Palynological Studies of Middle Pennsylvanian Coal Beds of the Proposed Pennsylvania System Stratotype in West Virginia

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By ROBERT M. KOSANKE

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A report on the occurrence of Middle Pennsylvanian palynomorph assemblages, range-zones, and coal correlations from the proposed Pennsylvanian System stratotype of West Virginia

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CONTENTS

ILLUSTRATIONS

[Plates follow index]

TABLES

PALYNOLOGICAL STUDIES OF MIDDLE PENNSYLVANIAN COAL BEDS OF THE PROPOSED PENNSYLVANIA SYSTEM STRATOTYPE IN WEST VIRGINIA

By ROBERT M. KOSANKE

ABSTRACT

Palynological studies of Middle Pennsylvanian coal beds and associated strata from the proposed Pennsylvanian System stratotype in West Virginia have established the occurrence and abundance of various taxa of the Kanawha Formation and Charleston Sandstone. The Kanawha Formation and the lower part of the Charleston Sandstone contain numerous coal beds and, in fact, are much more abundant than the corresponding section in the Illinois Basin. Samples were collected as uniformly as individual field circumstances permitted so that it would be possible to trace changes in palynomorph abundance from the seat rock, through the coal, and into the roof rock. Based on the palynomorphs, the resulting data are of value in identifying the fossil vegetation, of individual coal-bed sequences and collectively for the entire Middle Pennsylvanian Series. Some of this information is valuable for correlation purposes, although many suggested correlations are based on palynomorph range zones.

Forty-one different sets of coal samples and adjacent strata of the Kanawha Formation, including 153 individual samples, were prepared and examined in detail. The coal beds under consideration in the Kanawha Formation are the Douglas(?) coal bed through the Stockton Rider(?) coal bed in the proposed Pennsylvanian System Stratotype. A previous publication by the author (1984) contained many analyses of coal beds in the Charleston Sandstone. However, 16 additional sets of coal samples and adjacent strata from the Charleston Sandstone, including 37 individual samples, were prepared and examined in detail.

Species of the genus *Lycospora* dominate the palynomorph assemblages throughout much of the Kanawha Formation. Exceptions to this dominance are sporadic abundances of *Densosporites*, *Endosporites* and *Radiizonates*. *Laevigatosporites* is a minor consitiuent of many lower Kanawha coal beds, where it occurs at the rate of less than 5 percent, gradually increases in stratigraphically younger coal beds of the Kanawha Formation, and becomes the most abundant genus in one sample of the lower bench of the No. 2 Gas coal bed. Also, *Laevigatosporites* is more abundant than *Lycospora* in several sets of samples above the No. 2 Gas coal bed.

Laevigatosporites by itself and combined with *Torispora* in the lower part of the Charleston Sandstone dominates these palynomorph assemblages. *Lycospora* represents less than 20 percent of the palynomorph population in many samples of the Little No. 5 Block coal bed, generally less than 15 percent in the Lower No. 5 Block coal beds, and increases to 30 percent in the No. 6 Block coal bed. *Lycospora* is even more abundant in an unnamed coal bed a short distance stratigraphically above the No. 6 Block coal bed.

Range zones of selected species *Procoronaspora*, *Schulzospora*, *Laevigatosporites*, *Radiizonates*, *Torispora*, *Thymospora*, and *Schopfites* are most useful in correlation of coal beds.

Some paleobotanical evidence suggests that species of *Densosporites*, *Endosporites*, and *Radiizonates* are related to herbaceous plants. Periodically throughout the Kanawha Formation these taxa dominate palynormorph assemblages of some of the coal beds. This may suggest herbaceous plants replace arborescent swamp plants as the primary contributor to these coal beds.

INTRODUCTION

The Middle Pennsylvanian strata consist of the Kanawha and the Charleston Sandstone in the proposed Pennsylvanian System stratotype, according to Englund and others (1979). They followed Campbell and Mendenhall (1896) in using the Charleston Sandstone in place of the Allegheny Formation for central West Virginia. Bradley (1956) suggested that the boundary between the Lower and Middle Pennsylvanian Series be placed at the top of the New River Formation, and that the boundary between the Middle and Upper Pennsylvanian Series be placed at the approximate boundary of the Allegheny (Charleston) and Conemaugh Formations.

In a previous report by Kosanke (1984), the palynological content of selected coal beds and associated strata from the Pocahontas, New River, Kanawha, Charleston, and Monongahela Formations were described. This report is a detailed account of the palynomorphs extracted from the Kanawha Formation and the Charleston Sandstone, their occurrence, their abundance, their usefulness in coal-bed correlation, and the interpretation of the paleoecology and flora of the Middle Pennsylvanian Series of West Virginia.

PREVIOUS WORK

Palynological investigations of Middle Pennsylvanian coal beds of much of the United States have been extensive because numerous minable coal deposits occur

in this stratigraphic interval. If only those investigations concerned with northern Appalachian Basin palynomorphs are considered, the early thin section studies of Thiessen (1947) and his colleagues (Thiessen and others, 1924, 1941) are classic in nature. These investigations were directed toward understanding the transformation of plant accumulation into coal. Cross (1947) reported primarily on the occurrence of megaspores present in 13 coals in the Kanawha and Allegheny Formations of the northern Appalachian Basin. Cross and Schemel (1952) published an account of the occurrence of a number of Pennsylvanian and Permian palynomorph taxa of West Virginia and adjacent areas. In addition, Schemel (1957) completed a doctoral thesis at West Virginia University concerned with the "Small spore assemblages of mid-Pennsylvanian coals of West Virginia and adjacent areas." This thesis was not published nor was that of Denton (1957). Denton's masters thesis from West Virginia University was concerned with correlation of lower Allegheny coal beds of Columbiana County, Ohio with those of adjacent areas. Gillespie and others (1966) published a booklet, "Plant fossils of West Virginia," in which three plates illustrate palynomorph genera of the Pennsylvanian System of West Virginia. Gillespie and Pfefferkorn (1979) collected, identified, and recorded the plant megafossils from many localities of the proposed Pennsylvanian System stratotype in West Virginia. The important work of Clendening, primarily on the age of the Dunkard Group, has been noted previously by Kosanke (1984) except for Clendening (1975). In this paper he believes, based on palynomorph evidence, that the Dunkard Group is uppermost Pennsylvanian rather than Permian in age.

Habib (1966) discussed the palynomorph assemblages contained in the Lower Kittanning coal from 15 localities in western Pennsylvania. He also reported that the vertical and geographic palynomorph distribution was orderly with *Lycospora* abundant throughout the entire coal bed when the roof rock was nonmarine, and that a different assemblage was present in the top coal when the roof rock was marine.

Gray (1967) reported on the palynomorph content of four Allegheny coal beds the Lawrence, Lower Kittanning, Strasburg, and the Middle Kittanning from western Pennsylvania and eastern Ohio of the northern Appalachian Basin.

ACKNOWLEDGMENTS

The late H. H. Arndt, K. J. Englund, and T. W. Henry assisted in the collection of samples used in this report. Further, discussions with Arndt and Henry on the stratigraphy were most helpful. W. A. Fife, B. J. LeMaster, John Scholten and M. E. Zayhowski assisted in the preparation of samples, photomicrography, or in field work. Their help is gratefully acknowledged.

SAMPLE METHODS, PREPARATION, AND LOCALITIES

The sample methods and preparation are the same as discussed in Kosanke (1984) and need not be repeated here. For further discussion on methods, see Doher (1980). Figure 1 illustrates the area from which the samples were collected.

Samples from the Kanawha Formation and the Charleston Sandstone were collected, prepared, and examined. All samples were assigned laboratory maceration numbers, and all productive samples were assigned USGS Paleobotanical locality numbers (D numbers). In a previous investigation by Kosanke (1984) the palynomorphs of a number of samples from the Kanawha Formation and the Charleston Sandstone were reported and these samples also were assigned USGS Paleobotanical locality numbers. These D numbers are shown in parentheses in figures 2 and 3 to differentiate them from the newly assigned D numbers of this report. The overall percentages of various taxa reported in this report are weighted according to thickness of segment sample.

The Kanawha Formation according to Arndt (1979) is about 366 m thick. In the area of the Harewood mine near Boomer, W. VA, he reported that about 244 m of the Kanawha Formation is exposed there and is termed the Harewood section. In the area of the proposed Pennsylvanian System stratotype, there are a series of sections that are named, and they cover the stratigraphic units of the Middle Pennsylvanian Series, which is composed of the Kanawha Formation and the Charleston Sandstone. The coal beds occurring in these sections were collected in as similar a manner as possible so that palynomorph abundance data might be utilized to trace the changing vegetation throughout the individual coal beds and through geologic time. The coal beds of the Kanawha Formation are given in figure 2 and those of the Charleston Sandstone in figure 3. The samples are identified by maceration and D numbers in each figure.

Preservation of palynomorphs varies considerably from very poor to excellent, but overall the preservation is not as good as often found in coals of high volatile B-rank coal. The use of 90 percent HNO_3 on the coal samples did improve the palynomorph yield, and 96 out of 106 individual coal samples yielded palynomorphs good enough to obtain abundance counts. In a number of samples *Lycospora* is poorly preserved and

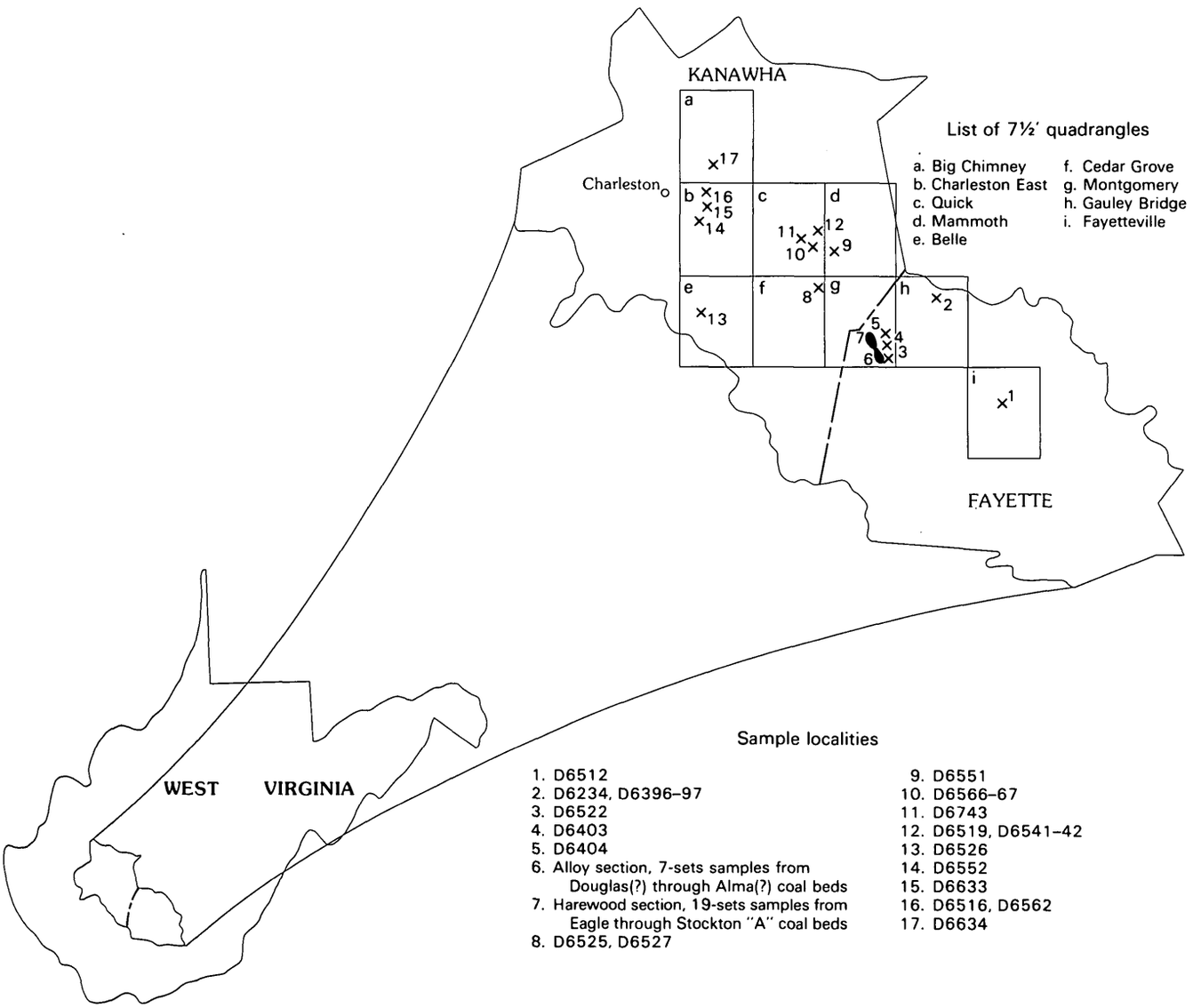

FIGURE 1.—Outline map of West Virginia with an insert of Kanawha and Fayette Counties. The location of sample sites within the 7½ minute quadrangles is marked by an X and adjacent numbers. These numbers may be used to identify the USGS Paleobotanical locality numbers given in the lower right corner.

identification to the species level is difficult and in some cases not possible.

All roof and seat rock samples yielded palynomorphs, but the poorest preservation was in these samples. Twenty-nine seat rock samples were available, and only four of these yielded sufficient palynomorphs to warrant abundance counts. Twenty-five roof rock samples were prepared, and seven of these yielded sufficient palynomorphs to permit abundance counts. More than 25,000 specimens were identified in the abundance counts. These are shown on the 58 tables, and additional specimens that were identified and not a part of the formal abundance counts are indicated by the symbol +.

