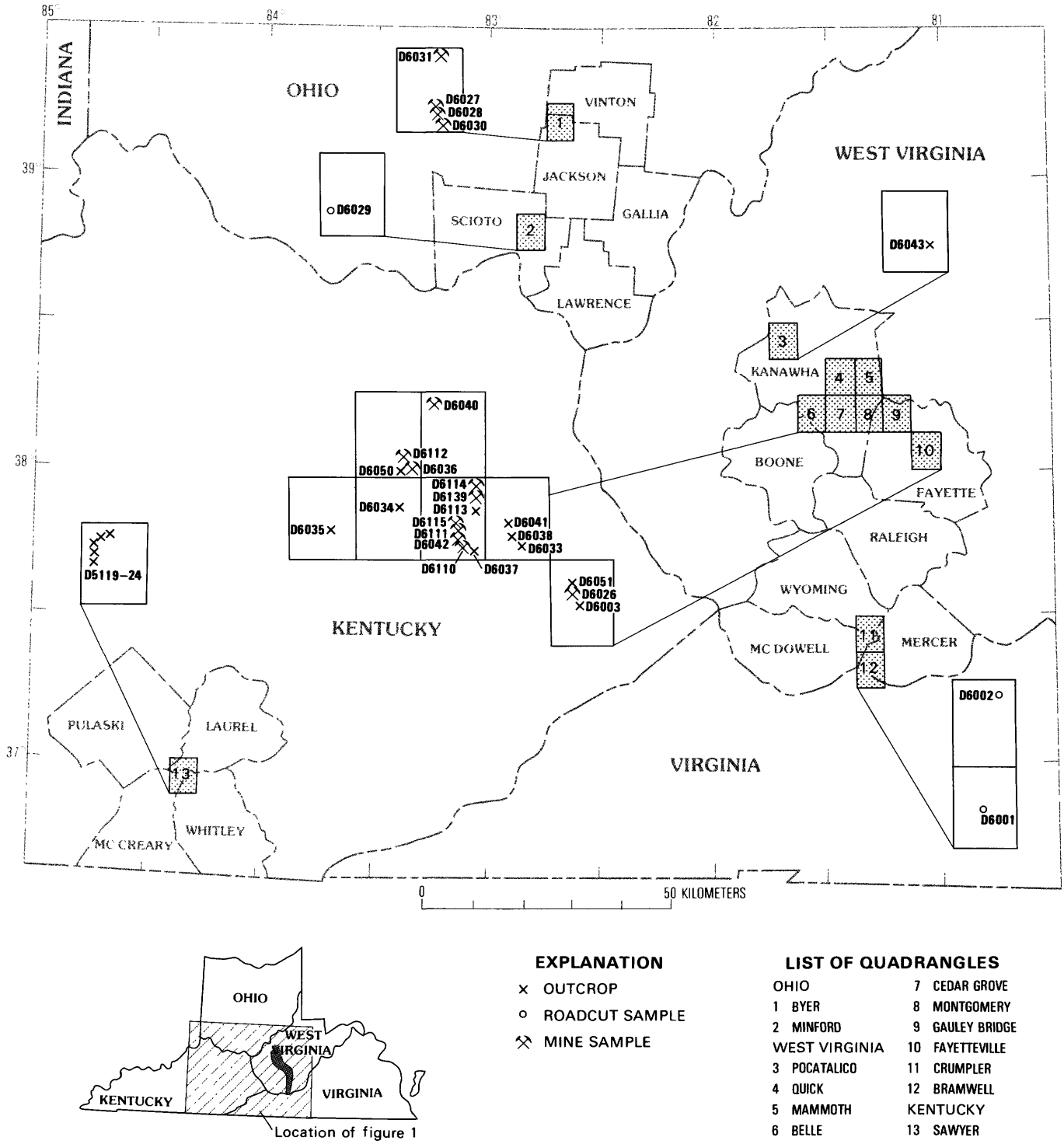

FIGURE 1.—Outcrop and mine samples used in this investigation, located in quadrangles in West Virginia, southern Ohio, and southeastern Kentucky. USGS Paleobotanical locality D numbers appear adjacent to sample symbols. Shaded area in index map indicates approximate area of the proposed Pennsylvanian System stratotype.

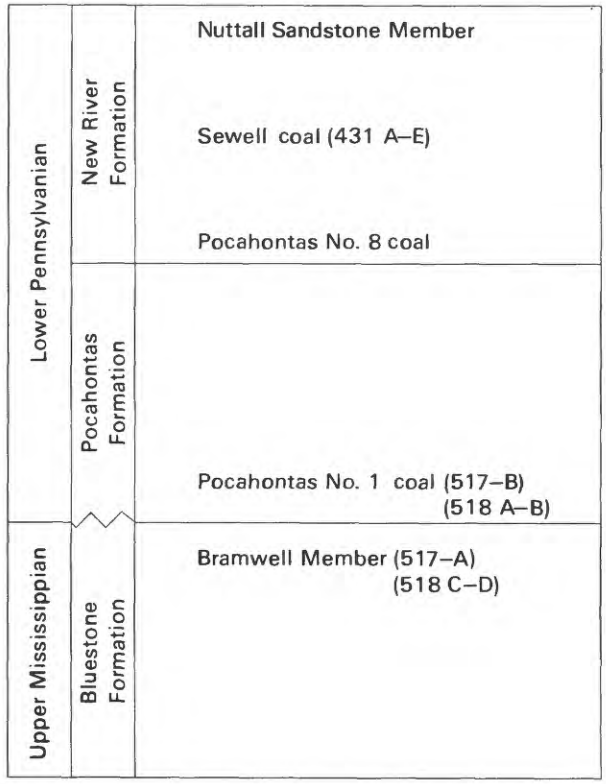

FIGURE 2.—Upper Mississippian and Lower Pennsylvanian stratigraphic units from the stratotype in West Virginia that were collected and examined for palynomorphs. Maceration numbers are shown in parentheses, and irregular contact line between the Pocahontas and Bluestone Formations depicts intertonguing of these formations.

The coal and other samples selected for examination and study from the proposed Pennsylvanian System stratotype in West Virginia are indicated on figures 1, 2, and 3. These samples are from the Bramwell Member of the Bluestone Formation, and the Pocahontas, New River, Kanawha, Charleston, and Monongahela Formations. Tables 1 through 22 and figure 4 summarize the results of palynological investigations conducted thus far on selected coals and samples from the Pennsylvanian System stratotype section.

PREVIOUS WORK

A number of people have contributed to our knowledge of the occurrence of Pennsylvanian age palynomorphs, spores, and pollen grains from West Virginia, including Thiessen and others (1923, 1924, 1941, 1947), Cross (1947), Cross and Schemel (1952), and Clendening (1962, 1965, 1967. 1968, 1969, 1970, 1972, 1974). In addition, theses at both the masters and doctorate level from the University of West Virginia have investigated the palynomorph content of various coals of West Virginia.

Thiessen and his associates conducted fundamental studies of Appalachian and other coals, with much of their effort directed toward quantitative coal petrology. The coal thin-section method of study was employed by Thiessen, and according to Schopf and Oftedahl (1976), the Thiessen coal thin-section slide collection consists of more than 19,000 slides from 682 different localities in the United States and elsewhere, with nearly one-third of these localities occurring within the Appalachian Basin. Observations reported by Thiessen on the occurrence and distribution of spores found in coal thin sections during his petrology studies were the first recognition in the United States of the potential value of these fossils for coal-correlation investigations. Some of the observations by Thiessen were cited by Kosanke (1943).

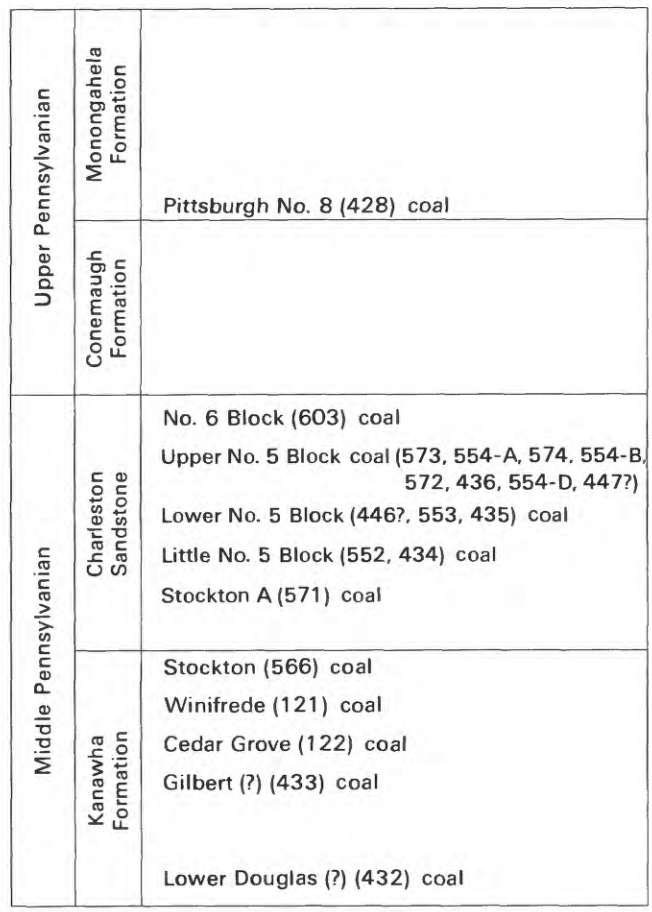

FIGURE 3.—Middle and Upper Pennsylvanian stratigraphic units that were collected and examined for palynomorphs. All are from stratotype except the Winifrede and Cedar Grove coals, which are from their respective type localities in West Virginia. Maceration numbers are shown in parentheses.

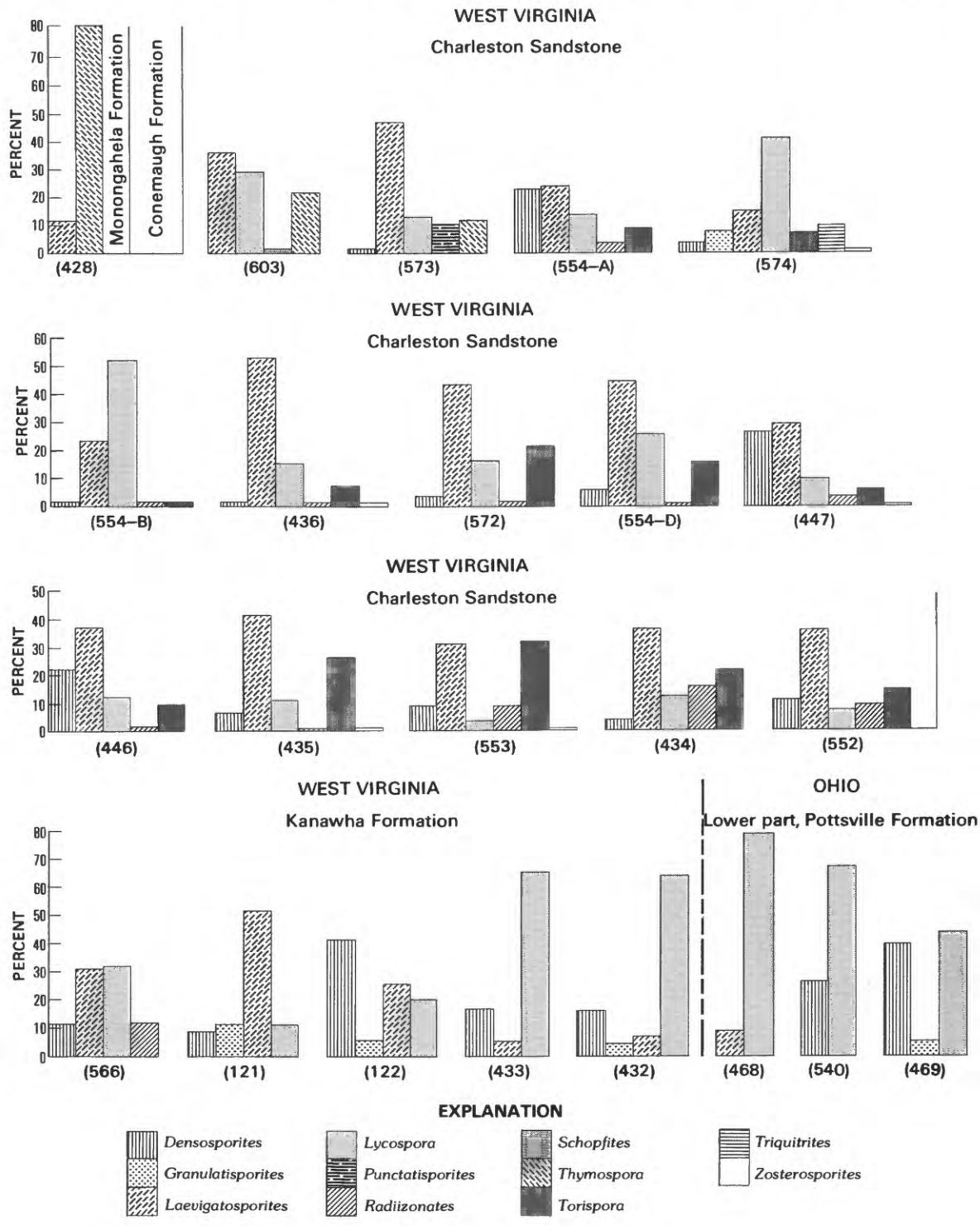

FIGURE 4.—Abundance of dominant and accessory genera occurring in Lower Pennsylvanian coals of Ohio and Middle and Upper Pennsylvanian coals from West Virginia and the proposed Pennsylvanian System stratotype. Coal beds are identified by maceration numbers as follows:

428—Pittsburgh No. 8
603—No. 6 Block
573—Upper No. 5 Block
554-A—Upper No. 5 Block
574—Upper No. 5 Block
446—Lower(?) No. 5 Block
435—Lower No. 5 Block
553—Lower No. 5 Block
434—Little No. 5 Block
552—Little No. 5 Block
554-B—Upper No. 5 Block
436—Upper No. 5 Block
572—Upper No. 5 Block
554-D—Upper No. 5 Block
447—Upper(?) No. 5 Block
566—Stockton
121—Winifrede
122—Cedar Grove
433—Gilbert(?)
432—Lower Douglas(?)
468—Quakertown No. 2
540—Anthony
469—Sharon No. 1

Cross (1947) and later Cross and Schemel (1952) began a reconnaissance of coals of West Virginia. Schemel (1957) completed a Ph. D. dissertation on West Virginia coal. Clendening published a series of papers that were largely concerned with palynomorphs from strata of the Dunkard Group, and the dates of these publications have been cited.

ACKNOWLEDGMENTS

A number of people assisted in the collection of samples used in this investigation, for which I am most grateful. K. J. Englund, H. H. Arndt, and T. W. Henry helped with the collection of samples from the proposed Pennsylvanian System stratotype in West Virginia. D. C. Alvord provided samples of the Cedar Grove and Winifrede coals from their respective type localities in West Virginia. H. R. Collins and C. L. Rice provided samples from Ohio, and the late Don E. Wolcott assisted in the collection of samples from Kentucky. Mark A. Mercer and John R. Scholten assisted with the preparation of samples, and Scholten prepared many of the original illustrations. This help is gratefully acknowledged. Appreciation is extended to G. K. Guennel of Marathon Oil company, who reviewed the manuscript.

SAMPLE METHODS, PREPARATION, AND LOCALITIES

The aim of the sampling method was to obtain a representative sample whenever possible for the coal units and other lithologies. For example, ribbon samples were cut from diamond-drill cores with a carborundum saw, and column samples were taken from mine and outcrop exposures of coal. The usual maximum vertical thickness of samples was set at 30.48 cm. Roof rock, partings, and seat rock were sampled separately. For a discussion of this type of sampling, see Kosanke (1977) and Schopf (1960).

The coal samples were prepared according to procedures described by Kosanke (1950, 1973), the only modification being the use of HNO_3 (90 percent concentration) for high-rank coal in place of HNO_3 (70 percent concentration). Precise preparation methods used for each maceration are recorded in maceration books of the Denver Palynological Laboratories, U.S. Geological Survey.

One hundred thirty-four samples of roof rock, coal, partings, seat rock, and shale samples were collected. One hundred three samples were from the proposed Pennsylvanian System stratotype section in West Virginia, 14 samples were from southern Ohio, and 17 samples were from eastern Kentucky.

All samples were assigned laboratory maceration numbers and all productive samples were also assigned USGS paleobotanical locality numbers (D numbers). The stratigraphic nomenclature used in this paper follows that of Englund and others (1979).

The following samples from West Virginia, Ohio, and Kentucky were studied in this investigation:

Bramwell Member, Bluestone Formation, shale from along State Route 102 at Bluestone, W. Va., maceration 517-A.

Pocahontas Formation, shale along State Route 102 at Bluestone, W. Va., D6001, maceration 517-B.

Pocahontas Formation, shale along State Route 10 near Garwood, W. Va., D6002 (518-B), macerations 518-A-B.

Upper member or tongue of Bluestone Formation, shale along State Route 10 near Garwood, W. Va., macerations 518-C-D.

Sewell coal, New River Formation, roof shale, coal, and seat rock from Royal Coal Company No. 5 mine, 2.3 km northeast of Fayetteville, W. Va., along the west side of new River Gorge, north of Marr Branch in Fayetteville quadrangle, D6026, macerations 431-A-E.

Sewell coal, near New River Bridge along State Route 82 at junction with Royal Coal Company No. 5 mine road, Fayette County, W. Va., macerations 543-A-D. Maceration 543-D was productive and assigned to D6051.

Lower Douglas (?) coal, Kanawha Formation, roof shale and coal along U.S. Route 19, 0.6 km northwest of Lansing, W. Va., D6032, macerations 432-A-C.

Gilbert(?) coal, Kanawha Formation, coal and seat rock along Cane Branch Road 0.3 km south of Cane Branch, Gauley Bridge quadrangle, Fayette County, W. Va., D6033, macerations 433-A-C.

Cedar Grove coal, Kanawha Formation, coal and seat rock from type locality 609.6 m northwest of highway on Kellys Creek, Cedar Grove, W. Va., D6034, macerations 122-A-C.

Winifrede coal, Kanawha Formation, coal and parting from type locality 3698.7 m north of south line and 4541.5 m from east line, Belle quadrangle, West Virginia, D6035, macerations 121-A-E.

Stockton coal, Kanawha Formation, coal and parting from Valley Camp Coal Company about 548.6 m north of Mammoth, Kanawha County, W. Va. This locality is near the 12-A mine, D6036, macerations 566-A-G.

Stockton A coal, Kanawha Formation, coal and shale from about 548.6 m northwest of Mammoth, Kanawha County, W. Va., D6050, macerations 571-A-C.

Little No. 5 Block coal, Charleston Sandstone, roof shale, coal, and seat-rock samples located on divide between Lake Branch and Twomile Creek about 9 km east of Carbondale, Fayette County, W. Va., D6038, macerations 552-A-G.

Little No. 5 Block coal, Charleston Sandstone, coal and parting from 2.4 km north-northeast of Boomer, Fayette County, W. Va., D6037, macerations 434-A-G.

Lower No. 5 Block coal, Charleston Sandstone, roof shale, coal, and seat rock from 18.2 m above Little No. 5 Block coal in the highwall of the Harewood No. 5 Block strip mine, north of first hollow up Blake Branch, 1126.5 m east of Carbondale and 3.8 km north of Boomer, Fayette County, W. Va., D6110, macerations 553-A-E.

Lower No. 5 Block coal, Charleston Sandstone, coal and seat rock from Semet-Solvay strip mine near crest of mountain north of Blake Branch and south of Twomile Creek, 2.4 km east of Smithers, Fayette County, W. Va., D6111, macerations 435-A-E.

Lower(?) No. 5 Block coal, Charleston Sandstone, roof shale, coal, and partings from Cannelton strip mine, 2.4 km north of Marting, Fayette County, W. Va., D6039, macerations 446-A-K.