SAMPLES FROM THE KANAWHA FORMATION

The samples used in this investigation are all from the proposed Pennsylvanian System stratotype of West Virginia as shown in figure 1. In order to conserve time and effort, all samples collected from the Alloy and Harewood sections of Montgomery 7½ minute quadrangle,

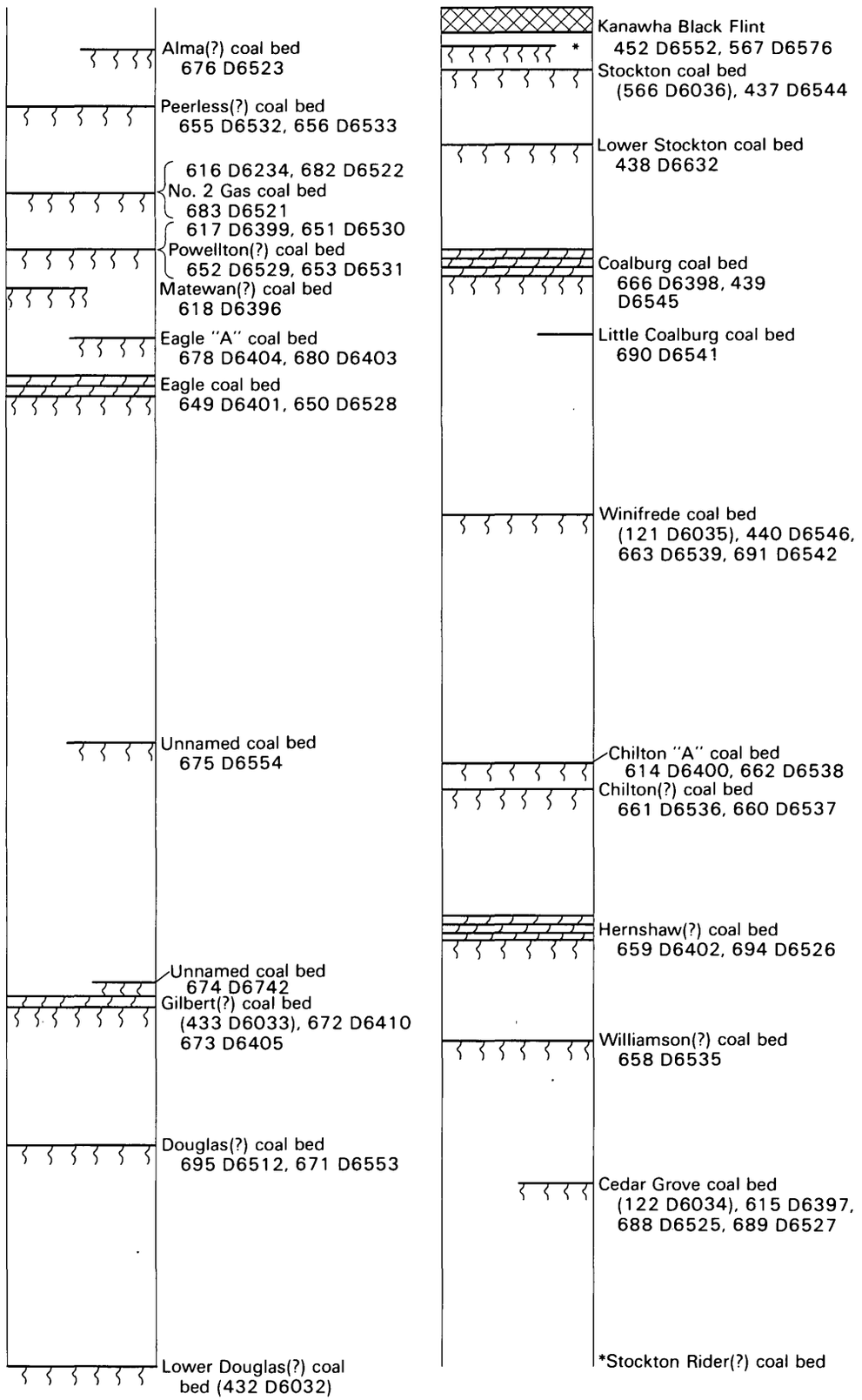

FIGURE 2.—Coal beds from the Kanawha Formation of the proposed Pennsylvanian System stratotype that were collected, prepared, and examined for palynomorphs are shown as well as identifying maceration and D numbers. The numbers shown in parentheses are part of a previous report by Kosanke (1984).

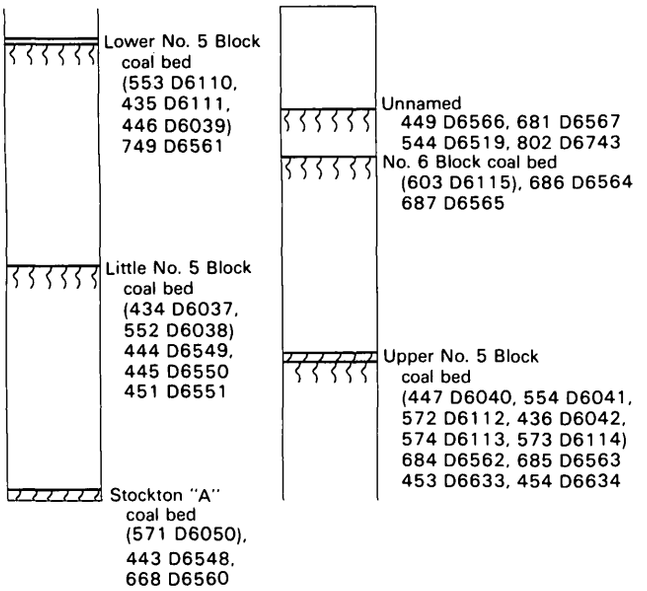

FIGURE 3.—Coal beds from the Charleston Sandstone of the proposed Pennsylvanian System stratotype that were collected, prepared, and examined for palynomorphs are shown as well as identifying maceration and D numbers. The numbers shown in parentheses were part of a previous report by Kosanke (1984).

Fayette County (Arndt, 1979) will subsequently be referred to as from one or the other of these two sections. The location of these sections is shown in figure 1, and the stratigraphic position of the respective unit numbers of Arndt (1979) is shown on their figures 25 and 29. Palynomorph content of samples previously reported on by Kosanke (1984) is shown in this report only by their respective D numbers in parentheses.

Lower Douglas(?) coal bed, (D6032).

Douglas(?) coal bed, eastern roadcut of U.S. Highway 19 at a point 160.9 m southwest of Lansing, exit 643.7 m northeast of the New River Bridge and 643.7 m northwest of bench mark 1864 at Lansing, Fayettville 7½ minute quadrangle, D6512, macerations 695-A-E.

Douglas(?) coal bed, units 7 through 9, Alloy section. The lower 183 m of the Kanawha Formation crops out in exposures along the southern side of Jarrett Branch and in roadcuts ascending the mountain southeast of Jarrett Branch northwest of Alloy, D6553, macerations 671-A-C.

Gilbert(?) coal bed, (D6033).

Gilbert(?) coal bed, lower bench, units 16 through 18, Alloy section, D6410, macerations 672-A-C.

Gilbert(?) coal bed, upper bench, units 20 through 22, Alloy section, same locality as preceding sample, D6405, macerations 673-A-C.

Unnamed coal bed, 2.1 m above Gilbert(?) coal bed, unit 24, Alloy section, D6742, maceration 674.

Unnamed coal bed, 30.4 m above Gilbert(?) coal bed, units 57 through 59, Alloy section, D6554, macerations 675-A-C.

Eagle coal bed, middle bench, units 9 through 11, Harewood section, 281.6 m north of Boomer, W. Va., D6401, macerations 649-A-F.

Eagle coal bed, middle bench, units 12 through 14, Harewood section. This is the same locality as the previous sample, D6528, macerations 650-A-E.

Eagle "A" coal bed, lower bench, near Alloy section, 1,448.4 m east-northeast of Alloy and 1,766.6 m north of bench mark 659 at Fall View, on south side of Jarrett Branch up old haulage road, Montgomery 7½ minute quadrangle, Fayette County, D6404, macerations 678-A-D.

Eagle "A" coal bed, upper bench, from same location as preceding sample. D6403, maceration 680.

Matewan(?) coal bed, Imperial Colliery Company core hole 1976-4 on the north side of Coalburg strip mine, 1,126.5 m southeast of Belva and 213.3 m east of a point between Schoolhouse Branch and Buck Run, Gauley Bridge 7½ minute quadrangle, Fayette County. The coal thickness is 45.7 cm at a depth of 196.9 m, D6396, macerations 618-A-B.

Powellton coal bed, Imperial Colliery Company core hole 1976-4, 55.8 cm coal at core depth of 170.2 m. The geographic location of core hole is given under Matewan(?) coal bed, D6399, macerations 617-A-C.

Powellton(?) coal bed, lower bench, units 20 through 22, Harewood section, D6530, macerations 651-A-C.

Powellton(?) coal bed, middle bench, units 27 through 30, Harewood section, D6529, macerations 652-A-D.

Powellton(?) coal bed, upper bench, units 34 through 36, Harewood section, D6234, macerations 653-A-D.

No. 2 Gas coal bed, Imperial Colliery Company core hole 1976-4, 45.7 cm coal at core depth of 161.7 m. The location of core hole is given under Matewan(?) coal bed, D6234, macerations 616-A-B.

No. 2 Gas coal bed, lower bench, 15.2-cm-thick coal sample taken from roadbed thought to be unit 103 of the Alloy section, D6521, maceration 683.

No. 2 Gas coal bed, upper bench, from a location 0.9 km north of bench mark 659 at Falls View, Fayette County. This locality is near the Alloy section and on a strip mine of the No. 2 Gas coal bed, D6522, macerations 682-A-D.

Lower Peerless(?) coal bed, grab sample from unit 45 of Harewood section, D6533, maceration 656.

Upper Peerless(?) coal bed, units 48 through 50, Harewood section, D6532, macerations 655-A-E.

Alma(?) coal bed, units 109 through 111, Alloy section, D6523, macerations 676-A-E.

Lower Cedar Grove Rider coal bed, units 5 through 7, Big Hollow section T. W. Henry, immediately south of Ward, Cedar Grove 71/2 minute quadrangle, Kanawha County, D6525, macerations 688-A-C.

Middle Cedar Grove Rider coal bed, units 8 through 10, Big Hollow section of T. W. Henry, from same location as previous sample, D6527, macerations 689-A-C.

Cedar Grove coal bed, (D6034), type locality.

Cedar Grove(?) coal bed, Imperial Colliery Company core hole 1976-4, 25.4 cm coal at a core depth of 115.4 m. The location of the core hole is given under Matewan(?) coal bed, D6397, macerations 615-A-B.

Williamson(?) coal bed, units 63 through 65, Harewood section, D6535, macerations 658-A-C.

Hernshaw coal bed, collected at collapsed entrance of the Marmet mine about 304.8 elevation east and about 76.2 m above Lens Creek, 0.48 km south of the Hoffman Cemetery, and about 2.5 km south of Hernshaw, Belle quadrangle, Kanawha County, D6526, type locality, macerations 694-A-E.

Hernshaw(?) coal bed, units 67 through 76, Harewood section, D6402, macerations 659-A-I.

Chilton(?) coal bed, lower bench, units 96 through 98 of Harewood section, D6537, macerations 660-A-E.

Chilton(?) coal bed, upper bench, units 110 through 112, Harewood section, D6586, macerations 661-A-E.

Chilton "A" coal bed, Imperial Colliery Company core hole 1976-1. The samples are 38.1 cm thick at a core depth of 52.7 m. The location of this core is on Coalburg strip mine in gap on Gauley Mountain west of Buck Run, 1.2 km southwest of Beech Glen, Gauley Bridge quadrangle, Fayette County, D6400, macerations 614-A-C.

Chilton "A" coal bed, units 119 and 120, Harewood section, D6538, macerations 662-A-B.

Winifrede coal bed (D6035), type locality.

Winifrede(?) coal bed, 15.2 cm of canneloid shale from unit 131, Harewood section, D6546, maceration 440.

Winifrede(?) coal bed, lower bench, units 126 through 130, Harewood section, D6539, macerations 663-A-F.

Winifrede coal bed, units 32 to 41, Mammoth West section of T. W. Henry, first hollow up west side of Left Fork of Kellys Creek, about 600 m northwest of Mannoth, Quick quadrangle, Kanawha County, D6542, macerations 691-A-F.

Little Coalburg coal bed, units 46 through 50, from same locality as preceding samples, D6541, macerations 690-A-D.

Coalburg coal bed, lower bench, units 132 through 152, Harewood section, D6398, macerations 666-A-O.

Coalburg coal bed, upper bench, unit 158, Harewood section, D6545, maceration 439.

Lower Stockton coal bed, unit 165, Harewood section, D6632, macerations 438-A-C.

Stockton coal bed (D6036).

Stockton coal bed, unit 175, Harewood section, D6544, macerations 437-A-B.

Stockton Rider(?) coal bed, northern Charleston city limits, immediately west of Airport Village, above east bank of Elk Creek, Kanawha County, D6576, macerations 567-A-E.

Stockton Rider(?) coal bed, unit 3 of Greenbrier Street section, Charleston, as shown in figure 35 of Arndt (1979), D6552, maceration 452.

SAMPLES FROM THE CHARLESTON SANDSTONE

Stockton "A" coal bed, (D6050).

Stockton "A" coal bed, units 179 through 180, Harewood section, D6560, macerations 668-A-E.

Stockton "A" coal bed, unit 84, Cannelton section of Arndt (1979). This sample was taken 1 m above the Kanawha black flint along Cannelton strip mine haulage road, 2.5 km north-northeast of the mouth of Bullpush Fork, Montgomery quadrangle, Kanawha County, D6548, maceration 443.

Little No. 5 Block coal bed (D6038).

Little No. 5 Block coal bed (D6037).

Little No. 5 Block coal bed, unit 19, Mammoth West section of T. W. Henry, first hollow up west side of Left Fork of Kellys Creek about 600 m northwest of Mammoth, Mammoth 7½ minute quadrangle, Kanawha County, D6551, macerations 451-A-E.

Little No. 5 Block coal bed, lower bench, unit 98, Cannelton section of Arndt (1979), D6550, maceration 445.

Little No. 5 Block coal bed, upper bench, units 102, Cannelton section of Arndt (1979), D6549, macerations 44-A-C.

Lower No. 5 Block coal bed (D6039).

Lower No. 5 Block coal bed (D6110).

Lower No. 5 Block coal bed (D6111).

Lower No. 5 Block coal bed, upper bench, parting, and lower bench, collected from highwall of Cannelton Industries, Inc., surface mine located on the south side of Hughes Fork of Hughes Creek, third point west of Jim Hollow, about 6 km northeast of Cannelton and about 4.5 km northwest of Marting, Montgomery quadrangle, Kanawha County, D6561, macerations 749-A-E.

Upper No. 5 Block coal bed (D6040).

Upper No. 5 Block coal bed (D6041).

Upper No. 5 Block coal bed (D6042).

Upper No. 5 Block coal bed (D6112).

Upper No. 5 Block coal bed (D6113).

Upper No. 5 Block coal bed (D6114).

Upper No. 5 Block(?) coal bed, lower bench, stop 21 of Arndt (1979) as shown in their figure 35. This is just south of the Kanawha Airport, Charleston East quadrangle, Kanawha County, D6633, macerations 453-A-E.

Upper No. 5 Block(?) coal bed, upper bench, at intersection of I-77 and I-79, Kanawha County. This coal bed occurs below the "Mahoning Sandstone", D6634, macerations 454-A-C.

Upper No. 5 Block coal bed, lower bench, D6563, collected from same locality as the Lower No. 5 Block coal bed, D6561, macerations 749-A-F, but 18 m stratigraphically above the Lower No. 5 Block coal bed, D6516, maceration 685.

Upper No. 5 Block coal bed, upper bench, D6562, collected from same locality as preceding sample, but 3 m stratigraphically above the lower bench (maceration 685), D6515, maceration 684.

No. 6 Block coal, one lump of coal (D6115).

No. 6 Block coal bed, lower bench, collected from highwall of Cannelton Industries, Inc., surface mine about 4.9 km northeast of Cannelton and 3.3 km northwest of Marting, Montgomery quadrangle, Kanawha County, D6564, maceration 686.

No. 6 Block coal bed, upper bench, collected from same locality as preceding sample, but 5.4 m stratigraphically above the lower bench of the No. 6 Block coal bed, D6565, maceration 687.

Unnamed carbonaceous shale, 22.8 cm thick from Left Fork of Kellys Creek, 0.8 km northwest of Mammoth, Quick quadrangle, Kanawha County, D6519, maceration 544.

Unnamed coal bed, 20.3 cm thick collected from low gap at head of Tenmile Fork of Campbells Creek, 2.5 km northwest of Mammoth, Quick quadrangle, Kanawha County, D6743, maceration 802.

Unnamed coal bed, 3.9 cm thick from Left Fork of Kellys Creek immediately south of Slabcamp Hollow, stop 20C of Arndt (1979), D6566, maceration 449.

Unnamed coal bed, 26.6 cm coal with roof and seat samples from same locality as preceding sample, D6567, macerations 681-A-C.

PALYNOMORPHS FROM THE KANAWHA FORMATION

The Kanawha Formation was named by Campbell and Mendenhall (1896) and comprises about two-thirds of the Middle Pennsylvanian Series. The Kanawha Formation occurs above the New River Formation and below the Charleston Sandstone in the proposed Pennsylvanian System stratotype of West Virginia.

The Lower Douglas(?) coal bed occurs near the base of the Kanawha Formation as shown in figure 2, and the palynomorph content of this bed, maceration series 432, was discussed previously by Kosanke (1984). In this coal bed, *Lycospora* is the dominant taxon and *Densosporites* is subdominant.

The Douglas(?) coal bed occurs above the Lower Douglas(?) coal bed about 30 m above the base of the Kanawha Formation as shown in figure 2. Samples of this coal bed were collected southwest of Lansing, Fayette County, W. VA, and assigned to maceration 695-A-E. Abundant and reasonably well-preserved palynomorphs were recovered from maceration 695-B but not from the noncoal samples and the bone-coal sample, maceration 695-D, which was weathered and barren of palynomorphs.

The numerically important genera of the Douglas(?) coal bed (maceration 695-B) are:

Densosporites	43.5 percent
Granulatisporites	3.5
Laevigatosporites	3.0
Lycospora	43.0
	93.0 percent

Densosporites and *Lycospora* are codominant, and the most abundant taxon in maceration 695-B is *Densosporites annulatus* (Loose) Schopf, Wilson, and Bentall as shown in table 1. A similar but even more pronounced abundance of this taxon was reported by Kosanke (1950) for the Reynoldsburg Coal Member of Illinois. I consider the presence of *Schulzospora* in maceration 695-B important because it adds to the continuity of its range, and this will be discussed in detail

TABLE 1.—*Palynomorphs from the Douglas(?) coal bed in West Virginia*

[Maceration series 695; USGS Paleobotanical loc. No. D6512; 200 specimens counted; +, present but count not attempted]

Taxon	695-A	695-B	695-C	695-E
		(percent)		
Acanthotriletes cf. *A. falcatus* (Knox) Potonié and Kremp	--	0.5	--	--
A. sp	--	--	+	
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	.5	+	+
Apiculatisporis sp	--	1.0		
Calamospora sp	--	1.0	--	+
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	--	+	--
Cyclogranisporites cf. *C. aureus* (Loose) Potonié and Kremp	--	--	+	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	32.0	+	--
D. spp	--	11.5	+	--
Endosporites sp	--	.5	--	--
Florinites sp	--	1.0	--	--
Granulatisporites pallidus Kosanke	--	1.0	--	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	+	--
G. spp	--	2.5	+	+
Knoxisporites cf. *K. rotatus* Hoffmeister, Staplin, and Malloy	--	.5	--	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	.5	+	+
L. ovalis Kosanke	--	2.0	+	--
L. sp	--	.5	--	--
Lycospora granulata Kosanke	--	.5	+	--
L. micropasillata (Wilson, and Coe) Schopf, Wilson, and Bentall	--	1.0	+	+
L. pelludica (Wicher) Schopf, Wilson, and Bentall-L pseudoannulata Kosanke	--	14.0	+	+
L. spp		27.5	+	+
Procoronaspora sp. 1	--	--	+	--
Puncatisporites sp	--	--	+	+
Raistrickia cf. *R. prisca* Kosanke	--	--	+	--
R. sp	--	--	+	--
Schulzospora sp	--	.5	--	--
Stenozonotriletes bracteolus (Butterworth and Williams) Smith and Butterworth	--	--	+	+
Wilsonites sp	--	--	+	--
Monosaccate	+	1.0	--	+
Unassigned	--	.5	--	--
		100.0		

DESCRIPTION OF MATERIAL IN MACERATION

695-A, 8.8 cm roof shale.
695-B, 8.8 cm coal (weathered).
695-C, 2.5 cm parting.
695-D, 8.9 cm bone coal (weathered and barren of palynomorphs).
695-E, 6.8 cm seat rock.

subsequently. *Densosporites* and *Lycospora* are codominant in the Douglas(?) coal bed while *Lycospora* is clearly dominant in the Lower Douglas(?) coal bed and *Densosporites* is subdominant (Kosanke, 1984).

Another sample thought possible to correlate with the Douglas(?) coal bed was collected from the Alloy section, units 7 through 9, and assigned to maceration series 671. The coal sample is only 1.27 cm thick, but a rather nice assemblage of palynomorphs was identified as is shown in table 2. A summary of important genera identified from 671-B follows:

Densosporites	32.0 percent
Granulatisporites	10.0
Laevigatosporites	1.0
Lycospora	35.5
	78.5 percent

Lycospora and *Densosporites* are codominant as was the case in maceration series 695-B. Also, the total assemblage of both maceration series 695 and 671 suggests a correlation.

The two benches of the Gilbert(?) coal bed from the Alloy section are correlated with the sample of the Gilbert(?) coal bed just south of Cane Branch along Cane

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

[Maceration series 671; USGS Paleobotanical loc. No. D6553; 200 specimens counted; +, present but count not attempted]

Taxon	671-A	671-B (percent)	671-C
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	0.5	--
Apiculatisporis sp	--	.5	--
Calamospora sp	--	1.5	--
Convolutispora sp	--	.5	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	.5	--
Cyclogranisporites cf. *C. aureus* (Loose) Potonié and Kremp	--	.5	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	+	29.0	+
D. triangularis Kosanke	--	1.0	--
D. sp	--	2.0	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	+	.5	--
Florinites visendus (Ibrahim) Schopf, Wilson, and Bentall	+	3.0	--
Granulatisporites pallidus Kosanke	+	2.5	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	2.0	--
G. spp	--	5.5	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	.5	--
L. ovalis Kosanke	--	.5	--
Lycospora granulata Kosanke	--	4.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	4.5	--
L. punctata Kosanke	--	1.0	--
L. spp	+	26.0	+
Procoronaspora sp. 1	--	2.0	+
P. sp	--	.5	--
Raistrickia sp	--	.5	--
Schulzospora rara Kosanke	+	3.5	--
Wilsonites vesicatus (Kosanke) Kosanke	--	3.5	--
Monosaccate	--	3.0	--
Unassigned	--	1.0	--
		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
671-A, 7.6 cm roof rock.
671-B, 1.2 cm coal.
671-C, 10.1 cm seat rock.

Branch Road, maceration series 433. This correlation is based on similar palynomorph assemblages and abundance ratios. The palynological content of the Gilbert(?) coal bed, macerations 433-A-B, previously was discussed by Kosanke (1984).

The two benches of the Gilbert(?) coal bed of England and others (1979) occurs approximately 18 m above the Douglas(?) coal bed. The lower bench has been assigned to maceration series 672; the upper bench to 673. They have been treated separately because each has its own underclay or seat rock. The lower bench, maceration series 672, was sampled as shown in table 3 with *Lycospora* clearly dominant:

Calamospora	4.5 percent
Laevigatosporites	7.0
Lycospora	77.5
	89.0 percent

The dominance of *Lycospora* and the presence of *Procoronaspora* and *Schulzospora* suggests a relationship with maceration 433-B.

The upper bench of the Gilbert(?) coal bed, maceration series 673, has a similar palynomorph content to that of maceration series 672 as seen in table 4. *Lycospora* is dominant, but *Densosporites* is more abundant than in maceration series 672:

Densosporites	4.5 percent
Laevigatosporites	3.5
Lycospora	85.0
	93.0 percent

The increase in *Densosporites* in the upper bench of the Gilbert(?) coal bed is somewhat similar to that in maceration series 433-A.

A thin unnamed coal 7.62 cm thick, maceration 674, occurring 2.1 m above the Gilbert(?) coal bed in the

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

[Maceration series 672; USGS Paleobotanical loc. No. D6410; 200 specimens counted; +, present but count not attempted]

Taxon	672-A	672-B (percent)	672-C
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	0.5	--
Calamospora breviradiata Kosanke	--	+	--
C. parva Guennel	--	3.0	--
C. spp	--	1.5	+
Cirratriradites sp	+	--	--
Convolutisoora sp	--	--	+
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	.5	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	+	.5	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	.5	--
D. sp	+	.5	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	+	--	--
Endosporites cf. *E. zonalis* (Loose) Knox	--	+	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	+	--	--
Granulatisporites pallidus Kosanke	--	2.5	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	.5	--
G. sp	--	.5	--
Knoxisporites rotatus Hoffmeister, Staplin, and Malloy	--	--	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	3.0	+
L. latus Kosanke	--	.5	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	.5	--
L. ovalis Kosanke	--	3.0	--
Leiotriletes cf. *L. sphaerotriangularis* (Loose) Potonié and Kremp	--	+	--
Lophotriletes cf. *L. gibbosus* (Ibrahim) Potonié and Kremp	--	+	+
Lycospora granulata Kosanke	--	1.5	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	1.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	40.0	--
L. spp	--	35.0	--
Procoronaspora sp. 2	+	--	--
Punctatisporites obesus (Loose) Potonié and Kremp	--	.5	--
P. sp	--	.5	--
Raistrickia prisca Kosanke	--	1.0	--
Reticulatisporites sp	--	--	+
Schulzospora sp	--	.5	--
Triquitrites sp	+	--	--
Vestispora cf. *V. costata* (Balme) Spode in Smith and Butterworth	--	--	+
Wilsonites sp	--	--	+
Monosaccate	--	2.5	--
Unassigned	--	--	+
		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

672-A. 10.1 cm roof rock.

672-B, 16.5 cm coal.

672-C, 10.1 cm seat rock.

Alloy section, unit 24, has an assemblage of palynomorphs vastly different from the assemblage identified in the Gilbert(?) coal bed below or the coal beds above. Saccate palynomorphs such as *Endosporites*, *Florinites*, *Wilsonites*, and bisaccates account for 65 percent of the assemblage as shown in table 5. *Lycospora*, an abundant taxon below and above this stratigraphic position in the Kanawha Formation, represents only 3 percent of the assemblage of this unnamed coal:

TABLE 4.—*Palynomorphs from the Gilbert(?) coal bed, upper bench, in West Virginia*

[Maceration series 673; USGS Paleobotanical loc. No. D6405; 200 specimens counted; +, present but not observed in count or count not attempted]

Taxon	673-A	673-B (percent)	673-C
Calamospora parva Guennel	--	0.5	--
C. sp	--	.5	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	+	+
Cyclogranisporites sp	--	+	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	3.0	--
D. sp	+	1.5	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	+	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	.5	--
E. sp	+	.5	+
Granulatisporites pallidus Kosanke	--	1.0	--
G. sp	+	2.0	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	+	--
L. latus Kosanke	--	+	--
L. medius Kosanke	--	+	--
L. ovalis Kosanke	--	2.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger		1.5	
Lophotriletes cf. *L. gibbosus* (Ibrahim) Potonié and Kremp		+	
Lycospora granulata Kosanke	--	1.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	41.0	--
L. spp	--	43.0	--
Punctatisporites sp	--	+	--
Raistrickia sp	--	.5	+
Schulzospora rara Kosanke	--	1.0	--
Monosaccate	+	.5	--
Unassigned	--	+	--
		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
673-A, 7.6 cm roof rock.
673-B, 26.0 cm coal.
673-C, 7.6 cm seat rock.

Calamospora	8.5 percent
Endosporites	54.0
Grumosisporites	5.0
Laevigatosporites	7.5
Lycospora	3.0
Spackmanites	3.0
Wilsonites	6.0
	87.0 percent

The palynomorph assemblage and abundance data of this unnamed coal is not one that is normally associated with the typical coal swamp environment. The presence of saccate palynomorphs at the rate of 65 percent perhaps would have been associated with an abundance of arborescent plants based on the work of Chaloner (1953, 1958), Brack and Taylor (1972), and others. Recently, DiMichele, and others (1979) described the anatomical details of 15 specimens of *Polysporia*, which they consider to be a herbaceous, heterosporous lycopod plant producing *Endosporites* microspores and megaspores assignable to *Valvisporites*. There is an interesting paradox in that *Densosporites*, whose affinities are generally considered to be associated with herbaceous lycopods, occurs only at the rate of less than 1 percent in this unnamed coal and is codominant with *Lycospora* in the Gilbert(?) coal 2.1 m below. The question must be asked, if this unnamed coal is a marshland herbaceous deposit, why is *Densosporites* so poorly represented in the assemblage?

Other aspects of the assemblage of maceration 674 are the presence of species of *Calamospora* at the rate of 8.5 percent, a modestly high percent for the genus, and the presence of *Grumosisporites rufus*, bisaccates, and *Spackmanites* sp. 1 in more than minor amounts.

An unnamed coal bed occurring about 30 m above the Gilbert(?) coal bed, units 57 through 59 of the Alloy section, Fayette County, W. Va. yielded an interesting but somewhat limited assemblage as shown in table 6 with *Lycospora* clearly dominant:

TABLE 5.—*Palynomorphs from an unnamed coal bed 2.1 m above Gilbert(?) coal bed in West Virginia*

[Maceration series 674; USGS Paleobotanical loc. No. D6742; 200 specimens counted; +, present but not observed in count]

Taxon	674 (percent)
Apiculatisporis sp	0.5
Calamospora breviradiata Kosanke	5.5
C. mutabilis (Loose) Schopf, Wilson, and Bentall	2.0
C. parva Guennel	1.0
Cirratriradites maculatus Wilson and Coe	+
Cristatisporites indignabundus (Loose) Staplin and Jansonius	.5
C. sp	.5
Densosporites sp	.5
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	53.0
E. staplinii Gupta and Boozer	.5
E. zonalis (Loose) Knox	.5
Florinites visendus (Ibrahim) Schopf, Wilson, and Bentall	2.5
Granulatisporites granularis Kosanke	.5
G. pallidus Kosanke	.5
G. sp	1.0
Grumosisporites rufus (Butterworth anf Williams) Smith and Butterworth	5.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	1.5
L. ovalis Kosanke	3.5
L. vulgaris (Ibrahim) Alpern and Doubinger	2.5
Leiotriletes inermis (Waltz) Ishchenko	1.0
Lophotriletes microsaetosus (Loose) Potonié and Kremp	1.0
Lycospora granulata Kosanke	1.5
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	.5
L. punctata Kosanke	.5
L. sp	.5
Punctatisporites sp	1.0
Raistrickia sp	.5
Spackmanites sp. 1	3.0
Spencerisporites radiatus (Ibrahim) Winslow	.5
Wilsonites vesicatus (Kosanke) Kosanke	6.0
Bisaccate	2.5
	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

674, 7.6 cm coal.