Upper(?) No. 5 Block coal, Charleston Sandstone, coal and parting from Union Carbide 7C mine approximately 0.9 km northeast of Sanderson, Kanawha County, W. Va., D6040, macerations 447-A-E.

Upper No. 5 Block coal above Lower No. 5 Block coal, Charleston Sandstone, coal located on divide between Lake Branch and Twomile Creek about 9 km east of Carbondale, Fayette County, W. Va., D6041, macerations 554-A-D.

Upper No. 5 Block coal, Charleston Sandstone, units 94-96, T. W. Henry's Mammoth West section (H-2), first hollow up west side of Left Fork of Kellys Creek, west and above Valley Camp Coal Company No. 12-A mine, 643.7 m northwest of Mammoth, Kanawha County, W. Va., D6112, macerations 572-A-F.

Upper No. 5 Block coal, Charleston Sandstone, roof rock, coal, and seat rock from about 0.01 km southwest of maceration series 435 and 20 m above the series 435 samples, Fayette County, W. Va., D6042, macerations 436-A-C.

Upper No. 5 Block coal (lower bench), coal located by pipeline 305.6 m northwest of head of Lynch Fork of Smithers Creek, 2.4 km northwest of Marting, and 563.2 m east of Kanawha-Fayette County line, Fayette County, W. Va., D6113, macerations 574-A-C.

Upper No. 5 Block coal (upper bench), coal from highwall of Cannelton Coal Company No. 5 Block strip mine, 482.8 m west and near the head of Jim Hollow, 2.7 km northwest of Marting, and 563.2 m east of the Kanawha-Fayette County line, Fayette County, W. Va., D6114, macerations 573-A-D.

No. 6 Block coal, Charleston Sandstone, one block of coal from highwall of Cannelton Coal Company strip mine, about 27.4 m above No. 5 Block coal (15.2 m above Cannelton No. 6 Block), 4.4 km northwest of Cannelton, and 482.8 m east of Kanawha-Fayette County line, West Virginia, D6115, maceration 603.

Pittsburgh No. 8 coal, Monongahela Formation, coal from 1.6 km south of Tupper Creek Road along Interstate 77, Pocatalico quadrangle, West Virginia, D6043, macerations 428-A-C.

The following samples from southern Ohio and eastern Kentucky have been examined:

Sharon No. 1 coal, Pottsville Formation, roof shale, coal, and seat rock from strip pit, 0.4 km northwest of Leo, Byer quadrangle, Jackson County, Ohio, D6027, macerations 469-A-F.

Sharon No. 1 coal, Pottsville Formation, coal sample from Cardinal Coal Company mine, west center sec. 23, Byer quadrangle, Jackson County, Ohio, D6028, maceration 542.

Anthony coal, Pottsville Formation, coal from Baltimore and Ohio railroad cut at Gepharts Station, NW sec. 31, Bloom Township, Minford quadrangle, Scioto County, Ohio, D6029, maceration 540.

Quakertown No. 2 coal, Pottsville Formation, roof shale, coal, and seat rock from strip pit 2.4 km southeast of Leo, Byer quadrangle, Jackson County, Ohio, D6030, macerations 468-A-D.

Quakertown No. 2 coal, Pottsville Formation, coal from Stewart Coal Company mine, sec. 23, Harrison Township, Byer quadrangle, Vinton County, Ohio, D6031, macerations 541-A-B.

Unnamed coal, Lee Formation, weathered coal blossom located 6 m above Pennington Formation, 1783 m FWL × 4724 m FNL, Sawyer quadrangle, Kentucky, D5119, maceration 134.

Hudson coal, Lee Formation, roof shale, coal, and seat rock located 30.4 m above Pennington Formation, 1828.8 m FWL × 4693.9 m FNL, Sawyer quadrangle, Kentucky, D5120, macerations 129-A-D.

Unnamed coal, Lee Formation, coal located 36.5 m above Pennington Formation, 1828.8 m FWL × 4617 m FNL, Sawyer quadrangle, Kentucky, D5121, maceration 130.

Stearns 1½ coal, Lee Formation, roof rock and coal located 44.2 m above Pennington Formation, 1859.2 m FWL × 4572 m FNL, Sawyer quadrangle, Kentucky, D5122, macerations 131-A-C.

Beaver Creek coal, Lee Formation, coal and seat rock located 60.9 m above Pennington Formation and below the Rockcastle Conglomerate Member of the Lee, 1981.2 m FWL × 4511 m FNL, Sawyer quadrangle, Kentucky, D5123, macerations 132-A-B.

Barren Fork coal, Lee Formation, coal and seat rock located 94.5 m above Pennington Formation and above the Rockcastle Conglomerate Member of the Lee, 2499.3 m FWL × 4541.5 m FNL, Sawyer quadrangle, Kentucky, D5124, macerations 133-A-F.

PALYNOMORPH ASSEMBLAGES FROM THE PROPOSED PENNSYLVANIAN STRATOTYPE SECTION OF WEST VIRGINIA

UPPER MISSISSIPPIAN AND LOWER PENNSYLVANIAN SERIES

BLUESTONE AND POCAHONTAS FORMATIONS

Figure 5, modified from Englund and others (1977), illustrates a section along State Route 102 at Bluestone, W. Va., from which two samples were collected and assigned to the maceration series 517. Maceration 517-A is from the Bramwell Member as shown on figure 5, whereas maceration 517-B is from the lower part of the Pocahontas Formation. Maceration 517-A did not yield palynomorphs, perhaps because the Bramwell Member is largely of marine origin. *Neuropteris pocahontas* White, however, occurs in the upper part of the Bramwell Member at this locality. Maceration 517-B was productive, and although the color of the palynomorphs indicates considerable thermal alteration, even so, a few were identified from a single slide as follows:

Ahrensisporites sp.
Densosporites irregularis Hacquebard and Barss (five specimens)
D. sp.
Dictyotriletes (?) sp.
Granulatisporites sp.
Lycospora spp. (seven specimens)

Four additional samples of the Bluestone and Pocahontas Formations were collected along State Route 10 near Garwood, W. Va., as shown on figure 6. These samples were assigned to the 518 maceration series as 518-A-D. Samples 518-C-D from the upper tongue of the Bluestone Formation were barren of palynomorphs. Samples 518-A-B are from the Pocahontas Formation; 518-A was barren of palynomorphs, but 518-B contained poorly preserved specimens of *Densosporites* and *Lycospora.*

NEW RIVER FORMATION

The Sewell coal occurs approximately in the middle of the New River Formation (fig. 2). This coal averages about 0.9 m in thickness and is primarily a low-volatile coal; a few analyses have reported as much as 34 percent volatile matter, placing such samples in the high-volatile range and presumably making them more amenable to maceration. Two sets of samples of the Sewell coal were collected.

The first set of samples was collected from the Royal Coal Company No. 5 mine, 2.5 km northeast of Fayetteville, W. Va., along the west side of the New River gorge, north of Marr Branch, Fayette County, Fayetteville quadrangle. These samples (macerations 431-A-E) did not respond to normal maceration procedures even though they were weathered. However, the use of HNO_3 (90 percent concentration) produced results, which are shown in table 1. Although palynomorphs were reasonably abundant, no statistical counts were made because of the uncertainty of species identification in a number of instances. The palynomorphs recovered from these samples of the Sewell coal (431-A-E) are translucent despite a brownish hue. Sixteen genera have been identified from these samples, and in addition, two specimens observed in maceration series 431-C were questionably assigned to *Laevigatosporites. Lycospora* appears to be dominant in all of the samples of maceration 431-A-E, followed by *Densosporites.*

The other set of samples of the Sewell coal (macerations 543-A-D) was collected near the New River Bridge along State Route 82, at the junction with the Royal Coal Company No. 5 mine road. The Sewell coal is 0.9 m thick and somewhat weathered at this locality. Even though 90 percent HNO_3 was used on these samples, they did not yield palynomorphs. This suggests that either the samples were not as deeply weathered as those of series 431 (weathering of coals often assists the maceration process) or they were of higher rank. The seat-rock sample (maceration 543-D) does contain abundant and reasonably well preserved spores and pollen grains, and despite a brownish color they are translucent. This assemblage is limited in diversity; only the following taxa were identified:

Calamospora sp.
Cirratriradites sp.

Crassispora kosankei (Potonié and Kremp) Bharadwaj
Granulatisporites sp.
Lophotriletes sp.
Lycospora granulata Kosanke
Lycospora pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke[1]
L. spp.
Punctatisporites sp.

Wanless (1939) correlated the Sewell coal of West Virginia with the Sharon No. 1 coal of Ohio. Although the assemblage of palynomorphs recovered from the Sewell coal is limited, nothing so far identified from the Sewell coal is in conflict with the assemblage of palynomorphs recovered from the Sharon No. 1 coal of Ohio. Wanless (1939) correlated the Sewell and Sharon No. 1 coal with the Barren Fork coal of eastern Kentucky. The Barren Fork coal, which occurs above the Rockcastle Conglomerate Member, is definitely younger than the Sewell and Sharon coals; and this will be discussed subsequently under palynomorph assemblages from Ohio and eastern Kentucky.

[1]*Lycospora pellucida* (Wicher) Schopf, Wilson, and Bentall and *L. pseudoannulata* Kosanke, for purposes of this report, are regarded as a single entity. Unquestionably, the holotype specimens of these two species are distinct taxa. It is also certain that consistency in identification is made difficult by preservational factors and by different preparation treatments required to free palynomorphs from high-rank coals. Because of this and the fact that separation of these two taxa does not play an important part in this investigation, the two are recorded as one entity.

MIDDLE PENNSYLVANIAN SERIES

KANAWHA FORMATION

A number of coals from the Kanawha Formation—the Lower Douglas(?), the Gilbert(?), the Cedar Grove, the Winifrede, and the Stockton—were examined. Their position within the Kanawha Formation is shown on figure 3.

The Lower Douglas(?) coal was collected near the base of the Kanawha Formation (macerations 432-A-C). The collecting site is east of the New River Bridge just northwest of Lansing, Fayette County, W. Va. Metamorphism has greatly altered the appearance of many

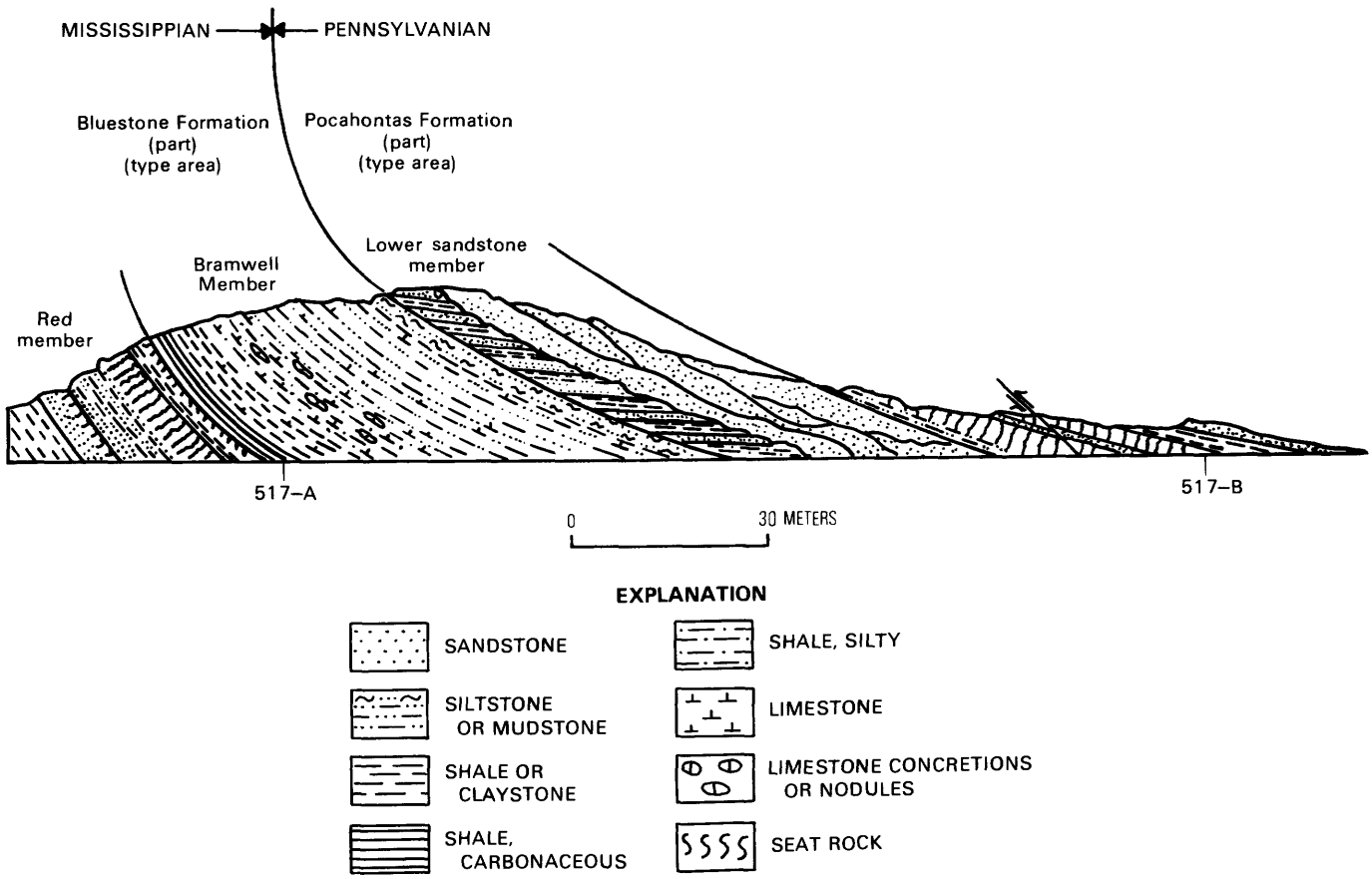

FIGURE 5.—Stratigraphic section along State Route 102 at Bluefield, W. Va. (modified from Englund and others, 1977). Maceration numbers 517-A-B mark position of samples taken. Fault shown with arrows to indicate direction of movement.

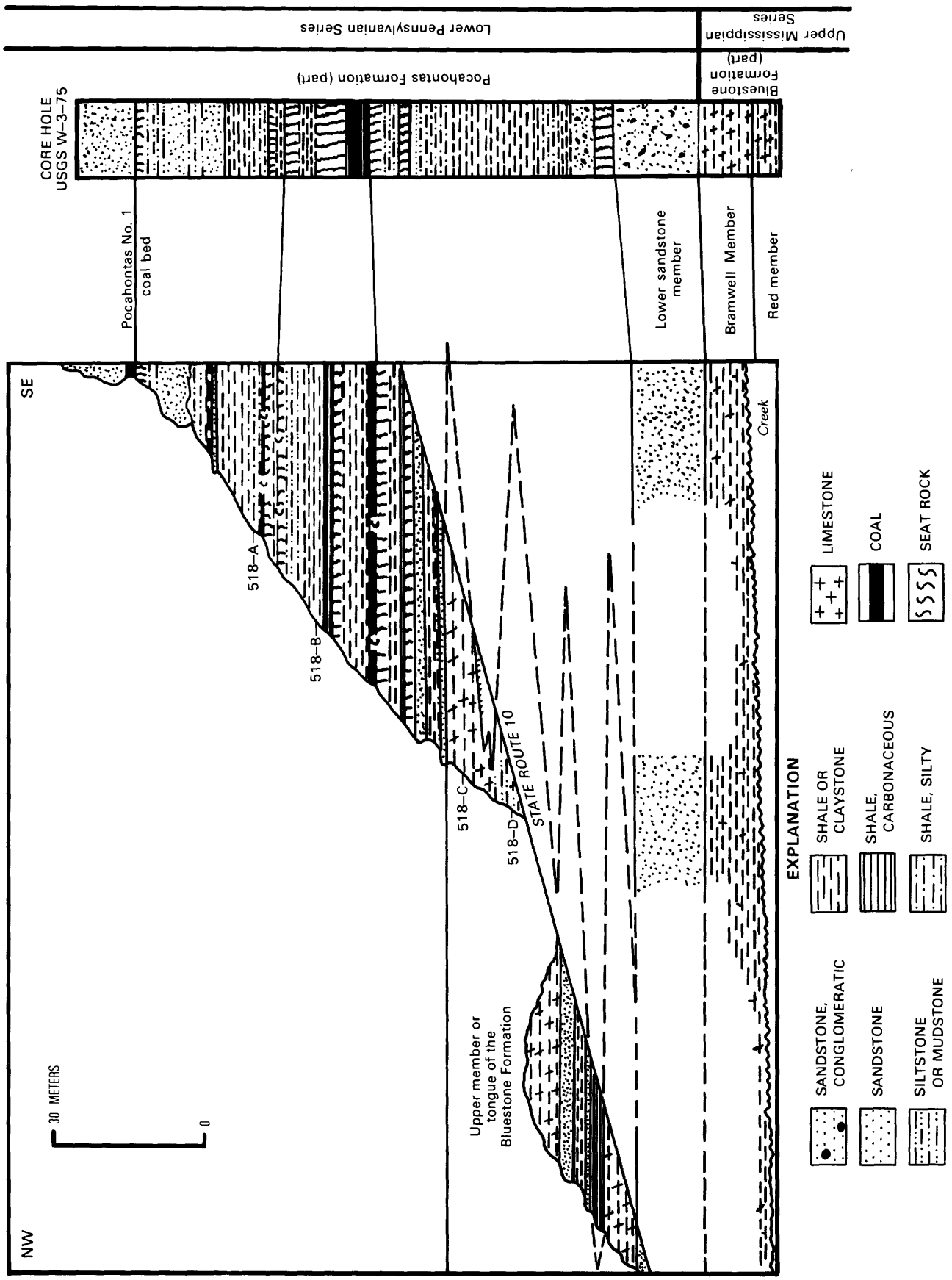

FIGURE 6.—Stratigraphic section along State Route 10 near Garwood, W. Va. (modified from Englund and others, 1977). Maceration numbers mark position of samples taken. Dashed lines show intertonguing relations or inferred contacts where covered.

palynomorphs resulting in the color intensification of individual ornamentation elements. The dark-brown color of the elements is especially well shown, for example, in the muri of *Dictyotriletes* or the grana of *Crassispora*. Two-thirds of the assemblage of macerations 432-B-C is assignable to *Lycospora*, as shown in table 2. *Densosporites annulatus* (Loose) Schopf, Wilson, and Bentall is abundant and restricted to the top of the coal. The dominant genera of the Lower Douglas(?) coal (macerations 432-B-C) are as follows:

Densosporites	15.5 percent
Granulatisporites	3.9
Laevigatosporites	6.3
Lycospora	66.6
	90.3 percent

Accessory taxa include *Dictyotriletes castaneaeformis* (Horst) Sullivan and *Stenozonotriletes bracteolus* (Butterworth and Williams) Smith and Butterworth.