Cristatisporites	4.5 percent
Laevigatosporites	13.5
Lycospora	72.5
	90.5 percent

Endosporites, which was the most abundant taxon in 674 maceration series in table 5, is not present in the 675 maceration series, which is dominated by *Lycospora*.

The Eagle coal bed occurs in the lower part of the Kanawha Formation and is benched in the area of the proposed Pennsylvanian System stratotype. Samples of the upper and middle benches of the Eagle coal bed have been collected, prepared, and examined in detail.

The middle bench of the Eagle coal bed, units 9 through 11 of the Harewood section, Fayette County, W. Va. maceration series 649, is dominated by several species of *Lycospora* as shown in table 7. Preservation of *Lycospora* is poor as was the case in the preceding sample. Despite this poor preservation, two possible new species of *Lycospora* are informally classified as *Lycospora* sp. 1 and sp. 2. These taxa are illustrated in plate 2, figures 3 and 4. Also. *Laevigatosporites* sp. 1 is present along with a second species listed as *L.* sp. 2 (pl. 2, fig. 16). The abundance of *Laevigatosporites* is increased over the upper bench of the Eagle coal bed. The following genera are numerically important in the middle bench of the Eagle coal bed:

TABLE 6.—*Palynomorphs from an unnamed coal bed 30.4 m above Gilbert(?) coal bed in West Virginia*

[Maceration series 675; USGS Paleobotanical loc. No. D6554; 200 specimens counted; +, present but count not attempted]

Taxon	675-A	675-B (percent)	675-C
Apiculatisporis sp	--	0.5	--
Cirratriradites maculatus Wilson and Coe	--	1.5	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	1.5	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	4.5	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	1.5	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	+	--	--
D. sp	+	--	--
Florinites visendus (Ibrahim) Schopf, Wilson, and Bentall	+	1.0	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	.5	--
L. latus Kosanke	--	2.5	--
L. medius Kosanke	--	.5	--
L. ovalis Kosanke	+	8.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	2.0	--
Leiotriletes sp.	--	1.0	--
Lycospora granulata Kosanke	--	3.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	+	31.5	--
L. punctata Kosanke	--	.5	--
L. spp	+	37.5	+
Schulzospora (?) sp	--	.5	--
Triquitrites cf. *T. exiguus* Wilson and Kosanke	--	1.0	--
T. sp	--	.5	--
Monosaccate	--	.5	--
		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
675-A, 10.1 cm roof rock.
675-B, 7.6 cm coal.
675-C, 10.1 cm seat rock.

Densosporites	2.6 percent
Laevigatosporites	19.2
Lycospora	71.2
	93.0 percent

The upper bench of the Eagle coal bed, units 12 through 14 of the Harewood section, Fayette County, W. Va., maceration series 650, is dominated by species of *Lycospora*. Preservation of *Lycospora* is poor and many specimens assignable to this genus could not be identified to the species level. *Lycospora* is the dominant genus as shown in the following:

Laevigatosporites	12.0 percent
Lycospora	68.0
	80.0 percent

Table 8 lists the identified taxa and their abundance in the upper bench of the Eagle coal bed. *Laevigatosporites* sp. 1 is informally listed in this report pending description as a new species and is illustrated in plate 2, figures 13 and 14.

The Eagle "A" coal bed occurs about 10 m above the Eagle coal bed. It is split at a locality near the Alloy section 1,448.4 m east-northeast of Alloy, W. Va. The lower split was assigned to maceration series 678 and the upper split to maceration series 680. The palynomorphs identified from 678-B-C are given in table 9 and the numerically important genera are:

Laevigatosporites	22.9 percent
Lycospora	61.3
Wilsonites	3.8
	88.0 percent

There is a great deal of similarity in the numerically important genera and in the species identified from these two sets of samples of the Eagle "A" coal bed. The identified taxa of the upper bench (maceration series 680) is shown in table 10. The two numerically important genera are:

Laevigatosporites	27.0 percent
Lycospora	60.5
	87.5 percent

Pityosporites sp. is present for the first time in coal beds of the Kanawha Formation in the upper bench of the Eagle "A" coal bed, maceration 680. Possible new

TABLE 7.—*Palynomorphs from the Eagle coal bed, middle bench, in West Virginia*

[Maceration series 649; USGS Paleobotanical loc. No. D6401; 600 specimens counted; +, present or not observed in count or count not attempted]

Taxon	649-A	649-B	649-C	649-D	649-E	649-F
			(percent)			
Acanthotriletes triquetrus Smith and Butterworth	--	--	+	--	--	+
Ahrensisporites querickei (Horst) Potonié and Kremp	--	1.0	--	--	--	--
Apiculatisporis sp	--	--	--	--	0.5	--
Calamospora breviradita Kosanke	--	--	--	0.5	.5	--
C. mutabilis (Loose) Schopf, Wilson, and Bentall	--	--	+	+	.5	--
C. parva Guennel	--	--	--	--	.5	--
Cirratriradites sp	--	1.0	--	--	--	--
Convolutispora sp	--	--	--	+	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	--	+	--	--
C. sp	--	1.0	--	--	--	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	+	3.0	+	--	--	--
Cyclogranisporites sp	+	1.0	--	--	1.5	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	+	8.0	--	1.0	--	--
D. covensis Berry	--	--	--	--	+	--
D. spp	+	1.0	+	--	--	--
Dictyotriletes sp	--	+	+	--	+	--
Endosporites cf. *E. globiformis* (Ibrahim) Schopf, Wilson, and Bentall	--	--	+	--	+	--
Florinites antiguus Schopf in Schopf, Wilson, and Bentall	--	3.0	--	.5	+	--
Granulatisporites pallidus Kosanke	--	2.0	--	.5	.5	--
G. spp	--	+	--	+	1.0	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	2.0	--	.5	2.0	--
L. latus Kosanke	--	+	--	--	1.0	--
L. medius Kosanke	--	4.0	--	1.0	.5	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	--	--	2.5	5.0	+
L. ovalis Kosanke	--	12.0	+	6.0	2.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	2.0	--	1.0	1.5	--
L. sp. 1	--	--	--	5.0	9.5	--
L. sp. 2	--	--	--	--	.5	--
Leiotriletes priddyi (Berry) Potonié and Kremp	--	+	--	--	--	--
L. sphaerotriangularis (Loose) Potonié and Kremp	--	1.0	--	--	--	--
L. sp	--	--	--	--	.5	--
Lycospora granulata Kosanke	+	5.0	--	15.5	6.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	--	--	+	2.0	+
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	1.0	+	12.0	12.0	+
L. punctata Kosanke	+	--	--	7.0	8.0	+
L. sp. 1	--	--	--	1.5	--	--
L. sp. 2	--	--	--	2.0	.5	--
L. spp	--	46.0	+	42.5	42.0	--
Microreticulatisporites concavus Butterworth and Williams	--	--	+	--	--	--
Punctatisporites sp	--	1.0	--	--	--	--
Pustulatisporites cf. *P. pustulatus Potonié* and Kremp	--	--	--	+	.5	--
Raistrickia cf. *R. prisca* Kosanke	--	1.0	--	--	--	--
R. saetosa (Loose) Schopf, Wilson, and Bentall	--	--	--	--	1.0	--
R. spp	--	+	+	1.0	--	--
Simozomotriletes intortus (Waltz) Potonié and Kremp	--	+	--	--	--	--
Monosaccate	--	2.0	--	--	--	--
Unassigned	+	2.0	--	--	--	--
		100.0		100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATION

649-A, 11.4 cm roof rock.
649-B, 12.7 cm coal.
649-C, 1.2 cm parting.
649-D, 22.8 cm coal.
649-E, 22.8 cm coal.
649-F, 10.1 cm seat rock.

TABLE 8.—*Palynomorphs from the Eagle coal bed, upper bench, in West Virginia*

[Maceration series 650; USGS Paleobotanical loc. No. D6528; 400 specimens counted; +, present but count not attempted]

Taxon	650-A	650-B	650-C	650-D	650-E
			(percent)		
Acanthotriletes triquetrus Smith and Butterworth	--	--	--	.5	--
A. sp	--	--	--	.5	--
Cappasporites distortus Urban	--	--	--	--	+
Calamospora breviradiata Kosanka	+	--	--	1.5	--
C. sp	--	1.0	--	--	--
Cirratriradites sp.	--	1.0	--	.5	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	+	--	--	--	--
Cyclogranisporites cf. *C. aureus* (Loose) Potonié and Kremp	--	.5	--	--	--
C. sp	--	.5	--	--	--
Densosporites sp	+	.5	--	1.0	--
Dictyotriletes sp	--	--	--	.5	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	.5	--	2.5	--
Florinites antiquus Schopf in Schopfm Wilson, and Bentall	+	1.5	--	--	--
F. sp	--	.5	--	.5	--
Granulatisporites pallidus Kosanke	+	--	--	--	--
G. sp	+	--	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	1.0	--	1.5	
L. Latus Kosanke	--	.5	--	--	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	.5	--	--	--
L. ovalis Kosanke	--	2.5	--	4.5	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	1.5	--	--	--
L. sp. 1	+	10.0	--	5.5	--
Lycospora granulata Kosanke	--	10.5	--	19.5	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	2.0	--	--	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	+	11.5	--	3.5	--
L. punctata Kosanke		11.5		8.5	
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	--	1.5	--	3.0	--
L. spp	+	35.5	+	43.0	--
Planisporites cf. *P. granifer* (Ibrahim) Knox	--	--	--	.5	--
Punctatisporites sp	--	--	--.5	--	--
Raistrickia sp	--	--	--	.5	--
Verrucosisporites sp	--	.5	--	--	--
Vestispora sp	--	.5	--	--	--
Wilsonites sp	--	1.5	--	--	--
Monosaccate	--	3.0	--	1.0	--
Unassigned	--	--	--	.5	--
		100.0		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
650-A 11.4 cm roof rock.
650-B, 2.5 cm coal.
650-C, 1.9 cm parting.
650-D, 15.8 cm coal.
650-E, 9.5 cm seat rock.

species of both *Laevigatosporites* and *Lycospora* are present as shown in table 10. In addition, a species of *Raistricka* might ultimately prove to be new, but additional specimens will be required to evaluate this taxon more clearly.

A portion of a drill-core sample, 45.7 cm thick, from Imperial Colliery Company core hole 1976-4 was available for study and assigned to maceration series 618. This sample came from a depth of 196.9 m and was thought possibly to be the Matewan coal bed which probably occurs between the Eagle "A" and Powellton coal beds. The Dominant genus is *Lycospora*, but more than half of the specimens assigned to this genus could not be identified below the generic level. *Laevigatosporites* is subdominant as shown in the following:

TABLE 9.—*Palynomorphs from the Eagle "A" coal bed, lower bench, in West Virginia*

[Maceration series 678; USGS Paleobotanical loc. No. D6404; 400 specimens counted; +, present but not observed in count or count not attempted]

Taxon	678-A	678-B	678-C	678-D
		(percent)		
Apiculatisporis aculeatus (Ibrahim) Smith and Butterworth	--	0.5	0.5	--
Calamospora cf. *C. straminea* Wilson and Kosanke	--	--	1.0	--
C. sp	--	+	+	--
Cirratriradites maculatus Wilson and Coe	--	1.5	--	--
C. sp	--	+	--	--
Convolutispora sp	+	+	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	+	+	--	--
Cyclocgranisporites sp	+	.5	--	--
Dictyotriletes castaneaeformis (Horst) Sullivan	--	+	--	--
D. sp. 1	--	.5	--	--
D. sp	--	+	+	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	1.0	1.0	--
Florinites sp	--	+	--	--
Granulatisporites pallidus Kosanke	--	+	+	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	.5	.5	--
G. sp	--	.5	.5	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	2.0	1.0	--
L. latus Kosanke	--	+	1.0	--
L. medius Kosanke	--	5.0	1.5	--
L. ovalis Kosanke	--	16.5	6.5	+
L. vulgaris (Ibrahim) Alpern and Doubinger	--	4.5	2.0	--
L. sp. 1	--	5.0	6.0	--
Leiotriletes cf. *L. sphaerotriangulus* (Loose) Potonié and Kremp	+	.5	.5	--
L. sp	--	1.0	.5	--
Lophotriletes cf. *L. gibbosus* (Ibrahim) Potonié and Kremp	+	1.0	--	+
Lycospora granulata Kosanke	+	3.0	5.5	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	1.5	+
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	+	16.5	25.0	--
L. sp. 1	--	.5	--	--
L. spp	+	30.5	43.0	--
Pustulatisporites sp	--	.5	--	--
Raistrickia sp	--	--	.5	--
R spp	--	--	+	--
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	--	.5	1.0	--
Wilsonites vesicatus (Kosanke) Kosanke	--	6.0	1.0	--
Monosaccate	--	1.5	--	--
Unassigned	--	.5	--	--
		100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATION
678-A, 19.0 cm roof rock.
678-B, 24.1 cm coal.
678-C, 19.0 cm transitional to seat rock.
675-D, 10.1 cm seat rock.

Laevigatosporites	16.4 percent
Lycospora	71.2
	87.6 percent

The two samples of the Eagle "A" coal bed, maceration series 678 and 680, and those of the Matewan(?) coal bed display a number of similarities. These include numerical similarity on both the generic and specific levels with *Lycospora* dominant and *Laevigatosporites* subdominant. Also, *Lycospora granulata* Kosanke and *Laevigatosporites ovalis* Kosanke are the most abundant taxa in all three sets of samples. However, the two sets of samples of the Eagle "A" coal bed contain more

TABLE 10.—*Palynomorphs from the Eagle "A" coal bed, upper bench, in West Virginia*

[Maceration series 680; USGS Paleobotanical loc. No. D6403; 200 specimens counted; +, present but not observed in count]

Taxon	680 (percent)
Apiculatisporis aculeatus (Ibrahim) Smith and Butterworth	+
Calamospora cf. *C. mutabilis* (Loose) Schopf, Wilson, and Bentall	1.5
C. parva Guennel	.5
C. Sp	1.0
Convolutispora sp	1.5
Cyclogranisporites sp	.5
Dictyotriletes sp	.5
Endosporites sp	.5
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	+
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.5
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	2.0
L. latus Kosanke	3.0
L. medius Kosanke	4.5
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	2.0
L. ovalis Kosanke	8.0
L. vulgaris (Ibrahim) Alpern and Doubinger	1.0
L. sp. 1	6.5
Leiotriletes sp	+
Lophotriletes gibbosus (Ibrahim) Potonié and Kremp	1.0
Lycospora granulata Kosanke	7.5
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	2.5
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	7.5
L. punctata Kosanke	4.0
L. sp. 1	1.5
L. sp. 2	+
L. spp	37.5
Pityosporites sp	.5
Punctatisporites sp	+
Raistrickia sp	.5
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	.5
Triquitrites sp	+
Wilsonites vesicatus (Kosanke) Kosanke	1.0
Monosaccate	2.5
	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

680, 3.8 cm coal.

than just a few specimens of *Laevigatosporites* sp. 1 and *Lycospora* sp. 1. These taxa are not known to occur in the Matewan(?) coal bed (maceration 618).

Laevigatosporites sp. 1 was not observed in either macerations 618-A or 618-B. The taxa identified from 618-A-B are shown in table 11.

The Powellton coal bed was initially mined at Powellton, Fayette County, W. Va. The coal lies below the No. 2 Gas coal bed. In some areas a rider coal, the Powellton A coal bed, occurs a short distance above the Powellton coal bed, but not at its type locality. Four sets of samples of the Powellton were collected and examined.

Twenty-four genera have been identified from a diamond drill core sample, maceration series 617, as shown in table 12. The dominant genera in the coal samples, 617-A and C, are:

Densosporites	14.7 percent
Laevigatosporites	14.7
Lycospora	51.0
	80.4 percent

Densosporites is reduced to less than one percent in the parting sample, 617-B, whereas *Laevigatosporites* has more than doubled in abundance in some measure at the expense of *Lycospora*. *Laevigatosporites* is reduced in abundance in the basal-coal unit, 617-C,

TABLE 11.—*Palynomorphs from the Matewan(?) coal bed in West Virginia*

[Maceration series 618; USGS Paleobotanical loc. No. D6396; 500 specimens counted; +, present but not observed in count]

Taxon	618-A (percent)	618-B (percent)
Ahrensisporites guerickei (Horst) Potonié and Kremp	+	--
Apiculatisporis aculeatus (Ibrahim) Smith and Butterworth	0.8	+
Calamospora pedata Kosanke	+	--
C. sp	--	0.8
?Densosporites sp.	--	0.8
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	1.6	.8
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.8	2.4
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	4.0	4.0
L. latus Kosanke	+	+
L. medius Kosanke	3.2	.8
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	1.6	.8
L. ovalis Kosanke	12.0	6.4
L. vulgaris (Ibrahim) Alpern and Doubinger	+	1.6
Lycospora granulata Kosanke	6.4	18.4
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	1.6
L. pseudoannulata Kosanke	19.2	14.4
L. punctata Kosanke	4.0	4.8
L. spp	38.4	35.2
Punctatisporites obesus (Loose) Potonié and Kremp	--	.8
P. sp	1.6	1.6
Raistrickia sp	+	+
Reticulatisporites cf. *R. lacunosa* Kosanke	.8	.8
Simozonotriletes sp		+
Triquitrites sp	.8	.8
Vestispora cf. *V. lucida* (Butterworth and Williams) Potonié	--	+
Wilsonites vesicatus (Kosanke) Kosanke	.8	+
Monosaccate	3.2	2.4
Unassigned	.8	
	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS
618-A, 22.5 cm coal.
618-B, 22.8 cm coal.

whereas the abundance of *Lycospora* is increased to 66 percent.

Three benches of coal possibly related to the Powellton coal bed were collected from the Harewood section in Fayette County, W. Va. These samples were collected from units 20 through 22 as the lower bench (maceration series 651), units 27 through 30 as the middle bench (maceration series 652), and units 34 through 36 as the upper bench (maceration series 653). The palynomorphs identified are given in Tables 13 to 15, and the numerically important genera in the coal samples are:

	651-B	652 C	653-B-C	
Densosporites	65.5	7.0	3.0	percent
Laevigatosporites	12.0	9.0	21.0	
Lycospora	4.0	78.0	57.5	
	81.5	94.0	81.5	percent

The lower bench of the Powellton(?) coal bed is strikingly different than the upper two benches in that *Densosporites* is so abundant in the coal sample (651-B). However, *Lycospora* is present at the rate of only 4 percent in this coal sample, and is the most abundant taxon of the coal units of the middle and upper benches. The assemblage of palynomorphs in these three benches has much in common with the core sample, maceration series 617, see table 12. Two additional species of *Lycospora* are informally recognized as sp. 3 and sp. 4 and are illustrated in plate 2, figures 5 and 6.

The No. 2 Gas coal bed occurs from 3 to 10 m above the Powellton(?) coal bed. Three sets of samples were available for study: lower and upper benches from the Alloy section in Fayette County, as well as a core-drill sample from Imperial Colliery Company core hole 1976-4.

TABLE 12.—*Palynomorphs from the Powellton coal bed in West Virginia*

[Maceration series 617; USGS Paleobotanical loc. No. D6399; 750 specimens counted; +, present but not observed in count]

Taxon	617-A	617-B	617-C
	(percent)		
Acanthotriletes cf. *A. echinatus* (Knox) Potonié and Kremp	0.4	--	--
A. falcatus (Knox) Potonié and Kremp	--	2.4	--
A. triguetrus Smith and Butterworth	--	1.6	--
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	--	0.4
Alatisporites pustulatus Ibrahim	--	+	--
A. sp	--	--	.4
Apiculatisporis abditus (Loose) Potonié and Kremp	.4	1.6	+
A. sp	--	.8	--
Calamospora breviradiata Kosanke	--	1.6	.8
C. cf. *C. hartungiana* Schopf in Schopf, Wilson and Bentall	--	--	+
C. mutabilis (Loose) Schopf, Wilson, and Bentall	--	+	--
C. straminea Wilson and Kosanke	--	--	2.0
C. sp	.8	1.6	.4
Cirratriradites annulatus Kosanke and Brokaw	--	--	.4
Convolutispora sp	--	--	.4
Crassispora kosankei (Potonié and Kremp) Bharaduraj	--	.8	.8
Cyclogranisporites aureus (Loose) Potonié and Kremp	.8	.8	.8
Densosporites annulatus (loose) Schopf, Wilson, and Bentall	16.0	--	--
D. sphaerotriangularis Kosanke	.4	.8	.8
D. sp	.4	--	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	--	--	2.0
Endosporites ornatus Wilson and Coe	.4	.8	.8
E. sp	--	.8	.4
Florinites antiguus Schopf in Schopf, Wilson, and Bentall	2.0	3.2	.4
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	2.0	4.8	1.6
G. spp	2.0	4.0	1.6
Knoxisporites sp.	--	--	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	2.0	.5	4.0
L. latus Kosanke	.8	3.2	--
L. medius Kosanke	1.6	7.2	.4
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	3.2	--
L. ovalis Kosanke	12.0	17.6	4.4
L. vulgaris (Ibrahim) Alpern and Doubinger	2.0	--	.4
Leiotriletes priddyi (Berry) Potonié and Kremp	.4	--	--
Lophotriletes cf. *L. gibbosus* (Ibrahim) Potonié and Kremp	--	--	+
Lycospora granulata Kosanke	10.8	2.4	13.2
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	2.4	.8	1.2
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	4.0	1.6	1.6
L. punctata Kosanke	5.2	1.6	10.0
L. spp	30.0	32.8	40.0
Pityosporites sp	.4	--	--
Punctatisporites spp	.4	.8	.4
Raistrickia cf. *R. crocea* Kosanke	--	+	.4
R. cf. *R. pilosa* Kosanke	--	+	--
R. sp	.8	.8	--
Reticulatisporites sp	--	+	.4
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	--	+	--
Monosaccate	1.6	1.6	.8
Unassigned	+		+
	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

617-A, 35.1 cm coal.

617-B, 6.3 cm parting.

617-C, 11.4 cm coal.

TABLE 13.—*Palynomorphs from the Powellton(?) coal bed, lower bench, in West Virginia*

[Maceration series 651; USGS Paleobotanical loc. No. D6530; 400 specimens counted; +, present but not observed in count or count not attempted]

Taxon	651-A	651-B (percent)	651-C
Acanthotriletes triquetrus Smith and Butterworth	--	--	+
Cristatisporites indignabundus (Loose) Staplin and Jansonius	1.0	--	+
Cyclogranisporites multigranus Smith and Butterworth	--	--	+
C. sp	4.0	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	1.0	1.0	--
D. sphaerotriangularis Kosanke	--	12.0	--
D. triangularis Kosanke	3.0	13.0	--
D. spp	27.0	53.0	--
Dictyotriletes cf. *D. muricatus* (Kosanke) Smith and Butterworth	--	+	--
D. sp	--	+	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	5.0	+
L. medius Kosanke	--	+	--
L. cf. *L. minutus* (Ibrahim) Schopf, Wilson, and Bentall	--	--	+
L. ovalis Kosanke	1.0	7.0	+
Lycospora granulata Kosanke	8.0	--	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	+
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	5.0	--	+
L. punctata Kosanke	5.0	--	--
L. spp	43.0	4.0	+
Procoronaspora ambugua (Butterworth and Williams Smith and Butterworth	--	+	--
P. sp. 2	--	+	--
Punctatisporites obesus (Loose) Potonié and Kremp	--	2.0	--
P. sp	--	--	+
Raistrickia cf. *R. prisca* Kosanke	--	--	+
Verrucosisporites sp	--	2.0	+
Monosaccate	1.0	1.0	+
Unassigned	1.0	--	--
	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
651-A, 5.0 cm roof rock.
651-B, 17.7 cm coal.
651-C, 8.2 cm seat rock.

The core sample of the No. 2 Gas coal bed was 45.7 cm thick from a depth 161.7 m. The following are numerically important genera identified from the core sample, assigned to maceration series 616:

Densosporites	8.0 percent
Florinites	5.4
Laevigatosporites	12.0
Lycospora	59.6
	85.0 percent

Comparing these numerically important genera of the No. 2 Gas coal bed with those of the Powellton(?) coal bed (maceration series 617), one sees a decrease in abundance of *Densosporites* and an increase in *Lycospora*. However, the abundance data for maceration series 617 and 616-A are very comparable. Table 16 contains the palynomorphs identified from the No. 2 Gas coal bed and their abundance. Several sparsely occurring taxa should be noted such as *Grumosisporites* cf. *G. papillosus* (Ibrahim) Smith and Butterworth, *Hymenospora*(?) sp. 1, and *Thysanites*(?) sp., even though they do not occur in two benches of the No. 2 Gas coal bed to be discussed subsequently.

The sample thought to be from the lower bench of the No. 2 Gas coal bed, unit 103 of the Alloy section, maceration 683, was only 15.2 cm thick. Because it was taken from a roadbed, it is an incomplete bed sample and abundance data is not necessarily valid. Table 17 contains the palynomorph information available for this sample, and it should be noted that *Laevigatosporites* is present at the rate of 56.5 percent and that *Lycospora* represents only 4.5 percent of the palynomorph population, which does not compare with either 616-A or B or the upper bench of the No. 2 Gas coal bed, maceration series 682.

TABLE 14.—*Palynomorphs from the Powellton(?) coal bed, middle bench, in West Virginia*

[Maceration series 652; USGS Paleobotanical loc. No. D6529; 400 specimens counted; +, present but count not attempted]

Taxon	652-A	652-B	652-C	652-D
	(percent)			
Acanthotriletes triquetrus Smith and Butterworth	0.5	--	--	--
Ahrensisporites guerickei (Horst) Potonié and Kremp	.5	--	--	--
Calamospora mutabilis (Loose) Schopf, Wilson, and Bentall	--	--	0.5	--
C. sp	1.5	--	1.5	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	--	1.0	+
Cyclogranisporites aureus (Loose) Potonié and Kremp	4.5	--	--	--
C. multigranus Smith and Butterworth	2.5	--	.5	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	--	7.0	+
D. triangularis Kosanke	3.0	--	--	+
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	+	.5	--
Granulatisporites granularis Kosanke	.5	--	.5	--
G. sp.	.5	--		--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	+	3.5	+
L. latus Kosanke	--	+	1.0	--
L. medius Kosanke	--	--	--	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	--	.5	--
L. ovalis Kosanke	3.0	+	2.0	+
L. vulgaris (Ibrahim) Alpern and Doubinger	.5	--	.5	--
L. sp. 1	--	--	1.0	--
L. sp. 2	.5	--	.5	--
Leiotriletes sphaerotriangularis (Loose) Potonié and Kremp	--	--	--	+
Lycospora granulata Kosanke	4.5	+	14.0	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	4.5	+	1.5	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	16.5	+	11.0	+
L. punctata Kosanke	6.5	--	8.0	--
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	1.0	+	1.5	--
L. cf. *L. pusilla* (Ibrahim) Schopf, Wilson, and Bentall	--	--	.5	--
L. sp. 3	--	--	2.5	--
L. spp.	48.5	--	39.0	+
Microreticulatisporites concavus Butterworth and Williams	.5	+	--	--
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	--	+
P. sp	--	--	1.0	--
Wilsonites sp	--	--	.5	--
Unassigned	.5	--	--	--
	100.0		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
652-A, 9.5 cm black shale with vitrinite.
652-B, 10.1 cm roof rock.
652-C, 30.4 cm coal.
652-D, 7.6 cm seat rock.

A fairly diversified assemblage of palynomorphs was recovered from the upper bench of the No. 2 Gas coal bed (maceration series 682) in that 23 genera are listed in table 18. However, *Hymenospora*(?) sp. 1, present in the 616 maceration series from the Imperial Colliery core hole, was not observed in maceration series 682. Only two genera are numerically important in the coal samples, macerations 682-A and C:

Laevigatosporites	17.2 percent
Lycospora	60.2
	77.4 percent

The palynomorphs identified from the upper bench of the No. 2 Gas coal bed are given in table 18.