The Gilbert(?) coal, macerations 433-A-C, was collected 49 m above the base of the Kanawha Formation along Cane Branch road south of Cane Branch, Fayette County, W. Va. The coal is 44.4 cm thick (see table 3). The color of the palynomorphs in the Gilbert coal is much more normal than in the Lower Douglas(?) coal, but the assemblage is small and fewer specimens were recovered from the coal samples. The seat-rock sample (433-C) is almost barren. The following genera are most abundant in the Gilbert(?) coal (433-A-B):

Densosporites	10.0 percent
Laevigatosporites	4.8
Lycospora	65.6
	86.4 percent

Accessory taxa include *Procoronaspora* sp., *Stenozonotriletes bracteolus* (Butterworth and Williams) Smith and Butterworth, and *Schulzospora rara* Kosanke. The presence of *Schulzospora rara* is considered significant because this taxon is consistently present in Upper Mississippian and Lower Pennsylvanian coals although not abundant in the upper part of its range zone. In eastern Kentucky this taxon is present to near the Corbin Sandstone Member of the Lee Formation; in Europe it is reported present to the Westphalian A-B boundary

TABLE 1.—*Palynomorphs from the Sewell coal bed in West Virginia*

[Maceration series 431; USGS Paleobotanical loc. No. D6026: × indicates presence of taxon]

Taxon	431-A	431-B	431-C	431-D	431-E
Calamospora sp	×	×	--	×	--
Cirratriradites sp	--	--	--	×	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	×	--	--	--	×
Cristatisporites sp	--	×	--	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	--	--	×	--
D. sinuosus Kosanke	×	×	×	×	×
D. spp	--	×	×	--	--
Granulatisporites pallidus Kosanke	--	×	×	--	--
G. tuberculatus Hoffmeister, Staplin, and Malloy	--	--	×	--	--
G. cf. *G. verrucosus* (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	×	--	×
? *Laevigatosporites* sp	--	--	×	--	--
Leiotriletes sp	--	--	×	--	--
Lophotriletes sp	--	--	--	--	×
Lycospora granulata Kosanke sp	×	--	×	×	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	×	×	--	--
L. spp	×	×	×	×	×
Punctatisporites sp	--	--	--	×	--
Raistrickia sp	--	--	--	×	--
Reinschospora speciosa (Loose) Schopf, Wilson, and Bentall	×	×	×	--	--
Reticulatisporites sp	--	×	--	--	--
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	--	--	×	×	--
Schulzospora rara Kosanke	--	×	?	--	--
Spencerisporites sp	--	×	--	--	--
Monosaccate	×	×	--	--	--

DESCRIPTION OF MATERIAL IN MACERATIONS

431-A, 8.9 cm roof shale.
431-B, 35.5 cm coal (weathered).
431-C, 35.5 cm coal (weathered).
431-D, 35.5 cm coal (weathered).
431-E, 8.9 cm seat rock.

by Smith and Butterworth (1967), and by Clayton and others (1977). Gillespie and Pfefferkorn (1979), based on their studies of plant megafossils, placed the Westphalian A–B boundary just above the Sewell coal bed in the New River Formation, somewhat below the Gilbert coal. *Procoronaspora* sp. and *Stenozonotriletes bracteolus* are not abundant, and only a few specimens have been identified. The top of their stratigraphic range in Europe is reported by Smith and Butterworth (1967) to be in the upper half of the Namurian; definite information about its range in the United States is lacking. Additional samples from this part of the proposed Pennsylvanian System stratotype should be investigated in order to provide a better understanding of these taxa.

The Cedar Grove coal from the type locality in the Cedar Grove quadrangle is not a part of the proposed Pennsylvanian System stratotype. The Cedar Grove coal occurs about in the middle of the Kanawha Formation (fig. 3, samples of macerations 122-A–D). Three coal samples were collected (table 4). *Densosporites* is the dominant taxon in the coal samples (122-A–C) as

TABLE 2.—*Palynomorphs from the Lower Douglas(?) coal bed in West Virginia*

[Maceration series 432; USGS Paleobotanical loc. No. D6032; 750 specimens counted; ×, present but not observed in count]

Taxon	432-A	432-B (percent)	432-C
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	0.8	×
Calamospora hartungiana Schopf in Schopf, Wilson, and Bentall	--	--	0.8
C. parva Guennel	1.2	--	1.6
C. sp	2.4	--	1.6
Convolutispora florida Hoffmeister, Staplin, and Malloy	--	.8	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	1.2	2.4	--
Cristatisporites sp	.4	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	9.2	37.6	--
D. spp	2.0	--	--
Dictyotriletes castaneaeformis (Horst) Sullivan	1.2	--	--
D. bireticulatus (Ibrahim) Potonié and Kremp	.4	--	--
Endosporites sp	--	--	.8
Florinites sp	--	--	×
Granulatisporites pallidus Kosanke	4.4	.8	1.6
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	5.6	.8	1.6
G. spp	8.4	.8	2.4
Knoxisporites triradiatus Hoffmeister, Staplin, and Malloy	1.6	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	.8
L. latus Kosanke	--	×	.8
L. ovalis Kosanke	4.0	4.0	6.4
L. sp	.4	--	--
Lophotriletes cf. *L. gibbosus* (Ibrahim) Potonié and Kremp	1.2	--	--
Lycospora granulata Kosanke	.4	--	.8
Lycospora micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	.4	1.6	8.8
L. pellucida (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke	22.4	12.8	25.6
L. spp	27.2	34.4	38.4
Raistrickia prisca Kosanke	--	×	--
R. spp	.4	1.6	.8
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	×	--	--
Stenozonotriletes bracteolus (Butterworth and Williams) Smith and Butterworth	.4	--	--
Triquitrites sp	.4	--	--
Wilsonites sp	--	--	.8
Monosaccate	3.2	1.6	5.6
Unassigned	1.6		
Total	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

432-A, 7.6 cm roof rock.
432-B, 7.6 cm coal.
432-C, 10.8 cm coal-bone.

shown in the summary of most abundant taxa:

Densosporites	40.5 percent
Granulatisporites	6.0
Laevigatosporites	25.3
Lycospora	20.2
	92.0 percent

Laevigatosporites is second in abundance to *Densosporites* with 25.3 percent of the assemblage. This is significantly higher than the 5 percent recorded for *Laevigatosporites* in the Gilbert(?) coal below. The presence of *L. ovalis* accounts for much of the increase in abundance of the genus. Although *Densosporites* is the dominant taxon, especially in 122-B, many of the specimens are poorly preserved and identification to the species level is impossible. Poor preservation is also noted for *Lycospora*, which accounts for 20.2 percent of the assemblage. Accessory taxa of the Gilbert(?) coal, *Procoronaspora*, *Stenozonotriletes*, and *Schulzospora* are not present in these samples of the Cedar Grove coal from the type locality. *Acanthotriletes* cf. *A. echinatus* (Knox) Potonié and Kremp, *Punctatisporites obesus* (Loose) Potonié and Kremp, and *P. sinuatus* (Artüz) Neves are present in limited numbers.

The Winifrede coal, in the upper half of the Kanawha Formation (fig. 3), was collected from the type locality in the Belle quadrangle and assigned to maceration 121 (table 5). This locality is considered to be outside the geographic area of the stratotype. *Laevigatosporites* is clearly the dominant taxon for the first time stratigraphically, with one-half the assemblage assigned to this genus in coal samples 121-A-B and D-E as follows:

Densosporites	9.0 percent
Granulatisporites	12.3
Laevigatosporites	51.6
Lycospora	11.7
	84.6 percent

Laevigatosporites globosus Schemel is an important member of the assemblage inasmuch as it represents 24.2 percent of the population of the coal samples. In the clay parting (No. 121-C), *L. globosus* Schemel represents 65.6 percent of the assemblage. This taxon is an important member of many younger Pennsylvanian coal assemblages in the United States. Seven species of *Laevigatosporites* are present in this set of samples of

TABLE 3.—*Palynomorphs from the Gilbert(?) coal bed in West Virginia*

[Maceration series 433; USGS Paleobotanical loc. No. D6033; 500 specimens counted; ×, present but not observed in count]

Taxon	433-A	433-B (percent)	433-C
Calamospora cf. *C. liquida* Kosanke	×	2.4	--
C. parva Guennel	×	1.6	--
C. sp	--	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	28.8	.8	--
D. triangularis Kosanke	×	--	--
D. sp	--	2.4	--
Granulatisporites pallidus Kosanke	×	1.6	--
G. sp	.8	2.4	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	--	--
L. latus Kosanke	1.6	--	--
L. ovalis Kosanke	5.6	.8	--
Lophotriletes sp	--	3.2	--
Lycospora granulata Kosanke	.8	2.4	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	23.2	19.2	×
L. spp	30.4	53.6	×
Procoronaspora sp	.8	2.4	--
Punctatisporites spp	3.2	4.0	×
Raistrickia sp	×	--	--
Schulzospora rara Kosanke	2.4	1.6	--
Stenozonotriletes bracteolus (Butterworth and Williams) Smith and Butterworth	×	--	--
Monosaccate	.8	1.6	--
Total	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

433-A, 22.2 cm coal.
433-B, 22.2 cm coal.
433-C, 7.6 cm seat rock.

the Winifrede coal (table 5). The primary differences between the Winifrede and Cedar Grove coals, from their respective type localities, are the presence of *L. globosus* Schemel and the dominance of *Laevigatosporites* in the Winifrede coal (see tables 4 and 5).

The Stockton coal, in the upper part of the Kanawha Formation (fig. 3), contains a parting similar to the Winifrede coal; this is shown in tables 5 and 6. Samples of the Stockton coal were collected from the Valley Camp Coal Company mine located north of Mammoth, W. Va., and assigned to macerations 566-A-G. Two important genera, *Radiizonates* and *Torispora*, are present

TABLE 4.—*Palynomorphs from the type locality of the Cedar Grove coal bed in West Virginia*

[Maceration series 122; USGS Paleobotanical loc. No. D6035; 1,000 specimens counted; ×, present but not observed in count]

Taxon	122-A	122-B	122-C	122-D
		(percent)		
Acanthotriletes cf. *A. echinatus* (Knox) Potonié and Kremp	--	--	1.2	0.4
Ahrensisporites sp	--	1.2	×	.4
Apiculatisporis sp	--	0.4	--	--
Calamospora breviradiata Kosanke	1.6	--	--	--
C. sp	0.4	.4	--	--
Cirratriradites maculatus Wilson and Coe	.4	--	.4	.8
Convolutispora sp	--	--	×	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	.4	--
Cristatisporites spp	2.0	2.4	1.2	.8
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	--	4.4	--
D. sphaerotriangularis Kosanke	.4	1.6	.4	.4
D. triangularis Kosanke	--	1.6	3.2	--
D. spp	3.2	76.8	29.2	4.4
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	1.6	.4	1.6	.4
D. castaneaeformis (Horst) Sullivan	--	--	--	×
Endosporites cf. *E. globiformis* (Ibrahim) Schopf, Wilson, and Bentall	.4	--	--	.8
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	.4	--	.8
F. sp	--	--	.8	--
Granulatisporites pallidus Kosanke	2.0	.8	2.0	1.6
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.8	--	--	.4
G. spp	3.6	3.6	4.8	9.2
Knoxisporites sp	.8	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	3.6	--	1.2	--
L. latus Kosanke	--	--	×	--
L. medius Kosanke	2.8	.8	2.4	.8
L. ovalis Kosanke	37.6	3.2	18.0	9.6
L. vulgaris (Ibrahim) Alpern and Doubinger	2.0	×	6.4	--
Lycospora granulata Kosanke	2.8	.4	9.6	6.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke	18.8	.4	10.4	12.0
L. spp	8.4	2.0	.4	44.0
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	.8	.4
P. sinuatus (Artüz) Neves	--	--	×	--
P. sp	2.8	2.4	.8	2.0
Raistrickia sp	×	×	×	--
Reticulatisporites sp	--	--	--	.8
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	--	--	--	×
Simozonotriletes intortus (Waltz) Potonié and Kremp	--	--	×	--
Vestispora sp	--	--	×	--
Wilsonites delicata (Kosanke) Kosanke	1.2	.4	.4	.4
Monosaccate	2.4	.8	--	3.6
Unassigned	.4	--	--	--
Total	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

122-A, 26.7 cm coal.
122-B, 27.8 cm coal.
122-C, 32.8 cm coal.
122-D, 12.7 cm seat rock.

TABLE 5.—*Palynomorphs from the type locality of the Winifrede coal bed in West Virginia*

[Maceration series 121; USGS Paleobotanical loc. No. D6035; 1,250 specimens counted; ×, present but not observed in count]

Taxon	121-A	121-B	121-C	121-D	121-E
			(percent)		
Acanthotriletes cf. *A. echinatus* (Knox) Potonié and Kremp	2.0	0.4	0.4	0.4	0.4
Apiculatisporis sp	--	1.2	--	--	.8
Calamospora breviradiata Kosanke	--	2.0	--	1.6	×
C. hartungiana Schopf in Schopf, Wilson, and Bentall	--	.4	--	.4	.4
C. sp	--	.4	--	--	--
Cirratriradites maculatus Wilson and Coe	--	--	--	.4	.8
Convolutispora sp	--	×	--	--	×
Cristatisporites sp	--	.4	--	.4	×
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	9.2	6.4	--	--	--
D. sphaerotriangularis Kosanke	.4	--	--	--	--
D. triangularis Kosanke	1.2	--	×	5.6	.4
D. spp	3.6	1.2	7.2	27.6	3.2
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	--	.8	--	--	.8
Endosporites ornatus Wilson and Coe	×	×	--	--	×
E. globiformis (Ibrahim) Schopf, Wilson, and Bentall	×	--	--	--	1.2
E. sp	--	--	.4	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.8	.4	--	--	.4
F. triletes Kosanke	×	--	--	--	--
F. sp	--	--	--	--	×
Granulatisporites pallidus Kosanke	.8	9.2	--	--	4.0
G. spp	1.2	15.2	1.2	3.6	14.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	--	.4	.4	.4
L. globosus Schemel	17.2	27.2	65.6	36.0	18.0
L. latus Kosanke	.8	.8	--	--	--
L. medius Kosanke	1.6	2.0	.8	.4	1.6
L. minutus (Wilson and Coe) Schopf, Wilson, and Bentall	10.4	4.4	11.2	3.6	6.4
L. ovalis Kosanke	24.8	10.4	8.4	6.4	13.2
L. vulgaris (Ibrahim) Alpern and Doubinger	4.8	2.8	.8	3.2	1.6
Lycospora granulata Kosanke	5.2	1.2	--	.8	3.6
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	.4	--	--	1.6	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke	.4	2.4	.4	.8	8.0
L. spp	10.0	3.6	--	2.4	6.8
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	--	.4	×
P. sinuatus (Artüz) Neves	×	--	--	--	--
P. spp	2.0	3.2	2.8	2.0	6.8
Raistrickia sp	--	--	--	.4	1.6
Reticulatisporites sp	.4	--	--	.4	.8
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	--	--	--	--	2.0
Triquitrites cf. *T. pulvinatus* Kosanke	--	×	--	--	--
T. sculptilis Balme	--	.4	--	×	×
T. sp	--	.8	.4	--	.8
Verrucosisporites sp	--	.4	--	--	×
Wilsonites cf. *W. vesicatus* (Kosanke) Kosanke	.4	--	--	--	--
W. sp	--	×	--	×	×
Monosaccate	.8	2.4	--	1.2	2.0
Total	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

121-A, 40.6 cm coal.
121-B, 40.6 cm coal.
121-C, 10.2 cm parting (clay).
121-D, 24.1 cm coal.
121-E, 22.9 cm coal.

in this coal that help differentiate the Stockton from the Winifrede coal below. *Laevigatosporites* and *Lycospora* are the most abundant taxa in the coal samples (566-A-C and E-F):

Densosporites	11.4 percent
Laevigatosporites	30.2
Lycospora	30.7
Radiizonates	12.5
	84.8 percent

The presence of *Radiizonates* in the coal samples at the rate of 12.5 percent is of interest because it was not observed in the Winifrede coal below. *Radiizonates tenuis* (Loose) Butterworth and Smith in Butterworth and others (1964) and *R.* cf. *R. faunus* (Ibrahim) Smith and Butterworth contribute significantly to this percentage as well as specimens assigned to *R.* sp. *Radiizonates* is also present in many of the block coals of the Charleston Sandstone as shown in tables 7-18. Kosanke (1973) reported *Radiizonates* present in the Richardson-Skyline coals from their respective type localities in eastern Kentucky. *Torispora* is present only in the top coal sample (566-A), but not in sufficient abundance to occur in the abundance counts.

Trihyphaecites triangularis Peppers was originally described from the Carbondale Formation of Illinois and has been identified from the Stockton coal (566-C). This is an unusual taxon because it is considered to be of fungal origin and produces septate hyphae at each of its three corners. I have also identified this taxon from several coals in eastern Kentucky including the Whitesburg, Fire clay rider, and Francis, all from the Breathitt Formation.

CHARLESTON SANDSTONE

The terminology employed by Englund and others (1979) for stratigraphic units previously included in the Allegheny Formation is used in this report. Additional modifications suggested by T. W. Henry (written commun., 1980) and by H. H. Arndt (oral commun., 1981) have helped to interpret the palynomorph data and to better utilize the stratigraphic and palynomorph data in an effort to understand the geologic history of the Charleston Sandstone.

The samples from the Charleston Sandstone are from exposures, mines, and diamond drill holes in the vicinity of Charleston, Kanawha County, W. Va. The coals examined are the Stockton A, Little No. 5 Block, Lower No. 5 Block, Upper No. 5 Block, and the No. 6 Block coal.

Arndt (1979) summarized the geology of the Charleston Sandstone. From this summary and from field work it is clear that the coals of the Charleston Sandstone were deposited without marine deposition having occurred between the coals; terrestrial deposition followed by marine deposition did not occur in the area of the stratotype. The possible influence of this type of deposition on the palynomorph assemblages is potentially great.

The Stockton A coal (maceration series 571) occurs a short distance above the Kanawha black flint. Palynomorphs are abundant and well preserved in the Stockton A coal, especially in sample 571-A. In this sample *Lycospora* is most abundant, and *Laevigatosporites* and *Endosporites* are well represented. Also, *Florinites, Raistrickia, Verrucosisporites, Cyclogranisporites, Crassispora, Densosporites, Cirratriradites, Acanthotriletes, Wilsonites,* and *Spackmanites* have been identified in this sample. *Spackmanites* has not been identified from older coals in this study. *Torispora securis* Balme, which is present in one sample of the Stockton coal (566-A) of the Kanawha Formation, has not been identified in the samples of the Stockton A coal.

The Little No. 5 Block coal (macerations 552-A-G and 434-A-H) was examined for palynomorphs. Samples for macerations 552-A-G were collected from a highwall of the Harewood strip mine located east of Carbondale, Fayette County, W. Va. The taxa identified and their abundance are shown in table 7. The dominant and accessory genera are shown on figure 4. The coal samples yielded abundant and well-preserved palynomorphs, but neither the roof nor seat samples yielded sufficient palynomorphs to make abundance counts worthwhile. The most abundant genera in the Little No. 5 Block coal (552-B-F) are as follows:

Densosporites	10.5 percent
Laevigatosporites	35.5
Lycospora	7.1
Torispora	14.1
Radiizonates	8.8
	76.7 percent

Laevigatosporites is the most abundant genus, and eight species have been identified (table 7). *Laevigatosporites* is, in a large measure, uniformly abundant in all the coal samples. *Densosporites*, especially *D. triangularis* Kosanke, is numerically important in two coal samples (552-C-D). *Torispora securis* Balme is the most abundant in the three coal samples (552-B-D), whereas *Radiizonates tenuis* (Loose) Butterworth and Smith in Butterworth and others is abundant only in

one coal sample (552-E). *Lycospora* is numerically important only in the bottom coal sample (552-F). Preservation of specimens assignable to *Lycospora* is poor and a number of these specimens could not be identified to the species level, especially in the bottom coal sample (552-F). What I have classified as *L. pellucida-L. pseudonnulata* in table 7 is most abundant.

The second set of samples taken from the Little No. 5 Block coal (maceration 434-A-H) were collected from the Semet-Solvay mine at Harewood northeast of Boomer, Montgomery quadrangle, Fayette County, W. Va. Analyses of these samples are shown in table 8 and on figure 4, and they are very similar to the other set of Little No. 5 Block coal samples (552-A-G) except for the leader coal sample (434-H). The same species of *Laevigatosporites* are present in the leader coal in approximately the same abundance, but *Lycospora* represents nearly 50 percent of the assemblage. *Lycospora* is present at the rate of only 11.5 percent in the main part of the coal (434-A-E) as shown:

Densosporites	3.9 percent
Laevigatosporites	36.1
Lycospora	11.5
Radiizonates	15.3
Torispora	21.0
	87.8 percent

Radiizonates and *Torispora* are greatly reduced in the leader coal (434-H), as shown in table 8. Stratigraphic and palynological evidence suggests an equivalence between these two samples of the Little No. 5 Block coal (maceration series 552 and 434).