A grab sample from the Lower Peerless(?) coal bed, maceration 656, from unit 45 of the Harewood section, yielded fairly abundant palynomorphs but a limited

TABLE 15.—*Palynomorphs from the Powellton(?) coal bed, upper bench, in West Virginia*

[Maceration series 653; USGS Paleobotanical loc. No. D6531; 600 specimens counted; +, present but count not attempted]

Taxon	653-A	653-B	653-C	653-D
		(percent)		
Acanthotriletes triquetrus Smith and Butterworth	+	2.0	--	--
A. sp	--	.5	0.5	--
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	1.0	--	--
A. sp	--	--	--	0.5
Apiculatisporis abditus (Loose) Potonié and Kremp	--	--	1.0	--
Calamospora mutabilis (Loose) Schopf, Wilson, and Bentall	--	--	.5	--
C. sp	--	--	--	1.0
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	.5	2.5
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	--	1.0	--
C. multigranus Smith and Butterworth	--	--	1.0	--
C. sp	--	--	--	2.5
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	+	1.0	--	--
D. triangularis Kosanke	+	.5	--	--
D. sp	--	1.5	--	--
Dictyotriletes sp	--	--	--	3.5
Endosporites globosus (Ibrahim) Schopf, Wilson, and Bentall	+	2.5	--	--
E. zonalis (Loose) Knox	--	.5	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	.5	--	--
F. visendus (Ibrahim) Schopf, Wilson, and Bentall	--	2.5	.5	.5
Granulatisporites granularis Kosanke	--	2.0	1.0	3.5
Knoxisporites cf. *K. stephaneohorus* Love	--	--	.5	5.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	+	6.5	3.0	2.5
L. latus Kosanke	+	1.5	1.0	--
L. medius Kosanke	--	--	1.0	4.5
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	--	--	.5
L. ovalis Kosanke	+	11.0	5.0	10.0
L. vulgaris (Ibrahim) Alpern and Doubinger	--	.5	.5	--
L. sp. 1	--	1.5	--	.5
Lycospora granulata Kosanke	+	6.5	8.0	3.0
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	2.0	2.5	2.5
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	4.0	10.0	2.5
L. punctata Kosanke	+	2.5	12.0	4.0
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	+	1.5	1.0	--
L. sp. 4	--	1.5	1.0	.5
L. spp	+	39.5	47.0	47.0
Microreticulatisporites concavus Butterworth and Williams	--	1.0	--	.5
Pityosporites sp	+	2.5	--	--
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	--	.5
P. cf. *P. sinuosus* (Artüz) Neves	--	--	.5	--
Raistrickia cf. *R. prisca* Kosanke	+	1.0	.5	--
Wilsonites vesicatus (Kosanke) Kosanke	+	1.0	--	1.5
Monosaccate	--	1.0	.5	.5
Unassigned	--	.5	--	.5
		100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

653-A, 7.6 cm roof rock.
653-B, 24.1 cm coal.
653-C, 24.1 cm coal.
653-D, 8.8 cm seat rock.

TABLE 16.—*Palynomorphs from the No. 2 Gas coal bed in West Virginia*

[Maceration series 616; USGS Paleobotanical loc. No. D6234; 500 specimens counted]

Taxon	616-A (percent)	616-B (percent)
Acanthotriletes cf. *A. echinatus* (Knox) Potonié and Kremp	0.4	--
A. sp	.8	0.4
Alatisporites hoffmeisterii Morgan	--	1.2
Calamospora sp	.8	1.2
Cirratriradites annulatus Kosanke and Brokaw	.4	1.6
Convolutispora sp.	--	.8
Cristatisporites indignabundus (Loose) Staplin and Jansonius	4.8	--
Densosporites granulosus Kosanke	3.6	--
D. sphaerotriangularis Kosanke	4.8	--
D. triangularis Kosanke	1.2	--
D. spp	6.0	.4
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	.4	.4
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	1.6	--
E. sp	.4	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	4.8	6.0
Granulatisporites granulatus Ibrahim	--	2.0
Grumosisporites cf. *G. papillosus* (Ibrahim) Smith and Butterworth	--	.8
Hymenospora(?) sp.	--	1.6
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	3.6	2.4
L. medius Kosanke	2.0	1.6
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	.4
L. ovalis Kosanke	8.0	6.0
Leiotriletes sp	.4	.4
Lycospora granulata Kosanke	18.4	12.4
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	2.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	9.2	10.4
L. punctata Kosanke	1.2	.4
L. spp	25.2	40.0
Punctatisporites sp.	.4	1.2
Raistrickia cf. *R. fulva* Artüz	1.2	.8
R. sp	--	1.6
Thysanites(?) sp.	.4	--
Triquitrites sculptilis (Balme) Smith and Butterworth	--	.4
Wilsonites delicatus (Kosanke) Kosanke	--	3.6
	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS
616-A, = 22.8 cm coal.
616-B, = 22.8 cm coal.

number of different taxa. *Lycospora* is the dominant taxon, but preservation is not good in many specimens. Possibly two new species of *Lycospora*, first observed in the Eagle coal bed, are present at the rate of 10 percent. *Lycospora* is dominant and *Laevigatosporites* subdominant in maceration 656:

Laevigatosporites	17.0 percent
Lycospora	75.0
	92.0 percent

The identified taxa and abundance data are given in table 19.

The Upper Peerless(?) coal bed, maceration series 655, from units 48 to 50 of the Harewood section, yielded abundant and reasonably well-preserved palynomorphs. The following genera are numerically important in the coal sample 655-B and D as shown in table 20:

Densosporites	4.2 percent
Florinites	8.7
Laevigatosporites	39.7
Lycospora	28.6
	81.2 percent

TABLE 17.—*Palynomorphs from the No. 2 Gas coal bed, lower bench, in West Virginia*

[Maceration series 683; USGS Paleobotanical loc. No. D6521; 200 specimens counted; +, present but not observed in count]

Taxon	683 (percent)
Acanthotriletes echinatus (Knox) Potonié and Kremp	+
Apiculatisporis aculeatus (Ibrahim) Smith and Butterworth	0.5
Calamospora sp	+
Cirratriradites maculatus Wilson and Coe	3.0
Convolutispora sp	1.0
Cyclogranisporites sp	2.0
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	3.5
D. triangularis Kosanke	+
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	+
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	4.5
Granulatisporites cf. *G. adnatoides* (Potonié and Kremp) Smith and Butterworth	+
G. granulatus Ibrahim	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	7.0
L. latus Kosanke	4.5
L. medius Kosanke	5.5
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	1.0
L. ovalis Kosanke	31.0
L. vulgaris (Ibrahim) Alpern and Doubinger	4.5
Leiotriletes cf. *L. sphaerotriangularis* (Loose) Potonié and Kremp	2.5
L. sp	.5
Lophotriletes gibbosus (Ibrahim) Potonié and Kremp	.5
Lycospora granulata Kosanke	4.0
L. spp	.5
Punctatisporites sp	+
Raistrickia sp	.5
Reticulatisporites cf. *R. carnosus* (Knox) Neves	+
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	+
Triquitrites sculptilis (Balme) Smith and Butterworth	+
Wilsonites vesicatus (Kosanke) Kosanke	5.0
Monosaccate	11.0
Unassigned	4.5
	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

683, 15.2 cm coal taken from roadbed.

The two possibly new species of *Lycospora* identified from the Lower Peerless(?) coal bed were not identified in the Upper Peerless(?) coal bed; however, a number of genera are restricted to the upper bench of this coal bed. *Laevigatosporites* for the second time in the proposed stratotype is more abundant than *Lycospora*. This change is the result of a marked increase in abundance of *Laevigatosporites ovalis* Kosanke as shown in table 20. The decrease in abundance of *Lycospora* represents a significant change in the coal-swamp vegetation. *Lycospora*, representing arborescent lycopods, was the most abundant palynomorph in nearly all of the coal beds thus far discussed. Exceptions to this are the Douglas(?) coal bed (maceration series 695); the unnamed coal bed (maceration series 674), a short distance above the Gilbert(?) coal bed; the lower bench of the Powellton(?) coal bed (maceration 651-B); and the lower bench of the No. 2 Gas coal bed (maceration 683). In the Douglas(?) coal bed *Densosporites* is slightly more abundant than *Lycospora* so that a mixture of herbaceons (*Densosporites*) and arborescent (*Lycospora*) taxa exist. In the unnamed coal bed, maceration series 674, a diminution of *Lycospora* was noted with a consequent increase in *Endosporites*. DiMichele and others (1979) reported that the parent plant of *Densosporites* was herbaceous. The Upper Peerless(?) coal bed, maceration series 655, has species of *Lycospora* that represent more than one-third of the

TABLE 18.—*Palynomorphs from the No. 2 Gas coal bed, upper bench, in West Virginia*

[Maceration series 682; USGS Paleobotanical loc. No. D6522; 600 specimens counted; +, present but not observed in count of count not attempted]

Taxon	682-A	682-B	682-C	682-D
	(percent)			
Acanthotriletes echinatus (Knox) Potonié and Kremp	--	--	+	--
A. triquetrus Smith and Butterworth	--	1.0	+	--
A. sp	0.5	--	--	--
Apiculatisporis cf. *A. abditus* (Loose) Potonié and Kremp	+	--	--	--
A. sp	+	--	--	--
Calamospora cf. *C. mutabilis* (Loose) Schopf, Wilson, and Bentall	+	--	--	--
C. parva Guennel	+	--	--	--
C. sp	.5	--	1.0	--
Cirratriradites annuliformis Kosanke and Brokaw	1.0	--	5.0	--
C. sp. 1	--	--	4.0	--
Convolutispora sp	--	--	+	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	1.0	--	--
Cyclogranisporites sp	+	2.0	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	3.0	--	--
D. sp	--	--	6.0	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	1.0	1.0	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	1.0	2.0	3.0	--
Granulatisporites pallidus Kosanke	+	+	--	--
G. sp	.5	1.0	1.0	--
Grumosisporites(?) sp	+	--	--	--
Knoxisporites stephanephorus Love	--	+	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	4.0	7.0	--
L. latus Kosanke	.5	--	--	--
L. medius Kosanke	.5	+	14.0	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	1.5	1.0	--	--
L. ovalis Kosanke	3.0	6.0	8.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	+	1.0	6.0	--
L. sp. 1	.5	--	--	--
L. sp. 2	--	+	--	--
Lycospora granulata Kosanke	6.5	5.0	2.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	46.5	4.0	--	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	6.0	4.0	1.0	--
L. punctata Kosanke	4.5	5.0	--	--
L. sp. 1	.5	--	--	--
L. spp	23.5	56.0	19.0	+
Pityosporites westphalensis Williams	--	--	8.0	--
Punctatisporites sp	--	1.0	1.0	--
Raistrickia cf. *R. saetosa* (Loose) Schopf, Wilson, and Bentall	--	+	3.0	--
R. spp	--	+	+	--
Reticulatisporites cf. *R. carnosus* (Knox) Neves	.5	--	--	--
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	+	--	--	--
Stenzonotriletes sp. 1	--	+	--	--
Triquitrites sp	--	+	--	--
Verrucosisporites sp	1.0	+	1.0	--
Wilsonites vesicatus (Kosanke) Kosanke	--	--	1.0	--
Monosaccate	--	1.0	8.0	--
Unassigned	.5	1.0	1.0	--
	100.0	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

682-A, 15.2 cm coal.

682-B, 3.5 cm parting.

682-C, 10.1 cm coal.

682-D, 10.1 seat rock.

TABLE 19.—*Palynomorphs from the Lower Peerless(?) coal bed in West Virginia*

[Maceration series 656; USGS Paleobotanical loc. No. D6533; 200 specimens counted]

Taxon	656 (percent)
Acanthotriletes triquetrus Smith and Butterworth	0.5
Alatisporites hoffmeisterii Morgan	.5
Convolutispora cf. *C. florida* Hoffmeister, Staplin, and Malloy	.5
Densosporites triarigularis Kosanke	.5
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.5
Granulatisporites sp	.5
Knoxisporites triangularis Hoffmeister, Staplin, and Malloy	.5
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	2.0
L. latus Kosanke	1.5
L. medius Kosanke	2.0
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	2.0
L. ovalis Kosanke	8.5
L. sp. 1	1.0
Lycospora granulata Kosanke	9.5
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	3.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall)—*L. pseudoannulata* Kosanke	13.0
L. punctata Kosanke	3.0
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	10.0
L. spp	36.5
Raistrickia sp	.5
Verrucosisporites sp	.5
Wilsonites vesicatus (Kosanke) Kosanke	1.0
Monosaccate	2.5
	100.0

DESCRIPTION OF MATERIAL IN MACERATION

656, one grab sample from unit 45 of Harewood section

palynomorph assemblage so this is a mixture of herbaceous and arborescent plants.

The Alma(?) coal bed from the Alloy section in Fayette County, W. Va., yielded abundant and well preserved palynomorphs from the coal samples 675-B and D. The roof sample, 676-A, yielded a number of different palynomorphs in contrast to the samples from the parting, 676-C, and the seat rock, 676-E. *Lycospora* is the most abundant genus in 676-B and D and the other numerically important genera are:

Florinites	5.4 percent
Laevigatosporites	30.6
Lycospora	40.1
	76.1 percent

The taxa identified from the Alma(?) coal bed are given in table 21. Compared to the upper bench of the Peerless(?) coal bed, which is stratigraphically below the Alma, *Lycospora* and *Laevigatosporites* have reversed abundance so that *Lycospora* is slightly more abundant than *Laevigatosporites* in the Alma(?) coal bed. *Densosporites* is not numerically important in the Alma(?) coal bed, but in a sample from the type locality of the overlying Cedar Grove coal bed (Kosanke, 1984), maceration series 122, this genus is dominant.