Spencerisporites gracilis (Zerndt) Winslow has not been found below the Little No. 5 coal (434-B). This is of interest because Winslow (1959) reported that the oldest occurrence of this taxon in Illinois was the upper part of the Tradewater Group, a term no longer used in

TABLE 6.—*Palynomorphs from the Stockton coal bed in West Virginia*
[Maceration series 566; USGS Paleobotanical loc. No. D6036; 1,750 specimens counted; ×, present but not observed in count]

Taxon	566-A	566-B	566-C	566-D	566-E	566-F	566-G
				(percent)			
Apiculatisporites sp	--	--	--	--	--	0.8	--
Calamospora breviradiata Kosanke	1.6	--	×	×	--	.8	--
C. hartungiana Schopf in Schopf, Wilson, and Bentall	--	--	--	×	×	.8	×
C. parva Guennel	--	--	--	1.6	×	2.4	2.4
C. pedata Kosanke	--	--	--	--	--	.8	--
C. sp	--	--	0.8	0.8	--	--	--
Cirratriradites maculatus Wilson and Coe	--	--	--	--	--	3.2	--
C. sp	0.8	--	.8	×	×	.8	×
Convolutispora sp	--	0.8	--	--	--	1.6	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	1.6	--	2.4	4.0	0.8
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	1.6	--	--	--	1.6	.8
D. sphaerotriangularis Kosanke	×	--	--	--	--	--	--
D. triangularis Kosanke	4.0	20.8	.8	--	--	--	--
D. spp	7.2	17.6	.8	--	--	--	--
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	.8	×	--	--	--	.8	×
Endosporites ornatus Wilson and Coe	×	×	--	×	--	--	--
E. sp	×	--	--	--	×	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	--	.8	2.4	×	--	.8
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	--	--	1.6	1.6	.8
G. spp	×	--	1.6	4.0	3.2	--	3.2
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	5.6	1.6	1.6	1.6	--	1.6	.8
L. globosus Schemel	5.6	11.2	.8	3.2	--	3.2	.8
L. latus Kosanke	--	×	--	--	1.6	×	1.6
L. medius Kosanke	2.4	.8	4.0	1.6	3.2	4.0	4.0
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	4.0	13.6	4.0	4.0	3.2	3.2	1.6
L. ovalis Kosanke	12.8	4.8	8.8	7.2	1.6	10.4	15.2
L. punctatus Kosanke	4.8	13.6	--	1.6	--	--	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	.8	--	.8	--	--	.8
Leiotriletes sp	--	--	.8	--	--	×	1.6
Lophotriletes spp	1.6	×	--	1.6	3.2	--	--

Illinois. Its rocks are now called the Spoon Formation. The presence of *S. gracilis* in the Little No. 5 coal may indicate approximate equivalence with the Illinois occurrence.

Torispora securis Balme is a prominent taxon of the assemblages of the Little No. 5 Block and the Lower No. 5 Block coals of West Virginia. *Torispora* was proposed by Balme (1952) for spores that were basically elliptical in proximo-distal orientation, and distinctly monolete, with a pronounced thickening at one extremity of the spore that may be expanded into a crescentic or rectangular projection. The outer layer of some sporangia contains specimens of *Torispora securis* Balme, which Horst (1957) considered were sporangial cells. For these Horst proposed the binomial *Bicoloria gothanii* Horst. Because Horst considered these to be sporangial in origin he did not recognize the presence of any proximal apertures. Subsequently, Doubinger and Horst (1941) emended the genus *Torispora* and recognized the presence of various types of proximal apertures. Guennel and Neavel (1961) summarized the development of *Torispora* and recognized *Bicoloria* for intact sporangia and *Torispora* for isolated dispersed spores. I have observed these peculiar thickenings on specimens I would identify with a number of monolete taxa, and in one instance on a trilete palynomorph. It is not relevant to this paper to be concerned with the proper classification of *Torispora securis* except to recognize that the range zone does not necessarily represent the range zone of an individual taxon, but rather a collection of taxa that possess thickenings. I prefer to regard *Torispora* as representing a monolete taxon with a thickened condition that occurred on certain palynomorphs for a period of geologic time. *Torispora* is present in coals of the proposed Pennsylvanian System stratotype from near the top of the Kanawha Formation through the Charleston Sandstone. It should be noted that the abundance of *Torispora* varies greatly, ranging

TABLE 6.—*Palynomorphs from the Stockton coal bed in West Virginia*—Continued

[Maceration series 566; USGS Paleobotanical loc. No. D6036; 1,750 specimens counted; ×, present but not observed in count]

Taxon	566-A	566-B	566-C	566-D (percent)	566-E	566-F	566-G
Lycospora granulata Kosanke	1.6	--	22.4	8.0	0.8	8.0	14.4
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	4.0	5.6	16.8	.8	4.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	--	--	2.4	16.0	10.4	8.0	10.4
L. punctata Kosanke	--	--	.8	2.4	4.8	2.4	3.2
L. spp	.8	2.4	26.4	28.8	36.0	23.2	28.0
Microreticulatisporites cf. *M. concavus* Butterworth and Williams	×	--	--	--	--	--	--
M. sulcatus (Wilson and Kosanke) Smith and Butterworth	--	--	×	1.6	1.6	--	--
Punctatisporites spp	--	--	3.2	1.6	.8	.8	.8
Raistrickia sp	--	.8	.8	.8	--	--	--
Radiizonates tenuis (Loose) Butterworth and Smith in Butterworth and others 1964	8.8	--	1.6	--	--	.8	--
R. cf. *R. faunus* (Ibrahim) Smith and Butterworth	7.2	--	--	--	--	.8	--
R. sp	29.6	4.8	7.2	.8	--	3.2	1.6
Torispora securis Balme	×	--	--	--	--	--	--
Trihyphaecites triangularis Peppers	--	--	×	--	--	--	--
Triquitrites crassus Kosanke	--	--	×	--	--	.8	.8
T. sculptilis Balme	×	--	--	2.4	--	--	.8
T. sp	--	.8	--	--	--	.8	--
Verrucosisporites sifati (Ibrahim) Smith and Butterworth	.8	2.4	--	×	×	--	--
V. sp	--	--	--	×	--	1.6	--
Vestispora costata (Balme) Spode in Smith and Butterworth	--	--	.8	--	--	3.2	--
V. fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	--	.8	--	4.8	.8	--
V. cf. *V. magna* (Butterworth and Williams) Smith and Butterworth	--	--	--	--	--	.8	--
V. sp	--	--	.8	--	.8	2.4	.8
Monosaccate	--	.8	1.6	1.6	2.4	--	--
Unassigned	--	.8	--	--	.8	--	--
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

566-A, 30.5 cm coal.
566-B, 30.5 cm coal.
566-C, 30.5 cm coal.
566-D, 38.1 cm parting.
566-E, 26.7 cm coal.
566-F, 26.7 cm coal
566-G, 15.2 cm seat rock.

from zero to 31 percent in adjacent levels of the same coal (434-D-E).

The Lower No. 5 Block coal (macerations 553-A-E) occurs approximately 18 m above the Little No. 5 Block coal (macerations 552-A-G) in the highwall of the Harewood strip mine, east of Carbondale, Fayette County, W. Va. The coal at this locality is 91.2 cm thick. Three equal coal samples were taken in addition to the roof and seat rock samples (table 9). *Laevigatosporites* is codominant with *Torispora*; both occur at the rate of 32 percent in the coal samples (553-B-D) as shown:

Densosporites	9.6 percent
Laevigatosporites	32.2
Lycospora	3.8
Radiizonates	9.2
Torispora	32.7
	87.5 percent

Densosporites and *Radiizonates* occur at about the same rate as they occur in the Little No. 5 Block maceration series (552). *Lycospora* decreased in abundance to less than 4 percent, largely because it was almost absent from the upper part of these samples of the Lower No. 5 Block coal. *Crassispora kosankei* (Potonié and Kremp) Bharadwaj reached 7.6 percent abundance in the bottom coal sample (553-D). *Zosterosporites triangularis* Kosanke is present in very limited quantities in part of the Lower No. 5 Block coal (macerations 553-A-B).

A second set of the Lower No. 5 Block coal (maceration series 435) was collected from the Semet-Solvay strip mine located east of Smithers, Fayette County, W. Va. The coal at this locality is somewhat thicker than that sampled for the previous set of Lower No. 5 Block coal samples (553-A-E); the palynological analyses are given in table 10. The dominant and ac-

TABLE 7.—*Palynomorphs from the Little No. 5 Block coal bed in West Virginia, series 552*
[Maceration series 552; USGS Paleobotanical loc. No. D6038; 1,250 specimens counted; ×, present but not observed in count]

Taxon	552-A	552-B	552-C	552-D (percent)	552-E	552-F	552-G
Alatisporites hexalatus Kosanke	--	--	0.8	--	--	--	--
A. trialatus Kosanke	--	--	--	--	×	--	--
Apiculatisporites sp	--	--	--	--	0.4	--	--
Calamospora breviradiata Kosanke	--	--	--	--	--	0.8	--
C. hartungiana Schopf in Schopf, Wilson, and Bentall	--	--	--	--	×	--	--
C. parva Guennel	--	--	--	--	×	.8	×
C. sp	--	1.6	.8	--	2.4	.4	--
Cirratriradites annulatus Kosanke	--	1.2	×	0.4	.8	.4	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	0.4	--	--	.4	1.6	--
Cristatisporites indignabundus (Loose) Potonié and Kremp	--	.4	--	--	--	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	.4	--	--	--	--	--
D. sphaerotriangularis Kosanke	--	--	--	2.4	--	--	--
D. triangularis Kosanke	×	--	10.4	9.2	--	--	--
D. spp	×	2.0	16.8	9.2	2.4	--	--
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	--	--	1.6	×	.4	--	--
Endosporites ornatus Wilson and Coe	×	.4	--	--	--	.4	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	--	--	×	.4	1.2	--
Granulatisporites pallidus Kosanke	--	--	--	--	1.2	1.2	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	1.2	--	--	--	--	--
G. sp	--	1.2	2.4	--	2.8	.4	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	2.0	--	.8	2.8	3.2	--
L. globosus Schemel	--	5.6	6.4	8.0	2.8	5.6	--
L. latus Kosanke	--	.4	--	--	.4	--	--
L. medius Kosanke	×	4.0	4.0	2.8	1.6	1.6	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	×	9.2	8.0	9.2	6.8	8.0	--
L. ovalis Kosanke	×	15.6	13.6	8.4	9.6	20.4	--
L. punctatus Kosanke	--	.4	--	3.2	9.6	.8	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	--	--	--	1.6	.8	--
Lycospora granulata Kosanke	--	1 .6	×	--	.8	3.2	--

cessory genera are given on figure 4. These analyses are similar to those of the Lower No. 5 Block coal already discussed (maceration series 553), although minor differences exist. For example, in the coal samples of maceration series 435, *Laevigatosporites* and *Lycospora* are more abundant and *Torispora* is somewhat less abundant than in the coal samples of maceration series 553. Once again, *Zosterosporites triangularis* Kosanke and *Crassispora kosankei* (Potonié and Kremp) Bharadwaj are present, the latter species constituting 8 percent (435-B).

Another set of Lower No. 5 Block coal samples (maceration series 446), identified on the basis of stratigraphic position, were collected from the Cannelton Coal Company strip mine near the head of Bullpush Fork, Fayette County, W. Va. The coal is very thick at this locality (238 cm) and contains two partings (table 11). The identified palynomorphs of maceration series 446 are shown in table 11, and the abundant and accessory genera are shown:

Densosporites	6.8 percent
Laevigatosporites	41.7
Lycospora	11.4
Torispora	26.5
	86.4 percent

The preservation of palynomorphs is poor in Lower No. 5 Block coal (maceration series 446) compared to other block coals studied in this report. This is shown by the fact that many specimens of *Densosporites* could not be identified to the species level and are classified either as *Densosporites* sp. or as *D.* "rings." The designation "rings" means that only the thickened equatorial structure remains. The number of specimens of *Lycospora* and *Torispora* not identified to the species

TABLE 7.—*Palynomorphs from the Little No. 5 Block coal bed in West Virginia, series 552*—Continued

[Maceration series 552; USGS Paleobotanical loc. No. D6038; 1,250 specimens counted; ×, present but not observed in count]

Taxon	552-A	552-B	552-C	552-D (percent)	552-E	552-F	552-G
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	1.6	--	--	.8	2.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	--	2.0	--	--	1.2	15.2	--
L. spp	×	6.8	×	×	.8	23.2	--
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	--	×	--	--	--	--	--
Punctatisporites spp	×	4.0	4.0	.8	--	1.6	--
Radiizonates tenuis (Loose) Butterworth and Smith in Butterworth and others, 1964	--	--	--	10.4	32.8	.4	--
R. cf. *R. faunus* (Ibrahim) Smith and Butterworth	--	--	×	--	--	--	--
R. sp	--	.4	--	--	3.2	--	--
Raistrickia cf. *R. crocea* Kosanke	--	--	--	--	--	.4	--
R. imbricata Kosanke	--	--	--	--	--	.4	--
R. sp	--	.8	--	--	.4	--	--
Torispora securis Balme	×	30.0	30.4	32.4	9.2	2.0	--
Triquitrites protensus Kosanke	×	.4	--	--	--	.4	--
T. sculptilis Balme	--	--	--	--	--	.4	--
Verrucosisporites sifati (Ibrahim) Smith and Butterworth	--	--	--	2.0	2.0	--	--
V. sp	--	--	--	.4	--	--	--
Vestispora costata (Balme) Spode in Smith and Butterworth	--	1.2	--	--	--	.8	--
V. fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	2.4	--	--	1.2	1.6	--
Wilsonites vesicatus (Kosanke) Kosanke	--	.8	--	--	--	--	--
W. sp	--	--	×	--	.4	--	--
Monosaccate	--	2.0	.8	.4	.8	.8	--
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

552-A, 7.6 cm roof rock.
552-B, 25.4 cm coal.
552-C, 25.4 cm coal.
552-D, 25.4 cm coal.
552-E, 25.4 cm coal.
552-F, 25.4 cm coal.
552-G, 7.6 cm seat rock.

level is further proof of poor preservation (maceration series 446). The preservation of palynomorphs in the parting sampled is also poor, preventing a worthwhile abundance count.

Basically the same taxa are present in maceration series 446 as are present in the other Lower No. 5 Block coal samples previously discussed. *Crassispora kosankei* (Potonié and Kremp) Bharadwaj is present at the rate of 8.8 percent in the bottom coal sample (446-K) corresponding to similar abundances in the other samples of the Lower No. 5 Block coal (553-D and 435-B). The most abundant genera occurring in the coal samples of maceration series 446 (table 11) are:

Densosporites	22.3 percent
Laevigatosporites	37.7
Lycospora	12.1
Torispora	9.4
	81.3 percent

Zosterosporites triangularis Kosanke, which was present in the first two sets of Lower No. 5 Block coal samples, has not been identified from samples of maceration series 446. On the basis of overall abundance, it is questionable whether or not samples of maceration series 446 correlate with those of the Lower No. 5 Block coal (maceration series 553 and 435). A separate evaluation of the three coal benches of maceration series 446 suggests that the lower bench (446-I-K) is more closely related to the Lower No. 5 Block coal samples (553 and 435).

Thick and somewhat variable in occurrence, the coals of the Charleston Sandstone may represent rapid accumulation and burial as a result of the absence of disruptive marine incursions between coals. The amount of elapsed geologic time might not be as great as one might expect. Similarity of palynological assemblages may very well be a measure of similarity of paleoecologic conditions.

TABLE 8.—*Palynomorphs from the Little No. 5 Block coal bed in West Virginia, series 434*

[Maceration series 434; USGS Paleobotanical loc. No. D6037; 1,500 specimens counted; ×, present but not observed in count]

Taxon	434-A	434-B	434-C	434-D	434-E	434-F	434-G	434-H
				(percent)				
Alatisporites hexalatus Kosanke	--	--	×	×	--	--	--	--
A. sp	×	--	--	--	--	--	--	--
Calamospora hartungiana Schopf in Schopf, Wilson, and Bentall	0.4	--	×	--	0.8	--	--	--
C. parva Guennel	--	--	--	--	2.0	--	--	0.4
C. spp	.4	--	--	--	.4	--	--	1.6
Cirratriradites annulatus Kosanke	1.2	×	--	×	--	--	--	--
Convolutispora sp	--	--	×	--	--	--	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	.4	--	--	--	1.2	--	×	3.2
Densosporites sphaerotriangularis Kosanke	.4	--	0.8	--	.8	--	×	--
D. triangularis Kosanke	--	1.2	6.0	0.8	--	--	×	--
D. sp	--	1.6	5.2	2.4	--	×	×	.4
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	--	--	×	.4	--	--	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	2.0	--	×	--	--	--	--	--
E. ornatus Wilson and Coe	2.0	--	--	--	.8	--	--	--
E. sp	--	--	--	--	--	--	×	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	1.2	×	--	--	.4	--	--	.8
F. triletus Kosanke	--	--	--	--	.4	--	--	--
Granulatisporites pallidus Kosanke	--	×	--	--	--	--	--	.8
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	--	.4	2.0	--	--	1.2
G. spp	2.8	1.2	1.6	.4	.8	×	×	.4
Knoxisporites sp	--	--	--	--	--	--	×	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	.8	1.2	.4	1.2	.8	--	--	1.2
L. globosus Schemel	5.2	5.2	10.8	8.0	12.8	×	×	8.0
L. latus Kosanke	3.2	0.8	.8	×	.4	--	--	.4
L. medius Kosanke	1.6	1.6	.8	.4	.4	--	--	1.6
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	14.8	12.0	8.8	5.2	10.0	×	×	7.2
L. ovalis Kosanke	14.4	2.4	11.2	4.4	9.6	×	×	14.4
L. punctatus Kosanke	6.0	5.6	10.8	6.8	1.6	--	--	1.2
L. vulgaris (Ibrahim) Alpern and Doubinger	--	×	--	--	--	--	--	--
Lycospora brevijuga Kosanke	--	--	--	--	--	--	--	.4
L. granulata Kosanke	2.4	.4	--	--	4.4	--	--	7.2

Wanless (1939) correlated the No. 5 Block coal, which is mined extensively in the Kanawha River Valley, with the Lower Kittanning coal of Pennsylvania and Ohio. In the current nomenclature of the block coals, the No. 5 Block coal of Wanless is probably the Lower No. 5 Block coal. The Lower No. 5 Block coal does not correlate with the Lower Kittanning coal, but is older, and this will be taken up subsequently with the discussion of the Upper No. 6 Block coal.

The Upper No. 5 Block coal occurs in benches, coal separated from coal by non-coal layers, and the correlation of these separate benches may be difficult. The correlation of these coal benches is based on palynological evidence such as abundance, or guide fossils, or a combination of these factors. For example, the thin coal (maceration 554-A) does not contain *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala and as a result is not correlative with samples of maceration series 573, but is older.

Upper No. 5 Block(?) coal (maceration series 447, table 12) was collected from the Union Carbide 7C mine located near Sanderson, Kanawha County, W. Va. A parting 12.7 cm thick separates the bottom 40.6 cm of coal from the top 100.8 cm of coal. The overall abundance is similar to that of the Lower No. 5 Block(?) coal (maceration series 446, table 11). However, *Crassispora kosankei* (Potonié and Kremp) Bharadwaj does not exceed the 2 percent level in any of the segment samples, and *Zosterosporites triangularis* Kosanke is present in the parting sample (447-D).

Preservation of palynomorphs extracted from coal samples of maceration series 447 is better than that of coal samples of maceration series 446. The non-coal samples of maceration series 447 did not yield sufficient or well-preserved palynomorphs to make abundance counts. The majority of the specimens that were identified from this parting are thought to be herbaceous. The same is true of the parting samples of the 446

TABLE 8.—*Palynomorphs from the Little No. 5 Block coal bed in West Virginia, series 434*—Continued

[Maceration series 434; USGS Paleobotanical loc. No. D6037; 1,500 specimens counted; ×, present but not observed in count]

Taxon	434-A	434-B	434-C	434-D	434-E	434-F	434-G	434-H
				(percent)				
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	4.8	.4	2.0	.4	9.6	×	--	2.8
L. pellucida (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke	8.8	--	1.2	--	11.6	--	×	13.6
L. punctata Kosanke	--	--	--	--	4.0	×	--	2.0
L. spp	7.2	--	2.0	.4	18.0	--	×	22.4
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	--	--	--	--	.4	--	--	--
Murospora kosankei Somers	--	×	--	--	--	×	--	--
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	--	×	--	--	--	1.2
P. quasiarcuatus Kosanke	--	--	--	.8	--	--	×	.8
P. spp	1.6	2.0	2.8	1.2	1.6	--	--	.4
Radiizonates tenuis (Loose) Butterworth and Smith in Butterworth and others, 1964	2.4	22.8	--	28.0	.8	--	--	.4
R. spp	--	13.2	.4	7.2	1.6	--	×	--
Raistrickia sp	.4	--	--	--	--	--	--	.4
Reinschospora sp	--	--	.4	--	--	--	--	--
Reticulatisporites sp	--	.4	.4	--	--	--	--	--
Spencerisporites gracilis (Zerndt) Winslow	--	×	--	--	--	--	--	--
Torispora securis Balme	13.6	28.0	31.6	31.6	--	×	×	.8
Triquitrites cf. *T. exiguus* Wilson and Kosanke	.4	--	--	--	--	--	--	.4
T. pulvinatus Kosanke	.4	--	1.2	--	--	--	--	.8
T. sp	.4	--	--	--	.4	×	×	.4
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	--	--	--	1.2	--	×	1.2
V. sp	--	--	×	--	--	--	--	--
Wilsonites sp	--	--	×	--	--	--	--	--
Monosaccate	.4	--	.8	--	.8	--	×	.4
Unassigned	.4	--	--	--	--	--	--	--
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

434-A,	30.5 cm coal.	434-E,	30.5 cm coal.
434-B,	30.5 cm coal.	434-F,	12.7 cm seat rock
434-C,	30.5 cm coal.	434-G,	7.6 cm seat rock.
434-D,	30.5 cm coal.	434-H,	15.2 cm coal.

TABLE 9.—*Palynomorphs from the Lower No. 5 Block coal bed in West Virginia, series 553*

[Maceration series 553; USGS Paleobotanical loc. No. D6110; 750 specimens counted; ×, present but not observed in count]

Taxon	553-A	553-B	553-C (percent)	553-D	553-E
Acanthotriletes sp	--	×	--	0.4	--
Ahrensisporites sp	--	--	--	×	--
Alatisporites sp	--	0.4	--	--	--
Calamospora breviradiata Kosanke	--	--	--	×	--
C. hartungiana Schopf in Schopf, Wilson, and Bentall	--	--	--	.2	--
C. parva Guennel	--	.2	--	--	--
C. sp	--	.6	0.4	1.0	--
Cirratriradites annulatus Kosanke	--	.4	.4	.4	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	--	7.6	×
Cristatisporites sp	--	.2	--	--	--
Cyclogranisporites cf. *C. multigranus* Smith and Butterworth	--	.4	×	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	×	--	--	--
D. sphaerotriangularis Kosanke	--	2.0	.4	--	--
D. triangularis Kosanke	--	6.6	3.2	--	--
D. spp	--	12.2	4.8	.2	--
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	--	--	×	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	--	.4	--	--
E. sp	--	--	--	1.0	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	--	--	1.0	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	--	2.4	--
G. sp	--	.8	.4	1.6	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	.2	--	.6	--
L. globosus Schemel	×	12.2	7.6	9.6	--
L. latus Kosanke	--	×	--	.6	--
L. medius	--	1.2	1.6	2.6	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	4.8	6.4	5.4	×
L. ovalis Kosanke	--	2.4	2.4	16.0	×
L. punctatus Kosanke	--	8.0	6.0	8.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	--	1.2	.8	×
L. sp	--	--	--	.2	--
Lycospora granulata Kosanke	--	--	--	2.6	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	--	1.4	×
L. pellucida (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke	--	--	--	--	×
L. punctata Kosanke	--	--	.4	.2	×
L. spp	--	.2	.4	.8	×
Punctatisporites obliquus Kosanke	--	1.2	--	1.6	--
P. spp	--	2.2	2.4	1.2	--
Radiizonates cf. *R. tenuis* (Loose) Butterworth and Smith in Butterworth and others, 1964	--	--	12.0	1.4	--
R. sp	--	.4	12.4	1.6	--
Raistrickia cf. *R. aculeata* Kosanke	×	×	--	--	--
R. cf. *R. crocea* Kosanke	--	.2	--	--	--
R. sp	--	--	--	.2	×
Torispora securis Balme	×	40.2	34.4	21.8	--
T. sp	--	.8	.4	--	--
Triquitrites sculptilis Balme	--	.4	--	.6	--
T. sp	--	.4	.4	.4	--
Verrucosisporites sifati (Ibrahim) Smith and Butterworth	--	×	--	1.6	--
V. sp	--	--	2.0	2.4	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	--	--	.6	×
Zosterosporites triangularis Kosanke	×	×	--	?	--
Monosaccate	×	1.4	--	2.0	--
Unassigned	--	.4	--	×	×
Total	100.0	100.0	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

553-A, 15.2 cm roof rock. 553-B, 30.4 cm coal. 553-C, 30.4 cm coal. 553-D, 30.4 cm coal. 553-E, 7.6 cm seat rock.

TABLE 10.—*Palynomorphs from the Lower No. 5 Block coal bed in West Virginia, series 435*

[Maceration series 435; USGS Paleobotanical loc. No. D6111; 1,000 specimens counted; ×, present but not observed in count]

Taxon	435-A	435-B	435-C (percent)	435-D	435-E
Acanthotriletes cf. *A. echinatus* (Knox) Potonié and Kremp	--	1.2	--	--	--
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	×	--	--	--
Anapiculatisporites spinosus (Kosanke) Potonié and Kremp	--	--	×	0.4	--
Calamospora breviradiata Kosanke	--	0.8	--	--	--
C. hartungiana Schopf in Schopf, Wilson, and Bentall	--	--	0.4	×	--
C. parva Guennel	--	.4	--	×	--
C. sp	0.8	1.6	×	1.2	--
Cirratriradites annulatus Kosanke	--	×	--	.8	--
C. sp	.4	×	×	--	×
Convolutispora sp	.8	--	--	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	8.0	--	5.2	×
Densosporites sphaerotriangularis Kosanke	--	.4	--	--	--
D. triangularis Kosanke	4.0	--	×	--	--
D. spp	8.4	.4	.8	1.2	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	--	--	.8	--
Granulatisporites pallidus Kosanke	.4	--	--	1.2	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	1.2	.8	×	.8	×
G. spp	2.4	.8	.8	4.0	--
Knoxisporites sp	--	--	.4	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	3.6	--	.4	--
L. globosus Schemel	6.4	4.8	12.8	10.8	--
L. medius Kosanke	2.0	2.8	.4	1.2	×
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	10.4	4.8	42.8	30.0	×
L. ovalis Kosanke	6.8	10.0	×	5.6	--
L. punctatus Kosanke	11.2	2.8	1.6	1.2	--
Lophotriletes cf. *L. gibbosus* (Ibrahim) Potonié and Kremp	--	--	--	.4	--
Lycospora granulata Kosanke	--	1.6	--	2.0	×
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	3.2	--	7.6	×
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	--	6.4	--	×	×
L. punctata Kosanke	.4	9.2	--	1.2	--
L. spp	2.4	21.2	.4	10.8	×
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	--	1.6	--	1.2	--
Punctatisporites cf. *P. obesus* (Loose) Potonié and Kremp	.4	.4	--	--	--
P. obliquus Kosanke	×	×	.8	.8	--
P. spp	3.6	1.2	2.0	.4	--
Radiizonates cf. *R. tenuis* (Loose) Butterworth and Smith in Butterworth and others, 1964	×	--	1.6	1.2	--
R. sp	--	×	--	--	--
Raistrickia crocea Kosanke	--	--	--	×	--
R. imbricata Kosanke	--	.4	--	--	--
R. sp	--	--	×	×	--
Reticulatisporites sp	--	--	--	.4	--
Torispora securis Balme	30.4	1.6	6.8	.8	--
T. sp	3.2	×	28.4	4.4	--
Triquitrites cf. *T. arculatus* Wilson and Coe	1.6	--	--	.4	--
T. protensus Kosanke	--	--	--	×	--
T. pulvinatus Kosanke	.4	.4	--	.8	--
T. sculptilis Balme	--	.8	--	--	--
T. spp	--	4.0	--	2.4	--
Verrucosisporites sp	--	.8	--	--	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	2.4	--	.4	×
Zosterosporites triangularis Kosanke	1.2	--	×	--	--
Monosaccate	--	.4	--	--	--
Unassigned	1.2	1.2	--	--	--
Total	100.0	100.0	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

435-A, 30.4 cm coal. 435-B, 30.4 cm coal. 435-C, 30.4 cm coal. 435-D, 30.4 cm coal. 435-E, 7.6 cm seat rock.

series. Both the 447 and 446 maceration series have a higher proportion of *Densosporites* and a lower concentration of *Torispora* than was found in either set of samples of the Lower No. 5 Block coal (maceration series 553 and 435). The abundant genera in 447-A-C and E are as follows:

Densosporites	26.6 percent
Laevigatosporites	34.6
Lycospora	9.9
Torispora	7.0
	78.1 percent

Upper No. 5 Block coal (maceration series 554) was collected starting about 12 m above the Lower No. 5 Block coal (553 series). Samples 554-A-B and D were productive; the data are shown in table 13 and on figure 4. The coal sample 554-D, occurring 12 m above the Lower No. 5 Block coal (553 series), has *Laevigatosporites* as the dominant taxon of the assemblage and *Lycospora* as the subdominant as shown:

	554-A	554-B	554-D	
Densosporites	23.2	0.8	5.6	percent
Laevigatosporites	24.0	22.4	44.8	
Lycospora	13.6	52.4	25.4	
Torispora	8.0	.8	16.0	
	68.8	78.8	91.3	percent

TABLE 11.—*Palynomorphs from the Lower No. 5 Block coal bed in West Virginia, series 446*

[Maceration series 446; USGS Paleobotanical loc. No. D6039; 1,750 specimens counted; ×, present but not observed in count]

Taxon	446-A	446-B	446-C	446-D	446-E	446-F	446-G	446-H	446-I	446-J	446-K
						(percent)					
Acanthotriletes echinatus (Knox) Potonié and Kremp	×	--	--	--	--	--	--	--	--	--	--
Ahrensisporites cf. *A. guerickei* (Horst) Potonié and Kremp	--	×	--	--	--	×	--	--	--	--	--
Alatisporites sp	--	--	--	--	--	×	--	--	--	0.4	--
Anapiculatisporites spinosus (Kosanke) Potonié and Kremp	--	0.4	--	--	--	0.4	--	--	--	--	--
Calamospora pedata Kosanke	--	--	--	--	--	--	--	--	--	×	--
C. spp	--	.4	--	--	--	×	--	--	--	1.6	1.6
Cirratriradites maculatus Wilson and Coe	×	--	--	--	--	.4	--	--	--	--	0.8
Convolutispora spp	--	--	--	--	--	.4	--	--	0.8	1.2	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	--	×	--	--	--	--	.8	--	8.8
Densosporites triangularis Kosanke	--	16.4	×	28.0	5.6	39.2	--	--	--	19.2	1.6
D. spp	--	1.6	×	5.2	0.8	4.8	×	×	.8	2.8	.8
D. "rings"	--	--	×	3.2	.8	2.0	--	--	.8	28.0	--
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	×	--	--	--	--	--	--	--	--	3.2	--
Endosporites formosus Kosanke	×	--	--	--	--	--	--	--	--	--	--
E. globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	--	--	--	--	×	--	--	--	--	--
E. ornatus	×	--	--	--	--	--	--	--	.8	--	--
E. sp	×	--	--	--	×	.8	--	--	.8	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	--	×	--	4.4	.4	--	×	11.2	.4	2.4
Granulatisporites pallidus Kosanke	--	--	×	×	×	--	--	--	4.0	--	.8
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	×	--	×	--	2.4	1.6	×	×	--	1.2	3.2
G. spp	--	.4	--	1.2	2.4	7.6	--	--	8.8	4.0	3.2
Knoxisporites cf. *K. rotatus* Hoffmeister, Staplin, and Malloy	--	--	--	--	--	×	--	--	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	.4	--	--	--	.4	--	×	.8	1.6	×
L. globosus Schemel	×	13.6	×	12.8	9.2	6.8	--	--	8.8	6.0	12.8
L. latus Kosanke	--	--	--	0.4	--	.8	--	--	--	--	--
L. medius Kosanke	--	2.8	--	1.6	4.4	1.2	--	--	3.2	2.4	3.2
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	20.8	×	15.2	24.0	6.8	--	--	11.2	11.2	2.4

Coal sample 554-B, occurring about 5 m above 554-D, has *Lycospora* as the dominant genus and *Laevigatosporites* as the subdominant. The bone coal sample 554-A, occurring about 2.5 m above 554-B, has *Densosporites* and *Laevigatosporites* as codominant genera. The codominance of these two genera together with specimens assigned to *Verrucosisporites* differentiates this sample (554-A) from the other two coal samples of this series (554-B and 554-D).

A set of samples of the Upper No. 5 Block coal (maceration series 572-A-F) was collected from above the 12-A of the Valley Camp Coal Company northwest of Mammoth, Kanawha County, W. Va. The palynological data are shown in table 14, and the abundant genera of the coal samples (572-B-E) are:

Densosporites	4.3 percent
Laevigatosporites	43.3
Lycospora	16.0
Torispora	21.4
	85.0 percent

Laevigatosporites is clearly dominant; *Lycospora*, *Torispora*, and *Densosporites* are present at approximately the same rate as in another sample of the Upper No. 5 Block coal (554-D).

Another coal sample that is thought from palynological evidence to be related to the Upper No. 5 Block coal (maceration series 436) was collected about 20 m above the Lower No. 5 Block coal (maceration series 435). The palynomorph analyses are shown in

TABLE 11.—*Palynomorphs from the Lower No. 5 Block coal bed in West Virginia, series 446*—Continued

[Maceration series 446; USGS Paleobotanical loc. No. D6039; 1,750 specimens counted; ×, present but not observed in count]

Taxon	446-A	446-B	446-C	446-D	446-E	446-F	446-G	446-H	446-I	446-J	446-K
						(percent)					
L. ovalis Kosanke	--	10.8	--	3.6	7.6	6.4	--	--	12.0	7.2	9.6
L. punctatus Kosanke	--	3.6	--	8.0	4.0	2.4	--	×	2.4	--	3.2
Lophotriletes microsaetosus (Loose) Potonié and Kremp	--	--	--	--	--	.8	--	--	--	--	--
Lycospora granulata Kosanke	--	1.2	--	.4	1.2	.8	--	--	.8	--	7.2
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	.4	--	--	4.4	--	--	--	.8	--	4.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke	--	3.6	--	--	×	--	--	--	2.4	--	--
L. punctata Kosanke	--	7.6	--	--	5.2	1.2	--	--	--	.4	--
L. spp	--	11.2	×	.4	5.6	9.6	×	×	8.8	2.8	12.8
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	×	.8	--	--	3.6	--	--	--	2.4	×	--
Punctatisporites obliquus Kosanke	--	.4	--	--	.8	.4	--	--	.8	--	4.0
P. spp	×	--	--	×	--	1.2	--	×	6.4	2.4	3.2
Radiizonates sp	--	--	--	--	--	×	--	--	--	--	--
Raistrickia crinita Kosanke	--	--	--	--	--	--	--	--	--	--	.8
Reticulatisporites sp	--	--	--	--	--	--	--	--	--	--	.8
Torispora securis Balme	×	3.2	--	--	10.8	1.6	--	×	--	2.4	--
T. sp	--	--	--	16.8	1.2	1.6	--	--	--	1.2	6.4
Triquitrites protensa Kosanke	×	--	--	2.4	1.2	--	--	--	4.0	--	3.2
T. sp	--	×	--	--	.4	×	--	--	--	--	--
Verrucosisporites sifati (Ibrahim) Smith and Butterworth	--	×	--	--	--	--	--	--	--	--	--
Vesicaspora wilsonii (Schemel) Wilson and Venkatachala	--	--	--	--	--	--	--	--	×	--	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	--	--	--	--	--	--	--	3.2	--	--
Wilsonites sp	--	--	--	--	--	--	--	--	.8	--	--
Monosaccate	--	--	--	--	--	--	--	×	2.4	--	--
Unassigned	--	.8	×	.8	--	.4	×	--	--	.4	3.2
Total		100.0		100.0	100.0	100.0			100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

446-A,	5.1 cm roof rock.	446-G,	25.4 cm parting.
446-B,	34.3 cm coal.	446-H,	25.4 cm parting.
446-C,	2.5 cm parting.	446-I,	33.6 cm coal.
446-D,	34.3 cm coal.	446-J,	33.6 cm coal.
446-E,	34.3 cm coal.	446-K,	33.6 cm coal.
446-F,	34.3 cm coal.		

TABLE 12.—*Palynomorphs from the Upper No. 5 Block(?) coal bed in West Virginia, series 447*

[Maceration series 447; USGS Paleobotanical loc. No. D6040; 1,000 specimens counted; ×, present but not observed in count]

Taxon	447-A	447-B	447-C (percent)	447-D	447-E
Alatisporites hexalatus Kosanke	--	--	1.2	--	--
A. sp.	--	--	0.4	--	--
Calamospora hartungiana Schopf in Schopf, Wilson, and Bentall	×	--	--	--	--
C. spp	0.4	1.2	2.4	--	0.4
Cirratriradites maculatus Wilson and Coe	--	0.8	1.6	--	.4
Crassispora kosankei (Potonié and Kremp) Bharadwaj	2.0	--	2.0	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	--	--	--	.4
D. triangularis Kosanke	10.4	34.8	32.0	×	11.6
D. spp	6.8	7.2	2.4	--	4.8
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	.8	.4	.4	--	.4
Endosporites ornatus Wilson and Coe	×	--	2.0	--	--
E. sp	.4	--	1.6	×	.8
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.8	.8	--	--	--
F. sp	--	.8	.8	--	1.2
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.4	--	2.8	×	.4
G. spp	×	3.6	1.6	--	.4
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	.8	.8	1.6	--	2.8
L. globosus Schemel	8.4	11.6	4.0	×	8.4
L. latus Kosanke	.4	--	--	--	.4
L. medius Kosanke	4.0	.8	.4	×	5.2
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	14.8	8.4	2.4	×	1.2
L. ovalis Kosanke	31.2	2.4	10.8	--	9.2
L. punctatus Kosanke	2.0	2.0	2.4	×	4.0
Lycospora granulata Kosanke	.8	1.2	2.8	×	1.6
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	3.2	.8	--	2.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke	3.6	.8	2.8	--	2.4
L. spp	5.2	4.0	7.2	--	3.2
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	.4	--	--	--	--
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	.8	--	.8
P. quasioarcuatus Kosanke	--	2.4	--	--	1.2
P. spp	2.0	4.8	3.6	--	4.8
Radiizonates tenuis (Loose) Butterworth and Smith in Butterworth and others, 1964	--	--	--	--	14.0
R. cf. *R. faunus* (Ibrahim) Smith and Butterworth	--	--	--	--	×
Raistrickia sp	×	--	--	×	--
Reticulatisporites cf. *R. polygonalis* (Ibrahim) Loose	--	.8	1.6	--	--
Torispora securis Balme	2.4	4.8	4.0	×	15.2
Triquitrites cf. *T. sculptilis* Balme	--	--	.4	--	--
T. sp	--	1.6	.4	--	--
Vestispora sp	.4	--	--	--	--
Zosterosporites triangularis Kosanke	--	--	--	×	--
Monosaccate	--	.8	2.8	--	2.4
Unassigned	--	--	--	--	.4
Total	100.0	100.0	100.0		100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

447-A, 33.6 cm coal.
447-B, 33.6 cm coal.
447-C, 33.6 cm coal.
447-D, 12.7 cm parting.
447-E, 40.6 cm coal.