Samples of the Lower Cedar Grove Rider coal bed and the Middle Cedar Grove Rider coal bed were collected from T. W. Henry's Big Hollow section in the area of the proposed Pennsylvanian System stratotype and were assigned to 688 and 689 maceration series, respectively. Only samples of the thin coal in each maceration series yielded sufficient palynomorphs to provide abundance data. These data are given in tables 22 and 23, and the generic summary of the more abundant palynomorphs follows:

	688-B	689-B
Calamospora	7.5	0.5 percent
Florinites	2.0	4.5
Granulatisporites	2.5	17.5
Laevigatosporites	33.0	18.5
Lycospora	41.5	41.5
Punctatisporites	.5	4.0
	87.0	86.5 percent

These thin rider coal beds (macerations 688 and 689) are not easy to evaluate with respect to the Alma(?) coal

TABLE 20.—*Palynomorphs from the Upper Peerless(?) coal bed in West Virginia*

[Maceration series 655, USGS Paleobotanical loc. No. D6532; 400 specimens counted; +, present but not observed in count or count not attempted]

Taxon	655-A	655-B	655-C	655-D	655-E
			(percent)		
Acanthosporites spp	+	--	--	3.0	--
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	+	--	--	--
Alatisporites hoffmeisterii Morgan	--	+	--	--	--
A. sp	--	--	+	--	--
Apiculatisporis abditus (Loose) Potonié and Kremp	--	--	--	1.5	--
A. sp	--	--	+	--	--
Calamospora mutabilis (Loose) Schopf, Wilson, and Bentall	--	--	--	1.0	--
C. sp	--	--	--	+	--
Cirratriradites sp	--	0.5	--	--	--
Convolutispora sp	--	+	--	--	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	6.0	--	--	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	1.5	--	+	--
C. sp. nov.	+	+	--	1.0	--
Densosporites annulatus (Loose) Schopf, Wilson and Bentall	+	.5	--	--	--
D. triangularis Kosanke	+	8.5	--	--	--
D. sp	--	--	--	.5	--
Dictyotriletes mediareticulatus (Ibrahim) Smith and Butterworth	--	--	--	.5	--
D. sp	--	.5	--	--	+
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	+	1.0	--	--	--
E. sp	--	1.0	--	--	--
Florinites antiguus Schopf in Schopf, Wilson, and Bentall	+	11.0	+	6.5	--
F. sp	--	.5	--	--	--
Granulatisporites pallidus Kosanke	--	--	--	+	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	+	2.5	--
Knoxisporites rotatus Hoffmeister, Staplin, and Malloy	+	--	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	+	8.0	+	5.0	--
L. latus Kosanke	+	3.5	1.5	--	--
L. medius Kosanke	+	7.0	+	7.5	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	--	--	.5	--
L. ovalis Kosanke	+	22.5	+	15.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	+	6.0	3.5	--	--
L. sp. nov.	--	1.0	--	--	--
Leiotriletes priddyi (Berry) Potonié and Kremp	--	.5	--	.5	--
Lycospora granulata Kosanke	+	1.5	--	6.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	+	1.5	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	1.5	--	4.5	--
L. punctata Kosanke	+	2.0	--	5.0	--
L. spp	+	7.5	+	25.0	--
Pityosporites westphalensis Williams	--	--	--	5.5	--
Punctatisporites sinuatus (Artüz) Neves	--	1.0	+	.5	--
P. sp	+	--	--	--	--
Raistrickia saetosa (Loose) Schopf, Wilson, and Bentall	--	--	--	.5	--
R. spp	--	.5	--	--	--
Reticulatisporites carnosus (Knox) Neves	--	1.5	+	.5	--
R. sp	--	--	--	--	+
Savitrisporites nux (Butterworth and Williams) Smith and Butterworth	--	--	--	--	+
Verrucosisporites sp	--	--	--	.5	--
Vestispora sp	--	+	--	--	--
Wilsonites vesicatus (Kosanke) Kosanke	--	+	--	--	--
Monosaccate	--	5.0	--	3.5	+
Unassigned	+	+	--	+	--
		100.0		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

655-A, 10.1 cm roof rock.
655-B, 17.7 cm coal.
655-C, 2.5 cm parting.
655-D, 21.5 cm coal.
655-E, 7.6 cm seat rock.

TABLE 21.—*Palynomorphs from the Alma(?) coal bed in West Virginia*

[Maceration series 676; USGS Paleobotanical loc. No. D6523; 400 specimens counted; +, present but not observed in count or count not attempted]

Taxon	676-A	676-B	676-C	676-D	676-E
			(percent)		
Acanthotriletes echinatus (Knox) Potonié and Kremp	--	+	--	--	+
A. triquetrus Smith and Butterworth	--	--	--	--	+
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	0.5	+	--	--
Apiculatisporis aculeatus (Ibrahim) Smith and Butterworth	--	.5	+	--	--
Calamospora cf. *C. straminea* Wilson and Kosanke	--	--	--	1.0	--
C. sp	--	1.0	--	1.0	--
Cirratriradites sp	--	.5	--	.5	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	+	--	+	--	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	+	1.0	--	--	--
Cyclogranisorites cf. *C. aureus* (Loose) Potonié and Kremp	--	2.5	--	2.5	--
C. cf. *C. minutus* Bharadwaj	--	--	--	5.0	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	+	.5	+	--	--
D. triangularis Kosanke	+	.5	--	--	--
D. sp	+	.5	--	.5	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	+	.5	--	--	--
D. sp	+	--	--	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	+	--	--	--	--
E. zonalis (loose) Knox	+	+	--	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	7.5	--	3.0	--
Granulatisporites pallidus Kosanke	--	+	--	1.5	--
G. verrucosus (Wilson and Coy) Schopf, Wilson, and Bentall	--	+	--	2.5	--
G. sp	--	.5	--	1.0	--
Knoxisporites rotatus Hoffmeister, Staplin, and Malloy	+	+	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	+	2.5	--	4.0	--
L. latus Kosanke	--	3.0	--	2.0	--
L. medius Kosanke	--	5.0	--	2.0	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	--	--	+	--
L. ovalis Kosanke	+	19.5	+	11.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	6.0	+	7.0	--
L. sp. 1	--	--	--	1.0	--
Leiotriletes sp	--	.5	--	.5	--
Lophotriletes gibbosus (Ibrahim) Potonié and Kremp	+	2.0	--	3.0	--
L. cf. *L. microsaetosus* (Loose) Potonié and Kremp	.5	--	--	--	--
Lycosora granulata Kosanke	--	5.5	--	3.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	3.0	--	.5	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	14.0	+	--		
L. sp	+	15.5	+	28.0	--
Pityosporites Hestphalensis Williams	--	--	--	3.5	--
Punctatisporites sinuatus (Artüz) Neves	--	+	--	--	--
P. sp	--	1.0	--	--	--
Pustulatisporites cf. *P. pustulatus Potonié* and Kremp	--	.5	--	--	--
Raistrickia prisca Kosanke	--	.5	--	--	--
R. sp	+	.5	--	.5	--
Reticulatisporites sp	--	+	--	--	--
Savitrispurites nux (Butterworth and Williams) Smith and Butterworth	--	--	+	--	--
Spencerisporites radiatus (Ibrahim) Winslow	+	--	--	--	--
Triquitrites sp	--	--	--	.5	--
Verrucosisporites sp	--	+	+	--	--
Vestispora sp	--	.5	--	--	--
Wilsonites vesicatus (Kosanke) Kosanke	--	3.0	--	4.5	--
Monosaccate	--	1.0	--	4.0	--
Unassigned	+	--	--	.5	
		100.0		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

676-A, 7.6 cm roof rock.
676-B, 11.4 cm coal with thin-shale laminae.
676-C, 2.5 partings.
676-D, 16.5 cm coal.
676-E, 7.6 seat rock.

TABLE 22.—*Palynomorphs from the Lower Cedar Grove Rider coal bed in West Virginia*

[Maceration series 688; USGS Paleobotanical loc. No. D6525; 200 specimens counted; +, present but not observed in count or count not attempted]

Taxon	688-A	688-B (percent)	688-C
Apiculatisporis abditus (Loose) Potonié and Kremp	--	+	--
Calamospora breviradiata Kosanke	--	4.0	--
C. mutabilis (Loose) Schopf, Wilson, and Bentall	--	1.0	--
C. parva Guennel	--	+	--
C. spp	--	2.5	--
Cirratriradites annulatus Kosanke and Brokaw	--	.5	--
C. sp	--	3.0	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	1.0	--
Cyclogranisporites cf. *C. multigranus Smith and Butterworth*	--	3.0	--
C. sp. nov. (wide grana)	--	+	--
C. spp	--	2.0	--
Densosporites sp	+	--	+
Dictyotriletes sp	--	+	--
Florinites aritiquus Schopf in Schopf, Wilson, and Bentall	--	1.0	--
F. sp (small)	--	1.0	--
Granulatisporites pallidus Kosanke	--	1.0	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	+	1.5	+
Laevigatosaorites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	6.0	--
L. latus Kosanke	--	2.5	--
L. medius Kosanke	--	1.0	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	7.5	--
L. ovalis Kosanke	+	9.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	6.5	--
L. sp. nov. 1	--	.5	--
Leiotriletes sphaerotriangulus (Loose) Potonié and Kremp	--	+	--
Lophotriletes cf. *L. gibbosus* (Ibrahim) Potonié and Kremp	--	+	--
Lycospora granulata Kosanke	--	3.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	16.0	+
L. punctata Kosanke	--	5.0	--
L. spp	+	17.5	--
Punctatisorites obesus (Loose) Potonié and Kremp	--	+	--
Raistrickia saerosa (Loose) Schopf, Wilson, and Bentall	--	1.5	--
R. sp	--	.5	--
Reticulatisporites carnosus (Knox) Neves	--	.5	--
Verrucosispories sp	--	1.0	--
Monosaccate	+	.5	--
		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
688-A, 8.8 cm roof rock.
688-B, 7.6 cm coal.
688-C, 7.6 cm seat rock.

bed below and the Cedar Grove coal bed prepared separately. In samples from what are thought to be the Cedar Grove coal bed in the Imperial Colliery core hole 1976-4, the banded coal in maceration 615-A yielded abundant palynomorphs, but the bone coal in maceration 615-B yielded relatively few. This is shown in table 24. The numerically abundant taxa of maceration 615-A, the normally banded coal, are:

Densosporites	12.8 percent
Laevigatosporites	26.0
Lycospora	54.4
	93.2 percent

The abundance of *Laevigatosporites* in maceration series 615 is approximately equivalent to the average for the whole coal at the type locality of the Cedar Grove coal bed. However, *Densosporites* is abundant and

TABLE 23.—*Palynomorphs from the Middle Cedar Grove Rider coal bed in West Virginia*

[Maceration series 689; USGS Paleobotanical loc. No. D6527; 200 specimens counted; +, present but count not attempted]

Taxon	689-A	689-Brr (percent)	689-C
Acanthotriletes sp	--	1.0	--
Calamospora sp	--	.5	--
Columinisporites(?)	+	--	
Cyclogranisporites sp	--	2.0	--
Densosporites sp	--	1.0	+
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	1.0	+
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	4.5	--
Granulatisporites spp	+	17.5	+
Laevigatosporites desminensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	3.5	+
L. latus Kosanke	--	2.0	--
L. medius Kosanke	--	1.5	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	+	2.0	+
L. ovalis Kosanke	+	4.5	+
L. vulgaris (Ibrahim) Alpern and Doubinger	--	1.5	--
L. sp	--	3.5	--
Lophotriletes sp	--	1.5	--
Lycospora granulata Kosanke	--	.5	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	2.0	+
L. punctata Kosanke	--	.5	--
L. spp	+	38.5	+
Punctatisporites spp	+	4.0	--
Raistrickia sp	+	--	--
Monosaccate	--	5.5	--
Unassigned	--	1.5	--
		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
689-A, 5.08 cm roof rock.
689-B, 3.17 cm coal.
689-C, 5.08 cm seat rock.

Note: The letters rr after maceration 689-B indicates that the first maceration of this sample failed to yield abundant palynomorphs so that the sample was rerun.

Lycospora is reduced in the Cedar Grove coal bed from the type locality (maceration series 122) when compared to the Alma(?) coal bed (maceration series 676). Comparing the Cedar Grove and Alma(?) coal beds overall, a close correlation does not exist, although the Alma(?) coal sample does resemble a portion of the upper part of the Cedar Grove coal bed.

The Williamson(?) coal bed, unit 64 of the Harewood section in Fayette County, is only 11.4 cm thick, it yielded a great deal of degraded organic matter, and palynomorph preservation was generally poor.

Abundance counts were made on the coal and seat-rock samples and the following genera were important numerically in the coal sample 658-B:

Crassispora	4.0 percent
Densosporites	5.0
Laevigatosporites	34.5
Lycospora	50.5
	94.0 percent

The seat rock sample contains *Lycospora micropapillata* (Wilson and Coe) Schopf, Wilson, and Bentall as the overwhelming dominant taxon as shown in table 25, suggesting the parent plant of this palynomorph was a primary invader in the swamp community. In the coal sample, maceration 658-B, *L. micropapillata* (Wilson and Coe) Schopf, Wilson, and Bentall is still the most abundant taxon, but is reduced to only 15 percent of the assemblage. *Laevigatosporites* is second in abundance to *Lycospora*, accounting for slightly more than one-third of the assemblage.

The type locality of the Henshaw coal bed, according to Wanless 1939(1939), is along Lens Creek near Hernshaw, Kanawha County. Four equal samples of coal and roof rock were collected from the type Hernshaw above Lens Creek at the collapsed entrance of the Marmet mine. At this locality, the Hernshaw appeared to consist of one bed approximately 61 cm thick. Wanless (1939) reported the Hernshaw was multibedded;

TABLE 24.—*Palynomorphs from the Cedar Grove(?) coal bed in West Virginia*

[Maceration series 615; USGS Paleobotanical loc. No. D6397; 250 specimens counted; +, present but not observed in count or count not attempted]

Taxon	615-A (percent)	615-B
Apiculatasporites spinulistratus (Loose) Ibrahim	0.4	--
Calamospora breviradiata Kosanke	.8	--
C. sp	.4	+
Cirratriradites annulatus Kosanke and Brokaw	.4	+
Crassispora kosankei (Potonié and Kremp) Bharadhaj		+
Cristatisporites indignabundus (Loose) Staplin and Jansonius	.4	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	12.4	--
P. sp	.4	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	.4	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.8	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.4	--
G. sp.	--	+
Knoxisporites sp	--	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	6.0	--
L. latus Kosanke	.8	+
L. medius Kosanke	4.0	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	+
L. ovalis Kosanke	13.6	+
L. striatus Alpern	+	--
L. vulgaris (Ibrahim) Alpern and Doubinger	1.6	--
Lycospora granulata Kosanke	18.8	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	+
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	2.4	--
L. punctata Kosanke	5.6	+
L. sp	26.0	--
Punctatisporites sp	.8	+
Raistrickia sp	--	+
Reticulatisporites sp	+	--
Verrucosisporites sp	+	--
Wilsonites vesicatus (Kosanke) Kosanke	.8	--
Monosaccate	1.2	--
	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
615-A, 11.4 cm coal.
615-B, 13.9 cm bone coal.

however, evidence of the multibedded character of the Hernshaw was not established at the type locality of this coal bed. Unfortunately, the roof samples, maceration 694-A, and the seat rock sample, 694-E, did not yield sufficient, well preserved palynomorphs to warrant abundance counts.

T. W. Henry (1984), indicated that he thought that the Hernshaw coal bed, at its type locality, correlated physically with the Cedar Grove coal bed at its type locality. Palynologically, from the standpoint of abundance of various taxa, there is little correlation between these two beds. For example, *Lycospora micropapillata* (Wilson and Coe) Schopf, Wilson, and Bentall in the Hernshaw coal bed accounts for more than one-half of the palynomorph assemblage of 694-C, but is present only at the rate of one percent in 694-D, and is absent from 694-B as shown in table 26. This taxon has not been identified from the Cedar Grove coal bed (maceration series 122). Possibly this could mean that the upper part of the Hernshaw coal bed could be related to the Cedar Grove coal bed.