TABLE 13.—*Palynomorphs from the Upper No. 5 Block coal bed in West Virginia, series 554*

[Maceration series 554, USGS Paleobotanical loc. No. D6041; 750 specimens counted: ×, present but not observed in count]

Taxon	554-A	554-B	554-C	554-D
		(percent)		
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	0.4	--	--
Calamospora breviradiata Kosanke	--	.4	--	--
C. hartungiana Schopf in Schopf, Wilson, and Bentall	0.8	.8	--	--
C. parva Guennel	--	.4	--	--
C. sp	1.6	.8	--	×
Cirratriradites sp	.8	.4	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	.8	×	0.4
Cyclogranisporites sp	--	--	--	.8
Densosporites sphaerotriangularis Kosanke	--	--	--	.4
D. triangularis Kosanke	8.0	×	--	.4
D. sp	14.4	.8	--	4.4
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	--	.8	--	.4
D. sp	.8	--	--	--
Endisporites cf. *E. globiformis* (Ibrahim) Schopf, Wilson, and Bentall	--	4.4	--	--
E. ornatus Wilson and Coe	--	×	--	--
E. sp	--	1.6	--	1.2
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.8	2.4	--	1.6
Granulatisporites pallidus Kosanke	.8	--	--	×
G. sp	.8	1.6	×	×
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	.8	1.2	--	2.4
L. globosus Schemel	.8	6.0	×	6.0
L. latus Kosanke	--	×	--	1.2
L. medius Kosanke	2.4	2.8	--	3.6
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	2.4	1.6	--	5.2
L. ovalis Kosanke	14.4	10.4	×	16.0
L. punctatus Kosanke	2.4	1.2	×	8.2
L. vulgaris (Ibrahim) Alpern and Doubinger	.8	.8	--	2.0
Lycospora granulata Kosanke	4.0	2.8	--	1.6
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	--	×	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	1.6	26.4	--	6.4
L. punctata Kosanke	--	1.6	--	.8
L. spp	6.4	21.6	--	15.8
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	1.6	--	--	--
Murospora kosankei Somers	1.6	--	--	.4
Punctatisporites sp	5.6	.8	--	--
Radiizonates sp	3.2	×	--	.8
Reinschospora sp	--	--	×	--
Raistrickia cf. *R. aculeata* Kosanke	.8	--	--	--
Torispora securis Balme	8.0	.8	×	16.0
Triquitrites protensus Kosanke	--	×	--	--
T. pulvinatus Kosanke	.8	2.4	--	.4
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	1.6	×	--
V. levigata Wilson and Venkatachala	--	.4	--	--
Verrucosisporites sifati (Ibrahim) Schopf, Wilson, and Bentall	.8	--	--	--
V. verrucosus (Ibrahim) Ibrahim	2.4	--	--	.8
V. spp	5.6	.4	--	2.4
Wilsonites sp	--	.4	--	--
Monosaccate	1.6	1.2	×	.4
Unassigned	1.6	--	--	--
Total	100.0	100.0		100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

554-A, 12.7 cm bone coal, 2.5 m above 554-B.
554-B, 35.5 cm coal, 5 m above 554-D.
554-C, 7.6 cm shale 1 m below 554-B.
554-D, 35.5 cm coal 12 m above 553.

table 15, and the bottom two samples (436-B-C) were productive. Analyses of these samples suggest a similarity to other samples of the Upper No. 5 Block coal (554-D and maceration series 572). *Radiizonates* is present although not abundant in all sets of the Upper No. 5 Block coal (maceration series 436, 554, and 572). *Zosterosporites triangularis* is present in the seat-rock sample of the 436 maceration series. The numerically important genera of coal sample 436-B are:

Laevigatosporites	53.2 percent
Lycospora	15.2
Torispora	13.2
	81.6 percent

Another set of samples of the Upper No. 5 Block coal (574-A-C) were collected adjacent to a pipeline northwest of Marting, east of the Kanawha-Fayette County line, in Fayette County, W. Va. The sample breakdown and palynomorph analyses are given in table 16. These samples appear to be related to those of maceration 554-B because each coal sample has *Lycospora* as the dominant taxon. However, *Triquitrites* and *Granulatisporites* are notably more abundant in coal sample 574-A.

Zosterosporites triangularis Kosanke has been identified from both the Lower and Upper No. 5 Block coals, but it is not abundant and does not occur consistently. This type of range zone was observed in some coals of the Princess Reserve District of eastern Kentucky by Kosanke (1973). The abundant genera of coal sample 574-A are:

Granulatisporites	6.4 percent
Laevigatosporites	13.6
Lycospora	40.0
Torispora	5.6
Triquitrites	8.8
	74.4 percent

TABLE 14.—*Palynomorphs from the Upper No. 5 Block coal bed in West Virginia, series 572*

[Maceration series 572; USGS Paleobotanical loc. No. D6112; 1,250 specimens counted; ×, present but not observed in count]

Taxon	572-A	572-B	572-C	572-D	572-E	572-F
			(percent)			
Acanthotriletes cf. *A. triquetrus* Smith and Butterworth	0.8	--	--	--	×	--
Alatisporites trialatus Kosanke	.8	0.8	--	--	--	--
Anapiculatisporites spinosus (Kosanke) Potonié and Kremp	.8	×	--	--	--	--
Calamospora breviradiata Kosanke	--	3.6	0.4	--	0.4	--
C. sp	--	1.6	.4	--	.4	--
Cirratriradites annuliformis Kosanke and Brokaw	--	--	.4	0.4	1.2	--
C. sp	1.6	.4	--	--	.4	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	4.8	1.6	.4	.8	--	--
Cristatisporites sp	--	--	1.2	--	--	--
Densosporites triangularis Kosanke	4.0	--	3.2	.4	--	--
D. spp	2.4	×	10.8	1.6	.8	×
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	×	.4	.4	--	--	--
Endosporites ornatus Wilson and Coe	2.4	3.2	--	--	--	--
E. sp	2.4	1.2	.4	--	.4	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	4.0	.8	.4	.8	2.0	--
F. sp	1.6	--	.4	--	.8	--
Granulatisporites pallidus Kosanke	.8	--	--	--	--	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	.4	--	--	1.2	--
G. spp	1.6	1.2	.4	.4	.4	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	.8	.4	.8	.4	--
L. globosus Schemel	6.4	8.8	6.8	9.6	4.4	×
L. latus Kosanke	--	1.6	--	.4	.4	--
L. medius Kosanke	5.6	2.8	3.6	2.4	3.2	--
L. minutus (Wilson and Coe) Schopf, Wilson, and Bentall	4.8	3.6	9.2	11.2	1.2	×
L. ovalis Kosanke	12.8	31.2	14.4	12.8	9.2	×
L. punctatus Kosanke	--	8.0	9.2	12.4	4.4	--
L. vulgaris (Ibrahim) Alpern and Doubinger	.8	--	--	×	--	--
Leiotriletes sp	--	×	--	--	×	×
Lycospora brevijuga Kosanke	--	--	.4	--	×	--

The exact palynological placement of maceration 554-A is not certain, but it most likely would fall between maceration series 574 and 573 of the Upper No. 5 Block coal. Four samples (573-A-D) were collected from the highwall of the Cannelton Coal Company Mine, located northwest of Marting and east of the Kanawha-Fayette County line in Fayette County, W. Va., but only the coal sample 573-B-C contained sufficient palynomorphs to make abundance counts (table 17).

Most significant is the occurrence of *Thymospora* at the rate of 11.4 percent together with the presence of *Punctatisporites obliquus* Kosanke and *P. minutus* (Kosanke) Peppers, because this must place the samples of maceration series 573 very close to the position of the Lower Kittanning coal. In Illinois, the range zone of *T. pseudothiessenii* starts below the Colchester (No. 2) Coal Member according to Kosanke (1950) and Peppers (1970) and is present throughout the Carbondale Formation and the lower part of the Modesto Formation. Kosanke (1973) reported that the range zone of *T. pseudothiessenii*, in the Princess Reserve District of northeastern Kentucky, started in the Princess 5B coal, which is stratigraphically just below the Princess No. 6 coal and is present above in the Breathitt and Conemaugh Formations. Kosanke (1973) correlated the Princess No. 6 coal with the Lower Kittanning coal of western Pennsylvania and eastern Ohio. Gray (1967) reported on the palynomorph content of coals in the lower and middle Allegheny of western Pennsylvania and eastern Ohio. *Thymospora pseudothiessenii* was identified from the Lower Kittanning and younger coals but not from the Lawrence coal, a thin coal occurring below the Lower Kittanning coal.

The presence of *Thymospora* in coal samples of maceration series 573 suggests that the coal is near the position of the Lower Kittanning coal. A comparison of the assemblage of palynomorphs from the Lower Kittanning coal (Habib, 1966; Gray, 1967) with those of series 573, however, suggests that series 573 is older,

TABLE 14.—*Palynomorphs from the Upper No. 5 Block coal bed in West Virginia, series 572*—Continued

[Maceration series 572; USGS Paleobotanical loc. No. D6112; 1,250 specimens counted; ×, present but not observed in count]

Taxon	572-A	572-B	572-C	572-D	572-E	572-F
			(percent)			
L. granulata Kosanke	2.4	1.2	1.6	.4	15.6	×
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	.8	--	--	.8	×
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	--	--	2.4	--	2.8	×
L. punctata Kosanke	×	1.6	.8	--	6.4	×
L. spp	8.8	4.0	9.2	1.6	14.0	--
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	.8	.8	1.2	--	--	--
Murospora kosankei Somers	.8	×	--	--	×	--
Punctatisporites minutus (Kosanke) Peppers	1.6	--	--	.8	1.2	--
P. obesus (Loose) Potonié and Kremp	×	--	.4	.4	.4	--
P. sp	--	2.8	2.4	1.2	2.4	--
Reticulatisporites lacunosus Kosanke	--	--	.4	--	--	--
R. sp	--	.4	--	--	--	--
Radiizonates sp	.8	--	--	×	×	--
Reinschospora sp	.8	--	--	--	--	--
Torispora securis (Balme) Alpern, Doubinger, and Horst	12.0	11.2	15.2	39.6	19.6	×
Triquitrites protensus Kosanke	×	.8	.4	.8	.8	--
T. pulvinatus Kosanke	×	.8	--	--	--	--
T. sculptilis Balme	3.2	.8	--	--	--	×
T. sp	.8	--	.4	--	--	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	.8	1.2	--	.4	.4	--
V. sp	.8	1.2	.8	.8	.8	--
Wilsonites sp	3.2	--	.4	--	2.0	--
Monosaccate	3.2	.4	.8	--	1.6	×
Unassigned	--	×	.8	--	×	--
Total	100.0	100.0	100.0	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

572-A, 15.2 cm roof.
572-B, 33.0 cm coal.
572-C, 33.0 cm coal.
572-D, 33.0 cm coal.
572-E, 33.0 cm coal.
572-F, 15.2 cm seat rock.

TABLE 15.—*Palynomorphs from the Upper No. 5 Block coal bed in West Virginia, series 436*

[Maceration series 436; USGS Paleobotanical loc. No. D6042; 500 specimens counted; ×, present but not observed in count]

Taxon	436-A	436-B (percent)	436-C
Alatisporites various Kosanke	×	0.4	--
Calamospora sp	--	1.2	×
Cirratriradites annulatus Kosanke	×	×	--
Convolutispora sp	--	.4	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	.8	×
C. sp	--	--	×
Densosporites sphaerotriangularis Kosanke	×	--	×
D. triangularis Kosanke	--	.8	×
D. spp	×	.4	1.6
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	--	.4	--
Endosporites cf. *E. globiformis* (Ibrahim) Schopf, Wilson, and Bentall	×	×	--
E. ornatus Wilson and Coe	×	.8	--
E. sp	--	.8	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	4.0	1.6
F. sp	×	--	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	.8	--
G. spp	×	2.8	7.2
Knoxisporites sp	--	×	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	1.2	--
L. globosus Schemel	×	9.2	4.0
L. latus Kosanke	--	×	--
L. medius Kosanke	--	4.0	0.8
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	21.6	30.4
L. ovalis Kosanke	×	12.8	5.6
L. punctatus Kosanke	--	4.4	.8
Lycospora granulata Kosanke	--	.4	.8
Lycospora micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	1.2	1.6
L. punctata Kosanke	--	4.4	.8
L. spp	×	9.2	12.8
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	--	.4	1.6
Punctatisporites obesus Potonié and Kremp	--	×	--
P. spp	×	2.8	3.2
Radiizonates sp	×	--	--
Reinschospora sp	--	×	--
Torispora securis Balme	--	12.4	4.8
T. sp	--	.8	.8
Triquitrites cf. *T. arculatus* Wilson and Coe	--	.4	--
T. protensus Kosanke	--	--	.8
T. pulvinatus Kosanke	--	--	1.6
T. sculptilis Balme	--	--	6.4
T. spp	--	.4	12.0
Verrucosisporites sifati (Ibrahim) Schopf, Wilson, and Bentall	--	×	--
Vestispora sp	×	--	--
Zosterosporites triangularis Kosanke	--	--	.8
Monosaccate	×	1.2	--
Total		100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

436-A, 11.4 cm roof rock.
436-B, 38.1 cm coal.
436-C, 3.8 cm seat rock.

based on the presence of *Schopfites* in the Lower Kittanning coal and its absence from series 573. Further, the coal of maceration series 573 would be older than the Princess No. 6 coal of northeastern Kentucky (Kosanke, 1973) for the same reason, the lack of *Schopfites*. A summary of generic abundance for coal samples 573-B-C follows:

Acanthotriletes	11.4 percent
Laevigatosporites	47.4
Lycospora	12.0
Punctatisporites	5.0
Thymospora	11.4
	87.2 percent

No. 6 Block coal occurs about 15 m above the Upper No. 5 Block coal (573) in the highwall of the Cannelton Coal Company strip. The only good sample collected from the No. 6 Block coal (maceration 603) was a block of coal about 15 cm thick. This sample yielded an interesting assemblage of palynomorphs (table 18). *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala is present, constituting 21 percent of the assemblage. I have found *Schopfites* thus far only in the No. 6 Block coal bed of the proposed Pennsylvanian System stratotype of West Virginia. Such an occurrence places the No. 6 Block coal (maceration 603) at the position of the Princess No. 6 and No. 7 coals of eastern Kentucky (Kosanke, 1973, p. 4). Habib (1966) reported *Schopfites* sp. present in the Lower Kittanning coal of western Pennsylvania. Gray (1967) reported this genus present in the Lower and Middle Kittanning coals of western Pennsylvania and eastern Ohio. Kosanke originally described the genus from the Colchester (No. 2) Coal Member of the Carbondale Formation of Illinois and reported the genus to be present from there up to and including the Briar Hill (No. 5A) coal. Peppers (1970) reported *Schopfites* present in two thin coals below the Colchester (No. 2) Coal Member of the Carbondale and that it occurred above the Colchester up to and including the Briar Hill (No. 5A) Coal Member of the Carbondale. Interestingly, Gray (1967) reported *Schopfites* present in the Strasburg coal of Ohio, which occurs between the Lower and Middle Kittanning coals.

Normally *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala would not be present in the Lower Kittanning coal at the rate of 21 percent of the assemblage as it is in the No. 6 Block coal (maceration 603). The high percentage of *T. pseudothiessenii* is unexplained, but may be related to the fact that the sample (603) was merely a part of a coal bed (one block). Gray (1967) reported *T. pseudothiessenii* present in the Lower Kittanning coal at the rate of 2.9 percent based on overall occurrence in the coal, but it reached a maximum of 21 percent in the top half of the Lower Kittanning coal. Habib (1966) reported that *T. pseudothiessenii* occurred in his samples of the Lower Kittanning coal and varied in abundance from 2 to 19 percent. Peppers (1970) reported *T. pseudothiessenii* present in Illinois at the rate of less than 10 percent until the Summum (No. 4) Coal Member is reached, at which time it is abundant (from 12 to more than 25 percent) through the Briar Hill (No. 5A) Coal Member.

Because the No. 6 Block coal sample represents only one block rather than a column sample of the coal, it is possible to indicate only that this sample could correlate with the Lower Kittanning coal of western Pennsylvania and eastern Ohio and the Princess No. 6 coal of eastern Kentucky. Kosanke (1973) reported the overall average of *Thymospora pseudothiessenii* in the Princess No. 6 coal to be about 6 percent, but as high as 30 percent in the Princess No. 7 coal above.

A summary of most abundant genera of coal sample 603 follows:

Laevigatosporites	36.0 percent
Lycospora	28.8
Thymospora	21.6
	86.4 percent

UPPER PENNSYLVANIAN SERIES

CONEMAUGH AND MONONGAHELA FORMATIONS

The Conemaugh Formation in its type area in the northern part of the Dunkard Basin is bracketed below by the Upper Freeport coal and above by the Pittsburgh coal. Because coals are not prominent in this part of the Pennsylvanian System stratotype, the base of the Conemaugh Formation, according to T. W. Henry (oral commun., 1980), is the first appearance of the red bed sequence above what Krebs (1914) called the "Mahoning sandstone." The top of the Conemaugh Formation is the base of the Pittsburgh No. 8 coal. Samples from the Conemaugh Formation have been collected and are being studied.

The primary coal of the Monongahela Formation, the Pittsburgh No. 8 coal, is the base of the formation (fig. 3). A sample of coal from a locality 1.6 km south of

TABLE 16.—*Palynomorphs from the Upper No. 5 Block coal bed (lower bench) in West Virginia*

[Maceration series 574, USGS Paleobotanical loc. No. D6113; 500 specimens counted; ×, present but not observed in count]

Taxon	574-A	574-B (percent)	574-C
Acanthotriletes sp	--	0.4	--
Alatisporites hexalatus Kosanke	--	×	--
Apiculatisporis sp	0.8	--	--
Calamospora breviradiata Kosanke	.8	1.6	--
C. sp	×	.8	--
Cirratriradites annulatus Kosanke	.8	--	--
C. sp	.8	.4	×
Convolutispora sp	.8	.4	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	3.2	1.2	×
Densosporites triangularis Kosanke	--	2.8	--
D. sp	--	--	×
Dictyotriletes sp	--	×	--
Endosporites ornatus Wilson and Coe	×	.8	--
E. sp	×	.8	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	2.4	2.4	×
Granulatisporites granularis Kosanke	1.6	1.6	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	--	--
G. sp	3.2	1.6	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	.8	5.6	×
L. globosus Schemel	4.0	3.2	--
L. latus Kosanke	.8	.8	--
L. medius Kosanke	1.6	4.0	--
L. minutus (Wilson and Coe) Schopf, Wilson, and Bentall	2.4	5.6	--
L. ovalis Kosanke	2.4	11.2	×
L. punctatus Kosanke	1.6	.4	--
Lycospora granulata Kosanke	9.6	1.6	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	1.6	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	.8	.4	--
L. punctata Kosanke	5.6	4.8	--
L. spp	22.4	12.0	×
Mooresporites inusitatus (Kosanke) Neves	--	.4	--
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	3.2	5.6	--
Punctatisporites obliquus Kosanke	.8	.4	--
P. sp	.8	.4	--
Pustulatisporites sp	--	.4	--
Raistrickia sp	.8	×	--
Reticulatisporites sp	--	×	--
Torispora securis Balme	5.6	8.0	×
Trihyphaecites triangulatus Peppers	.8	--	--
Triquitrites exiguus Wilson and Kosanke	--	.8	--
T. pulvinatus Kosanke	4.0	5.2	--
T. sculptilis Balme	--	.8	--
T. spp	4.8	.8	--
Verrucosisporites sifati (Ibrahim) Schopf, Wilson, and Bentall	--	1.6	--
V. sp	--	.8	--
Vesicaspora wilsonii (Schemel) Wilson and Venkatachala	--	×	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	.8	.4	--
V. levigata Wilson and Venkatachala	.8	--	--
V. sp	1.6	--	--
Wilsonites vesicatus (Kosanke) Kosanke	1.6	2.4	--
Zosterosporites triangularis Kosanke	--	1.6	--
Monosaccate	3.2	4.0	--
Unassigned	1.6	.4	--
Total	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

574-A, 22.8 cm coal.
574-B, 6.4 cm carbonaceous shale.
574-C, 34.3 cm coal transitional to seat rock.

Tuppers Creek Road along Interstate 77 in the Pocatalico quadrangle was correlated with the Pittsburgh No. 8 coal. These samples were assigned to macerations 428-A-C, and the numerically important taxa appear in table 19 and on figure 4. The characteristic or diagnostic occurrence of *Thymospora thiessenii* (Kosanke) Wilson and Venkatachala as the dominant palynomorph in all levels of the Pittsburgh No. 8 coal was initially reported by Thiessen and Staud (1923), based on their coal thin-section investigations, and subsequently by Kosanke (1943) based on coal maceration studies. Theissen originally referred to this spore as the "Pittsburgh" spore and later as the "Pittsburgh microspore." Kosanke (1943) described this same taxon and named it *Laevigatosporites thiessenii*. Subsequently, Wilson and Venkatachala (1963) transferred it to *Thymospora thiessenii*. The most unusual aspect of the Pittsburgh No. 8 coal is that *T. thiessenii* represents more than three-fourths of the total palynomorph assemblage.

TABLE 17.—*Palynomorphs from the Upper No. 5 Block coal bed (upper bench) in West Virginia*

[Maceration series 573; USGS Paleobotanical loc. No. D6114; 500 specimens counted; ×, present but not observed in count]

Taxon	573-A	573-B	573-C	573-D
		(percent)		
Acanthotriletes flexuus Habib	--	7.6	15.2	×
Calamospora sp	--	--	.8	--
Cirratriradites annulatus Kosanke	--	×	.8	--
C. sp	--	--	×	--
Crassispora sp	--	--	.8	×
Densosporites triangularis Kosanke	--	1.6	--	--
D. sp	×	3.6	.8	×
Granulatisporites pallidus Kosanke	--	×	.8	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	.8	--
Gravisporites densus Habib	--	.8	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	.4	--	--
L. globosus Schemel	×	18.4	1.6	×
L. medius Kosanke	×	7.2	6.4	--
L. minutus (Wilson and Coe) Schopf, Wilson, and Bentall	--	19.2	16.0	--
L. ovalis Kosanke	--	9.6	1.6	--
L. punctatus Kosanke	--	9.2	1.6	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	.4	--	--
Lycospora brevijuga Kosanke	--	--	.8	--
L. granulata Kosanke	--	3.2	9.6	--
L. punctata Kosanke	--	.4	--	--
L. spp	--	2.8	7.2	--
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	×	.4	.8	--
Punctatisporites minutus (Kosanke) Peppers	--	×	--	×
P. obliquus Kosanke	--	1.6	--	--
P. sp	--	2.8	5.6	×
Thymospora pseudothiessenii (Kosanke) Wilson and Venkatachala	--	4.4	12.0	×
T. cf. *T. pseudothiessenii* (Kosanke) Wilson and Venkatachala	--	--	6.4	×
Torispora securis Balme	--	4.0	1.6	×
Triquitrites exiguus Wilson and Kosanke	--	--	×	--
T. pulvinatus Kosanke	--	--	.8	--
T. sp	--	.4	--	×
Verrucosisporites sifati (Ibrahim) Smith and Butterworth	×	--	5.6	--
V. sp	--	1.2	1.6	--
Monosaccate	--	.8	.8	--
Total		100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

573-A, 19.0 cm roof rock.
573-B, 19.0 cm coal.
573-C, 19.0 cm coal.
573-D, 1.9 cm seat rock.

TABLE 18.—*Palynomorphs from the No. 6 Block coal bed in West Virginia*

[Maceration 603; USGS Paleobotanical loc. No. D6115; 250 specimens counted; ×, present but not observed in count]

Taxon	603 (percent)
Calamospora breviradiata Kosanke	1.2
C. sp	2.0
Cirratriradites annuliformis Kosanke and Brokaw	0.4
Cyclogranisporites sp	.4
Endosporites sp	.4
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.4
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.4
G. sp	.8
Laevigatosporites globosus Schemel	12.8
L. medius Kosanke	1.6
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	13.2
L. ovalis Kosanke	4.8
L. punctatus Kosanke	2.8
L. vulgaris (Ibrahim) Alpern and Doubinger	.8
Leiotriletes sp	.8
Lycospora brevijuga Kosanke	4.0
L. granulata Kosanke	11.2
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	1.6
L. spp	10.0
Punctatisporites obliquus Kosanke	1.6
P. sp	.8
Raistrickia cf. *R. imbricata* Kosanke	.4
Schopfites dimorphus Kosanke	×
Thymospora pseudothiessenii (Kosanke) Wilson and Venkatachala	21.6
Torispora securis Balme	1.2
Triquitrites pulvinatus Kosanke	.8
T. sp	.8
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	×
Verrucosisporites sp	.4
Wilsonites sp	1.2
Monosaccate	1.6
Total	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

603, one lump of coal.

TABLE 19.—*Numerically important palynomorphs from the Pittsburgh No. 8 coal bed in West Virginia*

[Maceration series 428; USGS Paleobotanical loc. No. D6043; 750 specimens counted; ×, present but not observed in count]

Taxon	428-A	428-B	428-C	428 A-C
	(percent)			
Laevigatosporites medius Kosanke	3.2	2.0	7.2	4.1
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	4.0	2.8	6.0	4.2
L. ovalis Kosanke	3.6	3.2	6.4	4.4
Thymospora thiessenii (Kosanke) Wilson and Venkatachala	84.4	88.0	72.4	81.6
Total	95.2	96.0	92.0	94.3

DESCRIPTION OF MATERIAL IN MACERATIONS

428-A, 35.5 cm coal.
428-B, 35.5 cm coal.
428-C, 35.5 cm coal.

PALYNOMORPH ASSEMBLAGES FROM PART OF THE POTTSVILLE FORMATION OF OHIO AND THE LEE FORMATION OF EASTERN KENTUCKY

The Pennsylvanian rocks of Ohio and eastern Kentucky are not highly metamorphosed; therefore, recovery of palynomorphs is relatively easy and preservation is generally excellent. Figure 7, modified from Stout (1939), records the presence of four coals within the basal 30.4 m of the Pottsville Formation of Ohio. The oldest coal is the Sharon No. 1 coal, which occurs a short distance above the Sharon Conglomerate Member (Stout, 1939; Collins, 1979). Above this, in this 30.4 m interval, Stout recorded the presence of the Anthony, Huckleberry, and Quakertown No. 2 coals. The Sharon No. 1 and the Quakertown No. 2 coals were mined and prized for their low sulfur content. For a discussion of the lithostratigraphy, biostratigraphy, and coal resources of this part of the Pottsville of Ohio, see Collins (1979).

Two sets of samples of the Sharon No. 1 coal have been collected, prepared, and examined. These sets of samples (maceration series 469 and 542) are from Byer quadrangle, Jackson County, in southern Ohio. The coal of maceration series 469 is 83.7 cm thick. The palynological data are shown in table 20, and the abundant genera are:

Densosporites	40.2 percent
Granulatisporites	5.6
Lycospora	44.8
	90.6 percent

Lycospora and *Densosporites* are codominant taxa and represent 85 percent of the assemblage. Both of these genera are related to the Lycopsida. Chaloner (1958) reported that the spores of *Lycospora* have been associated with arborescent lycopods, whereas the spores of *Densosporites* are associated with herbaceous lycopods. Six species of *Densosporites* have been identified (table 20) and *Lycospora pellucida* (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke is the dominant taxon assigned to that genus. No specimens assignable to *Laevigatosporites* were observed. The second sample, maceration 542, is only 52.7 cm thick and was collected as a single unit. A somewhat smaller assemblage of similar taxa was observed in sample 542, except that *Densosporites* is the dominant taxon and *Lycospora* is subdominant. *Densosporites covensis* Berry and *D. irregularis* Hacquebard and Barss are present, and these taxa occur elsewhere in the United States in Lower Pennsylvanian coals.

The Anthony coal (maceration 540) is thin and not mined. The sample prepared and examined was 27.9 cm thick and came from the Sciotoville quadrangle in southern Ohio. *Lycospora* is the dominant taxon (table 21), and *Densosporites* is subdominant. *Lycospora pellucida* (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke represents 33.6 percent of the palynomorph assemblage. This assemblage is similar to the sample from the Sharon No. 1 coal in that *Densosporites covensis* Berry and *D. irregularis*

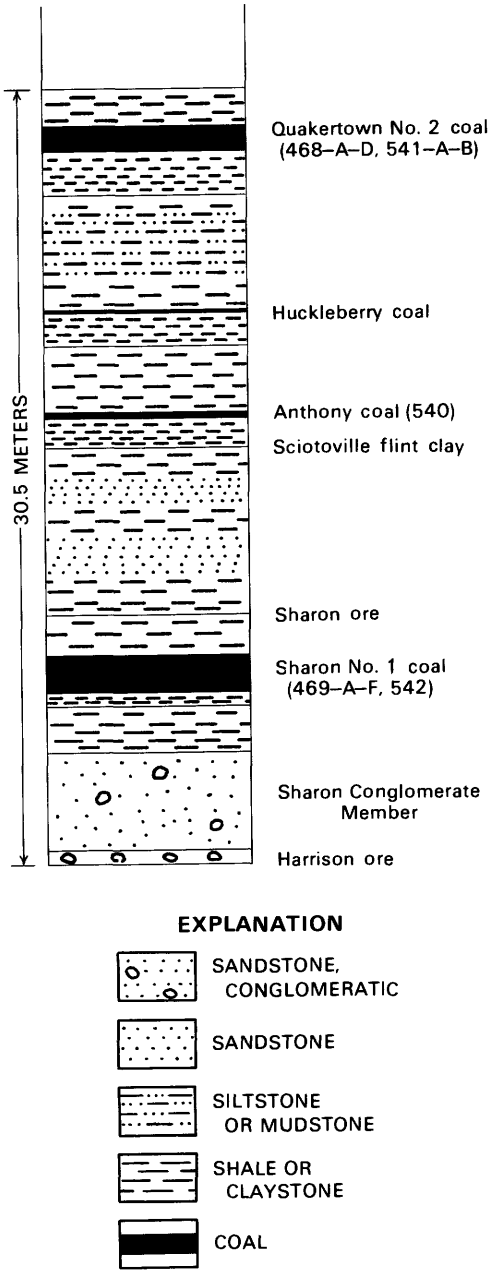

FIGURE 7.—Generalized section of the basal 30.5 m of the Pottsville Formation of Ohio, from Stout (1939). Maceration numbers in parentheses mark position of samples studied.

TABLE 20.—*Palynomorphs from the Sharon No. 1 coal bed in Ohio*

[Maceration series 469; USGS Paleobotanical loc. No. D6027; 1,500 specimens counted; ×, present but not observed in count]

Taxon	469-A	469-B	469-C	469-D	469-E	469-F
			(percent)			
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	1.6	--	0.8	--	1.6
Anapiculatisporites minor (Butterworth and Williams) Smith and Butterworth	0.4	--	--	--	--	×
Apiculatisporites spp	.4	--	--	--	0.8	×
Calamospora breviradiata Kosanke	--	--	1.6	--	--	--
C. hartungiana Schopf in Schopf, Wilson, and Bentall	--	.4	.4	--	--	--
C. spp	--	.8	--	.8	1.6	2.4
Camptotriletes bucculentus (Loose) Potonie and Kremp	--	--	--	--	--	3.2
Cirratriradites cf. *C. maculatus* Wilson and Coe	--	--	--	--	--	×
Convolutispora florida Hoffmeister, Staplin, and Malloy	--	--	--	--	×	--
C. spp	.8	--	.8	--	1.2	.8
Crassispora kosankei (Potonié and Kremp) Bharadwaj	.4	×	2.4	1.2	1.2	3.2
Cristatisporites sp	--	--	.8	1.2	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	2.8	.4	.8	4.4	--
D. dissimilis Felix and Burbridge	--	--	--	13.2	19.2	31.2
D. irregularis Hacquebard and Barss	1.6	2.4	9.6	5.2	5.6	--
D. spinifer Hoffmeister, Staplin, and Malloy	--	--	--	--	.8	--
D. triangularis Kosanke	--	--	4.4	13.6	--	--
D. variabilis Felix and Burbridge	2.0	15.6	3.2	8.4	.8	9.6
D. spp	2.4	4.0	22.0	12.0	12.0	11.2
Dictyotriletes castaneaeformis (Horst) Sullivan	1.2	--	--	--	--	3.2
Endosporites sp	--	--	--	--	×	--
Granulatisporites pallidus Kosanke	1.2	--	.8	.8	7.2	6.4
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	.4	--	--	--	--
G. spp	.8	2.8	1.6	4.4	6.4	5.6
Knoxisporites rotatus Hoffmeister, Staplin, and Malloy	×	--	--	--	--	--
Lycospora granulata Kosanke	6.0	--	.8	1.2	4.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	×	--	--	--	1.2	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	32.0	42.4	30.0	21.6	18.8	9.6
L. spp	32.8	21.6	18.0	9.6	8.4	6.4
Potonieisporites elegans (Wilson and Kosanke) Wilson and Venkatachala	--	×	--	--	.4	--
Punctatisporites sinuatus (Artüz) Neves	--	--	--	--	--	×
P. spp	2.0	.8	.8	.8	1.6	.8
Raistrickia spp	×	.4	--	.8	.8	.8
Reinschospora speciosa (Loose) Schopf, Wilson, and Bentall	--	--	--	--	×	--
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	--	.8	.4	2.8	.4	4.0
Schulzospora rara Kosanke	--	.4	--	--	--	--
S. sp	.4	--	--	--	--	--
Simozonotriletes intortus (Waltz) Potonié and Kremp	×	×	--	--	--	--
Stenozonotriletes lycosporoides (Butterworth and Williams) Smith and Butterworth	13.6	--	--	.8	--	--
Waltzospora priscus (Kosanke) Sullivan	.4	1.2	1.2	--	2.8	--
Monosaccate	.4	.4	--	--	.4	--
Unassigned	1.2	1.2	.8	--	×	--
Total	100.0	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

469-A, 15.2 cm roof rock.
469-B, 25.4 cm coal.
469-C, 15.2 cm coal.
469-D, 27.9 cm coal.
469-E, 15.2 cm coal.
469-F, 16.2 cm seat rock.

Hacquebard and Barss are present along with other species of the genus reported previously in the Sharon No. 1 coal, but dissimilar in that *Densosporites* is subdominant to *Lycospora* in abundance. The most abundant genera of the Anthony coal (maceration 540) are:

Densosporites	26.8 percent
Lycospora	66.8
	93.6 percent

The single specimens *Anaplanisporites* sp., *Apiculatisporis* cf. *A. aculeatus* (Ibrahim) Smith and Butterworth, *Convolutispora florida* Hoffmeister, Staplin, and Malloy, *Grumosisporites* cf. *G. varioreticulatus* (Neves) Smith and Butterworth, and others were observed as shown in table 21. No specimens assignable to *Laevigatosporites* were observed.

The Huckleberry coal is thin and occurs above the Anthony coal and below the Quakertown No. 1 coal. No samples of this coal were available for study, so it is not known whether or not *Laevigatosporites* first occurs in the Huckleberry or in the Quakertown No. 2 coal. The occurrence of *Laevigatosporites* is well established in the Quakertown No. 2 coal (table 22; fig. 4); this is the start of the consistent occurrence of *Laevigatosporites* range zone in Pennsylvanian coals of Ohio. Poorly preserved single specimens of what were questionably assigned to *Laevigatosporites* were observed in both sets of the Sewell and Sharon No. 1 coal. Both sets of samples of the Quakertown No. 2 coal are from the Byer

TABLE 21.—*Palynomorphs from the Anthony coal bed in Ohio*

[Maceration 540; USGS Paleobotanical loc. No. D6029; 250 specimens counted; ×, present but not observed in count]

Taxon	540 (percent)
Ahrensisporites guerickei (Horst) Potonié and Kremp	0.4
Anaplanisporites sp	.4
Apiculatisporis cf. *A. aculeatus* (Ibrahim) Smith and Butterworth	.4
Apiculatisporites spp	×
Calamospora parva Guennel	×
C. sp	×
Convolutispora florida Hoffmeister, Staplin, and Malloy	×
C. cf. *C. meltia* Hoffmeister, Staplin, and Malloy	×
Crassispora kosankei (Potonié and Kremp) Bharadwaj	.8
Cyclogranisporites sp	×
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	2.0
D. covensis Berry	.4
D. dissimilis Felix and Burbridge	15.2
D. irregularis Hacquebard and Barss	2.0
D. sinuosus Kosanke	2.0
D. spinifer Hoffmeister, Staplin, and Malloy	.8
D. sp	4.4
Granulatisporites pallidus Kosanke	2.4
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.4
G. sp	.4
Grumosisporites cf. *G. varioreticulatus* (Neves) Smith and Butterworth	×
Knoxisporites stephanephorus Love	×
K. sp	×
Lycospora granulata Kosanke	5.2
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	2.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke	33.6
L. spp	26.0
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	.4
Schulzospora rara Kosanke	×
Waltzospora priscus (Kosanke) Sullivan	×
Monosaccate	×
Unassigned	.8
Total	100.0

DESCRIPTION OF MATERIAL IN MACERATION

540, 27.9 cm coal.

quadrangle in southern Ohio (maceration series 468 and 541). The samples of the Quakertown No. 2 coal (maceration series 468) include both roof and seat-rock samples and 50.8 cm of coal sampled as the top and the bottom half of the coal. The samples of maceration series 541 consist of the top 27.8 cm and the bottom 37.4 cm of the coal. Recovery of palynomorphs from the Quakertown No. 2 coal is better in maceration series 468 than in 541. Table 22 gives the taxa identified and the abundance for the coal and seat-rock samples of maceration series 468. The roof sample of 468 did not yield well enough for an abundance count, but those taxa identi-

TABLE 22.—*Palynomorphs from the Quakertown No. 2 coal bed in Ohio*

[Maceration series 468; USGS Paleobotanical loc. No. D6030; 750 specimens counted; ×, present but not observed in count]

Taxon	468-A	468-B	468-C	468-D
		(percent)		
Acanthotriletes sp	×	--	--	--
Ahrensisporites guerickei (Horst) Potonié and Kremp	×	×	--	×
Calamospora hartungiana Schopf in Schopf, Wilson, and Bentall	--	--	2.4	--
C. parva Guennel	--	×	--	×
C. pedata Kosanke	--	×	--	.4
C. spp	×	1.2	.8	1.2
Cirratriradites sp	×	--	--	.8
Convolutispora ampla Hoffmeister, Staplin, and Malloy	--	--	×	--
C. sp	--	--	×	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	×	--	×	8.8
Cristatisporites sp	×	--	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	×	.4	--	--
D. variabilis Felix and Burbridge	×	--	--	--
D. spp	×	--	.8	--
Dictyotriletes bireticulatus (Ibrahim) Potonié and Kremp	×	×	--	--
Endosporites cf. *E. angulatus* Wilson and Coe	×	--	--	--
E. ornatus Wilson and Coe	×	--	--	2.8
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	--	--	1.6
F. sp	×	×	2.4	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	.8	1.6	2.8
G. sp	--	--	--	2.0
Grumosisporites varioreticulatus (Neves) Smith and Butterworth	--	×	--	--
Knoxisporites rotatus Hoffmeister, Staplin, and Malloy	--	--	--	.8
K. sp	--	--	--	1.2
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	--	1.6
L. latus Kosanke	--	×	1.6	--
L. medius Kosanke	×	1.2	--	2.8
L. ovalis Kosanke	×	4.8	11.2	4.4
Lycospora granulata Kosanke	×	26.0	13.6	2.8
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	×	2.0	.8	13.2
L. pellucida (Wicher) Schopf, Wilson, and Bentall–*L. pseudoannulata* Kosanke	×	44.0	24.0	25.2
L. spp	--	16.8	32.8	22.4
Potonieisporites elegans (Wilson and Kosanke) Wilson and Venkatachala	--	--	.8	--
Punctatisporites spp	×	.4	3.2	1.2
Raistrickia sp	--	.4	1.6	--
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	×	--	--	--
Schulzospora sp	×	--	--	--
Vestispora sp	--	--	--	.8
Monosaccate	--	1.2	1.6	2.8
Unassigned	--	.8	.8	.4
Total		100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

468-A, 10.2 cm roof rock.
468-B, 25.4 cm coal.
468-C, 25.4 cm coal.
468-D, 5.1 cm seat rock.

fied include *Schulzospora* sp. *Lycospora* is clearly dominant in 468-B-D as shown below:

Laevigatosporites	9.4 percent
Lycospora	79.6
	89.0 percent

L. pellucida (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke is the most abundant taxon (table 22). In addition, *L. granulata* Kosanke is numerically important in the top half of the coal (468-B). The following species of *Laevigatosporites* have been identified: *L. desmoinensis* (Wilson and Coe) Schopf, Wilson, and Bentall, *L. latus* Kosanke, *L. medius* Kosanke, and *L. ovalis* Kosanke. *Densosporites* is poorly represented in the Quakertown No. 2 coal, which contrasts markedly with the abundance of this taxon found in both the Sharon No. 1 and Anthony coals.

Maceration series 541, the Quakertown No. 2 coal, is 65 cm thick and was sampled as the top half of the coal (541-A) and the bottom half of the coal (541-B). *Lycospora* is the dominant genus in both samples with *L. granulata* Kosanke the most abundant species followed by *L. pellucida* (Wicher) Schopf, Wilson, and Bentall-*L. pseudoannulata* Kosanke. *Laevigatosporites* is present at about the same rate as was found in maceration series 468 (9.4 versus 9.7 percent), and an additional species, *L. vulgaris* (Ibrahim) Alpern and Doubinger, is present. The bottom sample (541-B) contains specimens which I assigned to *Endosporites* cf. *E. zonalis* (Loose) Knox. *Endosporites* is present in maceration series 468, but not this species.

The palynomorph content of three coals occurring within the basal 30 m of the Pottsville Formation of Ohio has been examined in detail. Representatives of both arborescent (*Lycospora*) and herbaceous (*Densosporites*) lycopods dominate the assemblages of these coals. The start of the consistent occurrence of *Laevigatosporites* is found in the Quakertown No. 2 coal. No palynological information is available on the Huckleberry coal; the start of the range zone of *Laevigatosporites* in Ohio should be clarified.

The basal Pennsylvanian formation in eastern Kentucky is the Lee Formation. The lower portion of this formation is well exposed along the London boat dock in the Sawyer quadrangle, Laurel County, Ky. Six sets of samples were collected along the road leading to the London boat dock (maceration series 129-134). Kilburn (1956) gave the measured thickness as 100.2 m. The section begins near BM B-202 at the dock at the Pennington-Lee contact and continues along the road to the top of the plateau in the Sawyer quadrangle. (For additional information see Puffett, 1962, and Rice and others, 1979.) Abundant and well-preserved spores and pollen grains were common to the upper five sets of coal samples (maceration series 129-133). The basal coal sample (maceration 134) contains a number of palynomorphs, but the sample is weathered and preservation of palynomorphs is poor so that abundance counts are not reliable. *Lycospora* is the most abundant taxon found in the other five sets of coal samples from the Hudson through the Barren Fork coal near the top of the section (fig. 8). The Barren Fork coal is the most diversified of the coals with respect to palynomorph content. *Schulzospora rara* Kosanke occurs in all six sets of the London boat dock section. *Densosporites irregularis* Hacquebard and Barss ranges from the Mississippian rocks below through the Beaver Creek coal in the Lee Formation (fig. 8). *Stenozonotriletes lycosporoides* (Butterworth and Williams) Smith and Butterworth occurs in the unnamed coal, the Hudson coal, and the Stearns 1½ coal, but *Trinidulus diamphidious* Felix and Padden is present only in the Stearns 1½ coal. *Punctatisporites sinuatus* (Artüz) Neves apparently first appears in the Hudson coal, *Dictyotriletes bireticulatus* (Ibrahim) Smith and Butterworth first appears in the thin unnamed coal (maceration series 130) just above the Hudson coal, and *Laevigatosporites* is known to occur first in the Barren Fork coal.

The *Schulzospora* range zone is continuous through all of the coals exposed in the London boat dock section of Kentucky and is known to terminate in the lower part of the Middle Pennsylvanian. In Ohio *Schulzospora* is known to be present in the Sharon No. 1, Anthony, and Quakertown No. 2 coals. The start of the *Laevigatosporites* range zone in eastern Kentucky is at the Barren Fork coal, and we know this genus is present in the Quakertown No. 2 coal of Ohio.

SUMMARY

Coals occurring in the upper half of the New River through the Monongahela Formations of the proposed Pennsylvanian System stratotype of West Virginia are amenable to the chemical maceration process allowing palynomorphs to be extracted. However, although coals occurring in the lower half of the New River and Pocahontas Formations react to the chemical maceration process, they do not consistently yield palynomorphs, so meaningful analyses are not possible. For this and other reasons, some Lower Pennsylvanian coals from Ohio have been incorporated into this report together with remarks on the occurrence of palynomorphs from some Lower Pennsylvanian coals from eastern Kentucky. Figures 4 and 9 summarize the abundance and occurrence of taxa useful in correlation

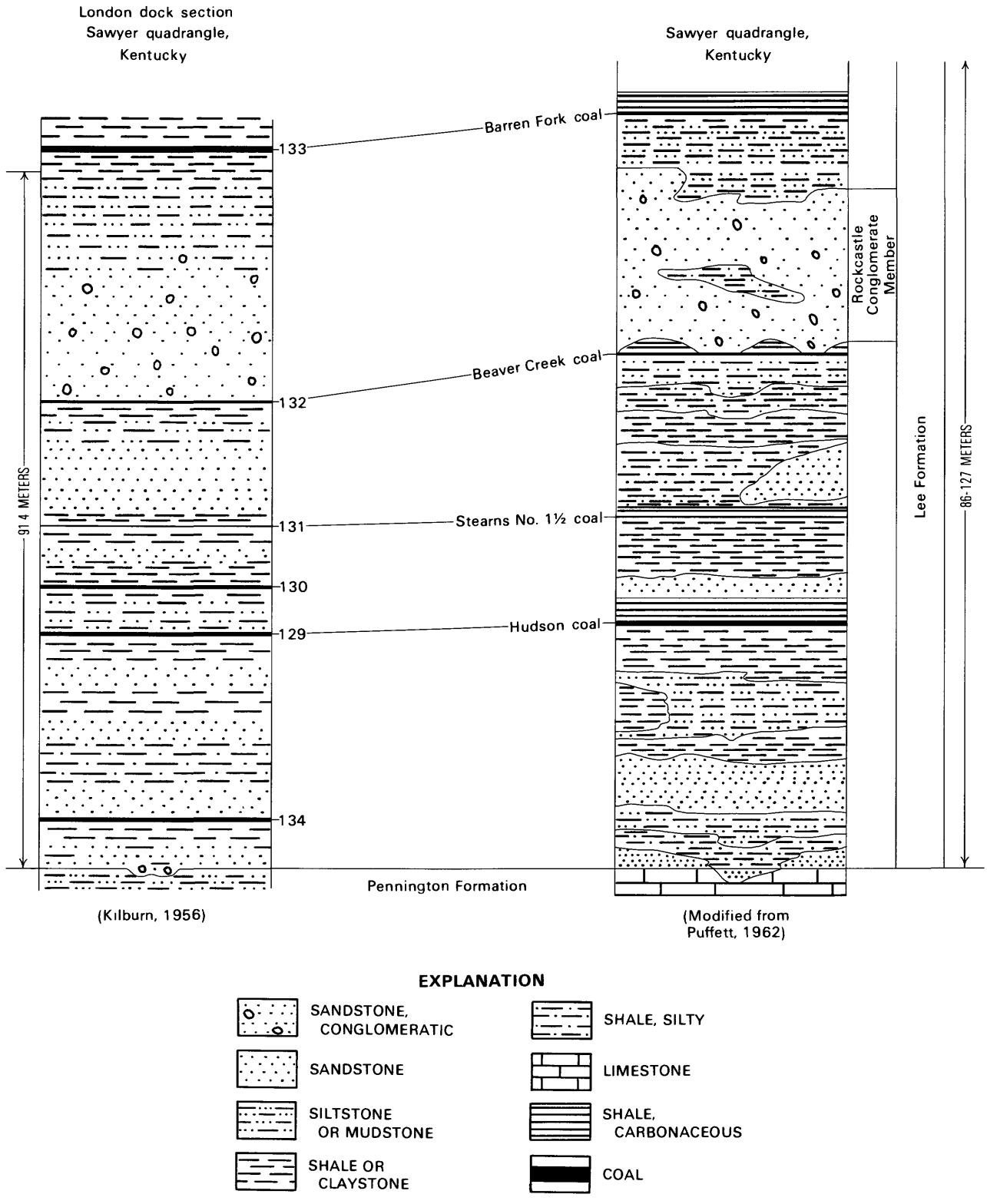

FIGURE 8.—London dock section, Sawyer quadrangle, Kentucky, as reported by Kilburn (1956), and a generalized section for Sawyer quadrangle as reported by Puffett (1962). The named coal beds have been examined as well as two thin coal beds occurring just above the Pennington Formation and above the Hudson coal. Maceration numbers 129-134 are shown.

studies. It should be noted that the scope of this investigation is the occurrence of palynomorphs of selected coal beds. Therefore, because every coal has not yet been examined, gaps remain in our knowledge concerning the precise range zones of some taxa.

The following are some of the taxa that have restricted or otherwise useful range zones (fig. 9), and are useful in biostratigraphic studies:

Densosporites annulatus (Loose) Schopf, Wilson, and Bentall
D. irregularis Hacquebard and Barss
Laevigatosporites globosus Schemel
L. punctatus Kosanke
Radiizonates spp.
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth
Schopfites dimorphus Kosanke
Schulzospora rara Kosanke
Thymospora pseudothiessenii
T. thiessenii (Kosanke) Wilson and Venkatachala
Torispora securis Balme

Lower Pennsylvanian coals from Ohio are dominated by lycopsid plants as evidenced by the abundance of *Lycospora* and *Densosporites* (fig. 4). The same is true for the Lee coals of eastern Kentucky. The Lower Douglas(?), Gilbert(?) and Cedar Grove coals from the lower part of the Kanawha Formation of West Virginia are dominated by lycopsid palynomorphs. Above the Cedar Grove coal in the Kanawha Formation of West Virginia, a significant change is noted in palynomorph assemblages by the dominance of *Laevigatosporites* in the Winifrede coal (maceration series 121). Changes were occurring rapidly by the time the Stockton coal (maceration series 566) was deposited somewhat below the Kanawha black flint, although some of these changes may have their roots in the Coalberg coal

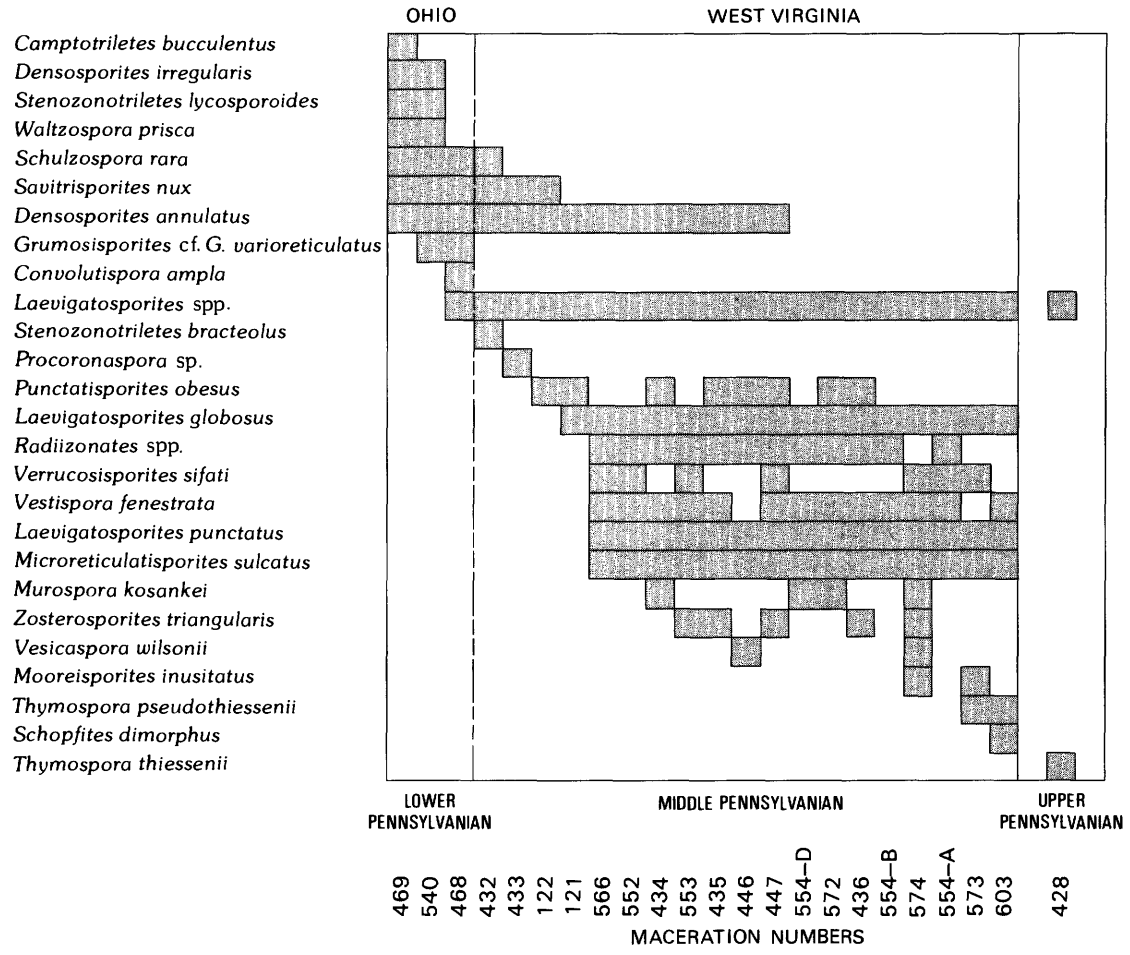

FIGURE 9.—Stratigraphic occurrence of selected taxa from Lower Pennsylvanian coals of Ohio, and Middle and Upper Pennsylvanian coals from West Virginia and the proposed Pennsylvanian System stratotype. Maceration numbers may be used to identify coal beds from which taxa have been extracted and identified.

below. Studies of the Coalberg coal have not been completed. Some of the changes noted in the Stockton coal are the following first occurrences:

Laevigatosporites punctatus Kosanke
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth
Radiizonates spp.
Torispora securis Balme
Verrucosisporites sifati (Ibrahim) Smith and Butterworth
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth

The Stockton A coal maceration series 571, occurring just above the Kanawha black flint in the Charleston Sandstone, lacks *Radiizonates* and *Torispora*, and *Lycospora* is the dominant taxon. The Little No. 5 Block coal occurs above the Stockton A coal in the Charleston Sandstone. Two sets of maceration samples have been examined (maceration series 552 and 434). The Little No. 5 Block coal is characterized by a dominance of *Laevigatosporites*, with *Torispora* and *Radiizonates* being well represented. The fact that *Torispora* is so well represented (14–20 percent) may be related to some environmental or other factor that controls the development of the unusual wall thickenings found on this taxon. The Lower No. 5 Block coal (maceration series 553 and 435) occurs above the Little No. 5 Block coal in the Charleston Sandstone. In these Lower No. 5 Block coal samples, *Laevigatosporites* and *Torispora* represent 65–70 percent of the assemblage of palynomorphs. The presence of *Crassispora* at the rate of 7–8 percent in one segment sample of each of the three sets of the Lower No. 5 Block coal examined (553-D, 435-B, and 446-K) is worthy of note.

Samples of maceration series 446 were thought, on the basis of stratigraphic position, to be the Lower No. 5 Block coal and should correlate with samples of maceration series 435 and 553. *Laevigatosporites* is the most abundant taxon in all three sets of samples, and as previously mentioned, *Crassispora* has a similar occurrence pattern in these samples. However, maceration series 446 differs from maceration series 435 and 553 in that *Densosporites* is subdominant and *Torispora* is significantly reduced in abundance. Another set of samples (maceration series 447) that has been considered to be at the Upper No. 5 Block level is palynologically similar to those of maceration series 446, with some minor differences.

The Upper No. 5 Block coal is benched, and a series of samples have been collected. These samples are arranged by stratigraphic position and by palynological content on figure 3. Samples from 436-A-C, 554-D, and 572-A-F are palynologically related by a dominance of *Laevigatosporites* and an occurrence of other taxa. Samples from 554-B and from 574-A-C are related by a dominance of *Lycospora*, even though minor differences occur. The presence of *Zosterosporites* in 574-B represents the youngest occurrence of this taxon thus far recorded from the stratotype sections. From palynological evidence, I place the bone coal sample (554-A) next in ascending order because it contains *Radiizonates*, which is lacking in maceration series 573. Samples of maceration series 573 are considered to be the upper bench of the Upper No. 5 Block coal and contain *Thymospora* and other taxa placing this coal close to the position of the Lower Kittanning coal of western Pennsylvania and eastern Ohio and the Princess No. 6 coal of eastern Kentucky. The presence of *Thymospora* is considered to be an important change in the palynomorph assemblage.

The No. 6 Block coal (maceration series 603) may be distinguished from all other coals in the Charleston Sandstone thus far discussed by the abundance of *Thymospora* and the presence of *Schopfites*. This coal is on a level with the Lower Kittanning of western Pennsylvania and eastern Ohio and the Princess No. 6 coal of eastern Kentucky.

The Pittsburgh No. 8 coal bed is characterized by a dominance of *Thymospora thiessenii* (Kosanke) Wilson and Venkatachala, according to Kosanke (1943). No other coal is known to have such a dominance of this taxon, so it is believed that the coal samples of maceration series 428 from the stratotype section correlate with the Pittsburgh No. 8 coal.

Palynomorph assemblages have been determined for selected coal beds and adjacent seat- and roof-rock samples from the proposed Pennsylvanian System stratotype of West Virginia with some additional samples from the States of Ohio and Kentucky. The floristic changes occurring in coal swamp vegetation throughout Pennsylvanian time and plant succession within individual coal beds are recorded by this investigation. Correlation of coal beds within and outside the proposed Pennsylvanian System stratotype can be accomplished with productive palynomorph samples. The range zones thus far established for the various palynomorph taxa provide a framework for subsequent biostratigraphic investigations.

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