The most abundant genera in the coal samples of the 694 maceration series are:

Calamospora	3.8 percent
Densosporites	4.8
Laevigatosporites	32.3
Lycospora	45.5
	86.4 percent

TABLE 25.—*Palynomorphs from the Williamson(?) coal bed in West Virginia*

[Maceration series 658; USGS Paleobotanical loc. No. D6535; 400 specimens counted; +, present but count not attempted]

Taxon	658-A	658-B (percent)	658-C
Acanthotriletes sp	--	--	3.0
Calamospora parva Guennel	--	2.0	--
C. sp	--	--	2.0
Cirratriradites sp	+	--	1.0
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	4.0	1.0
Cristatisporites sp	--	--	1.0
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	.5	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	4.5	1.0
D. sp	+	--	--
Granulatisporites granularis Kosanke	--	1.5	--
G. sp	--	--	1.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	5.5	2.0
L. latus Kosanke	--	.5	--
L. medius Kosanke	--	1.5	--
L minutus (Ibrahim) Schopf, Wilson, and Bentall		8.0	
L. ovalis Kosanke	+	11.5	1.0
L. sp. 1	--	7.5	--
Leiotriletes sp	--	.5	--
Lycospora granulata Kosanke	--	8.5	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	15.0	75.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	2.5	3.0
L. punctata Kosanke	--	8.0	--
L. torquifer (Loose) Potonié and Kremp	--	.5	--
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	--	1.0	--
L. cf. sp. 5	--	.5	--
L. spp	--	14.5	5.0
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	1.0
P. sp	--	1.5	--
Wilsonites vesicatus (Kosanke) Kosanke	--	.5	--
Unassigned	--	--	3.0
		100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS
658-A, 10.1 cm roof rock
658-B, 11.4 cm coal.
658-C, 10.1 cm seat rock.

A multibedded coal from units 67 through 76 of the Harewood section, Fayette County, thought possibly equivalent to the Hernshaw coal bed, was collected and assigned to the 659 maceration series. The results of the analyses are shown in table 27. Only three of nine samples yielded sufficient palynomorphs for meaningful abundance counts. Preservation was very poor in all noncoal samples of this series. In two of the coal samples opaque attritus was abundant, and the palynomorphs were a dark brown color. *Lycospora micropapillata* (Wilson and Coe) Schopf, Wilson, and Bentall averages 7.5 percent and at present accounts for 12 percent of the palynomorph assemblage in 659-B. The more abundant genera occurring in the coal samples are as follows:

Calamospora	2.1 percent
Granulatisporites	2.6
Laevigatosporites	25.0
Lycospora	55.2
	84.9 percent

Lycospora micropapillata, (Wilson and Coe) Schopf, Wilson, and Bentall although present in most coal beds of the lower part of the Kanawha Formation, is not abundant until the upper bench of the No. 2 Gas coal bed is reached. From the No. 2 Gas coal bed, going up section to the Williamson(?) coal bed, this taxon occurs rather irregularly; however, it is well represented in the Hernshaw(?) samples. The preservation of palynomorphs in maceration series 659 leaves much to be desired, nevertheless, several genera were identified that are not known to be present in maceration series 694 as can be seen by comparing tables 26 and 27. Because of environmental differences, the multibedded

TABLE 26.—*Palynomorphs from the Hernshaw coal bed in West Virginia*

[Maceration series 694; USGS Paleobotanical loc. No. D6526; 600 specimens counted; +, present but count not attempted]

Taxon	694-A	694-B	694-C	694-D	694-E
			(percent)		
Calamospora mutabilis (Loose) Schopf, Wilson, and Bentall	--	1.0	--	--	--
C. parva Guennel	--	2.0	2.0	--	--
C. cf. *C. straminea* Wilson and Kosanke	--	1.5	.5	--	--
C. spp	+	4.0	+	--	+
Cappasporites(?) sp	--	+	.5	--	--
Cirratriradites annuliformis Kosanke and Brokaw	--	3.5	--	--	--
C. sp	--	.5	--	1.0	+
Crassispora kosankei (Potonié and Kremp) Bharadwaj	+	2.0	--	1.5	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	+	--	4.5	+
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	+	--	--	1.5	--
D. sphaerotriangularis Kosanke		--	--	5.0	+
D. triangularis Kosanke	--	--	.5	3.0	+
D. sp	+	--	1.0	3.5	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	--	--	.5	1.0	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	.5	1.5	--	--
E. vesicatus Kosanke		--	1.0	--	--
E. sp	+	--	.5	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	1.0	--	3.5	+
F. sp	--	--	--	.5	--
Granulatisporites adnatoides (Potonié and Kremp Smith and Butterworth	--	+	--	--	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	1.0	--	--	+
G. sp	--	1.0	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	4.0	3.0	8.5	--
L. globosus Schemel	--	--	--	+	--
L. latus Kosanke	--	2.0	2.0	5.0	--
L. medius Kosanke	+	2.5	.5	3.0	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	5.0	1.5	--	+
L. ovalis Kosanke	+	17.0	9.5	27.5	+
L. vulgaris (Ibrahim) Alpern and Doubinger	--	1.0	1.0	3.5	+
L. sp	--	--	.5	--	--
Leiotriletes sp	--	1.0	--	--	--
Lophotriletes sp.	--	1.5	--	--	--
Lycospora granulata Kosanke	+	2.0	5.5	2.5	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	8.5	53.5	1.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	+	4.5	2.0	2.0	--
L. punctata Kosanke	--	4.5	2.5	5.5	--
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	--	.5	2.5	.5	--
L. spp	+	25.0	7.0	15.5	--
Punctatisporites sp	--	1.0	--	.5	--
Raistrickia cf. *R. crocea* Kosanke	--	+	--	--	--
R. sp	+	.5	.5	--	--
Reticulatisporites carnosus (Knox) Neves	--	.5	--	--	--
Triquitrites cf. *T. sculptilis* (Balme) Smith and Butterworth	--	--	--	--	+
Wilsonites sp	--	+	.5	--	--
Monosaccate	+	.5	--	--	+
Unassigned	--	.5	--	--	--
		100.0	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

694-A, 15.2 cm roof rock.
694-B, 15.2 cm coal.
694-C, 15.2 cm coal.
694-D, 15.2 cm coal.
694-E 15.2 cm coal.

TABLE 27.—*Palynomorphs from the Hernshaw(?) coal bed in West Virginia*

[Maceration series 659; USGS Paleobotanical loc. No. D6402; 600 specimens counted; +, present but not observed in count or count not attempted]

Taxon	659-A	659-B	659-C	659-D	659-E	659-F	659-G	659-H	659-I
				(percent)					
Acanthotriletes echinatus (Knox) Potonié and Kremp	--	--	--	+	--	--	--	+	--
A. triquetrus Smith and Butterworth	--	+	--	--	+	--	--	--	+
A. sp	--	--	+	+	--	--	--	--	+
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	--	--	--	--	--	+	--	--
Apiculatasporites spinulistratus (Loose) Ibrahim	--	--	--	+	--	--	--	--	--
Apiculatisporites sp	--	0.5	--	0.5	--	--	--	+	--
Calamospora breviradiata Kosanke	--	--	--	.5	--	--	--	--	--
C. hartungiana Schopf in Schopf, Wilson, and Bentall	--	--	--	+	--	--	--	--	--
C. mutabilis (Loose) Schopf, Wilson, and Bentall	--	--	--	.5	--	--	+	1.0	--
C. parva Guennel	--	--	--	.5	--	--	--	--	--
C. sp	--	1.5	--	1.5	--	+	--	1.0	--
Cirratriradites sp	--	.5	--	.5	--	--	--	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	.5	--	--	--	--	--	1.0	--
Cyclogranisporites multigranus Smith and Butterworth	--	.5	--	--	--	--	--	--	--
C. sp	--	.5	--	.5	--	--	+	3.0	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	+	--	--	+	--	--	--	--	--
D. sp	+	.5	--	--	--	--	--	--	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	+	--	--	--	--	--	--	--	+
D. reticulocingulum Smith and Butterworth	+	--	--	--	--	--	--	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	+	+	1.5	+	--	--	2.0	--
E. zonalis (Loose) Knox	--	--	--	.5	--	--	--	--	--
E. sp	--	.5	--	--	--	--	--	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	1.5	--	--	+	--	--	2.0	+
F. cf. *F. millotti* Butterworth and Williams	+	--	--	--	--	--	--	3.0	--
Granulatisporites pallidus Kosanke	--	--	--	1.0	+	--	+	1.0	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	.5	--	1.0	--	--	--	1.0	--
G. sp	+	1.5	--	1.0	+	--	+	3.0	--
Knoxisporites rotatus Hoffmeister, Stalin and Malloy	--	.5	--	--	--	--	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	6.0	--	4.0	--	+	+	2.0	--
L. latus Kosanke	--	.5	--	1.0	--	+	+	1.0	--
L. medius	--	4.0	+	3.5	--	+	+	2.0	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	+	2.5	--	3.0	+	+	+	3.0	+
L. ovalis Kosanke	--	14.0	--	10.5	+	+	+	16.0	+
L. vulgaris (Ibrahim) Alpern and Doubinger	--	--	--	--	--	+	--	2.0	--
Leiotriletes priddyi (Berry) Potonié and Kremp	--	--	--	+	--	--	--	--	--
L. sp	--	.5	--	--	--	--	--	--	--
Lycospora granulata Kosanke	--	7.0	+	7.0	--	--	--	3.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	12.0	+	9.0	+	+	--	4.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall) —*L. pseudoanulata* Kosanke	--	4.0	+	10.0	+	+	+	--	--
L. punctata Kosanke	+	11.5	+	11.5	+	--	--	3.0	--
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	--	.5	--	4.5	--	+	--	2.0	--
L. spp	+	23.0	+	23.5	+	+	--	25.0	+
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	--	1.0	+	+	--	1.0	--
P. sinuatus (Artuz) Neves	--	.5	--	--	--	--	--	--	--
P. spp	+	1.0	--	--	+	--	--	4.0	+
Raistrickia cf. *R. pilosa* Kosanke	+	--	--	--	--	--	--	--	--
R. sp	--	+	--	--	--	--	--	+	--
Triquitrites cf. *T. crassus* Kosanke	--	+	--	--	--	--	--	1.0	--
T. sculptilis (Balme) Smith and Butterworth	--	--	--	--	--	--	+	1.0	--
Verrucosisporites microtuberosus (Loose) Smith and Butterworth	--	--	--	1.5	--	--	--	--	--
V. spp	--	--	--	+	--	--	--	3.0	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	1.5	--	--	--	--	--	--	--
V. pseudoreticulata Spode in Smith and Butterworth	--	--	--	+	--	--	--	--	--
Wilsonites sp	+	--	--	.5	--	+	--	3.0	--
Monosaccate	--	2.5	--	--	--	--	+	6.0	--
		100.0		100.0				100.0	

DESCRIPTION OF MATERIAL IN MACERATION

659-A, 10.1 cm roof rock.
659-B, 20.3 cm coal.
659-C, 4.4 cm parting.
659-D, 15.2 coal.
659-E, 21.5 cm parting with coal.
659-F, 2.5 cm coal.
659-G, 9.5 cm coal.
659-H, 6.3 cm coal.
659-I, 8.8 cm seat rock.

TABLE 28.—*Palynomorphs from the Chilton(?) coal bed, lower bench, in West Virginia*

[Maceration series 660; USGS Paleobotanical loc. No. D6537; 400 specimens counted; +, present but not observed in count or count not attempted]

Taxon	660-A	660-B	660-C	660-D	660-E
			(percent)		
Acanthotriletes echinatus (Knox) Potonié and Kremp	--	3.0	--	1.0	+
A. sp	--	--	--	--	+
Apiculatisporis sp	--	2.0	--	--	--
Calamospora breviradiata Kosanke	+	--	--	--	--
C. mutabilis (Loose) Schopf, Wilson, and Bentall	--	2.0	--	--	+
C. sp	--	2.0	--	1.0	--
Cirratriradites saturni (Ibrahim) Schopf, Wilson, and Bentall	--	2.0	+	2.0	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	1.0	+	1.0	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	--	--	4.0	--
C. multigranus Smith and Butterworth	+	--	--	--	--
C. sp	+	2.0	--	3.0	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	1.0	+	--	--
D. sphaerotriangularis Kosanke	--	1.0	--	--	--
D. triangularis Kosanke	--	6.0	+	--	--
D. sp	--	2.0	+	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	1.0	--	1.0	--
Florinites sp	--	--	--	4.0	--
Granulatisporites granularis Kosanke	--	--	+	--	--
G. sp	--	1.0	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	+	10.0	--	16.0	+
L. latus Kosanke	--	4.0	--	8.0	--
L. medius Kosanke	--	4.0	+	3.0	--
L. minutis (Ibrahim) Schopf, Wilson, and Bentall	--	--	+	4.0	--
L. ovalis Kosanke	+	12.0	+	20.0	+
L. vulgaris (Ibrahim) Alpern and Doubinger	--	1.0	+	4.0	--
Leiotriletes priddyi (Berry) Potonié and Kremp	--	--	--	4.0	--
Lycospora granulata Kosanke	+	5.0	--	--	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	--	+	2.0	+
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	+	6.0	--	4.0	+
L. puncatata Kosanke	+	1.0	--	1.0	+
L. spp	+	21.0	--	4.0	--
Microreticulatisporites concavus Butterworth and Williams	--	2.0	--	--	--
Pitysporites westphalensis Williams	--	1.0	--	--	--
Pustulatisporites pustulatus Potonié and Kremp	--	--	--	1.0	--
Raistrickia sp	+	1.0	--	1.0	--
Triquitrites protensus Kosanke	--	--	--	1.0	--
T. cf. *T. sculptilis* (Balme) Smith and Butterworth	--	--	--	1.0	--
Verrucosisporites sp	--	--	--	2.0	+
Wilsonites sp	--	1.0	--	3.0	--
Monosaccate	--	5.0	+	4.0	--
Unassigned	--	+	--	--	+
		100.0		100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

660-A, 72.7 cm roof rock.
660-B, 26.6 cm coal.
660-C, 26.6 cm coal.
660-D, 27.9 cm coal.
660-E, 7.6 cm seat rock.

nature of samples of the 659 maceration series may be a factor in the occurrence of some of these taxa.

The Chilton coal bed was named for the town of Chilton, Kanawha County, where it was mined on Davis Creek. Stratigraphically, it occurs above the Henshaw coal bed and below the Chilton "A" coal bed. The Chilton coal bed is multibedded similarly to the Hernshaw coal bed below. The two coal beds have yielded poorly preserved palynomorphs.

Samples of the Chilton(?) coal bed from the Harewood section in Fayette County, W. Va. were assigned to maceration series 660 and 661. Preservation and recovery was poor in both of these maceration series so that little abundance data is available for comparison with other coal beds of the stratotype.

The palynomorphs identified from the lower bench of the Chilton(?) coal bed in the Harewood section, maceration series 660, are given in table 28. In all, 20 genera

TABLE 29.—*Palynomorphs from the Chilton(?) coal bed, upper bench, in West Virginia*

[Maceration series 661; USGS Paleobotanical loc. No. D6536; +, indicates presence of taxon]

Taxon	661-A	661-B	661-C (percent)	661-D	661-E
Acanthotriletes cf. *A. triguetrus* Smith and Butterworth	--	--	+	--	+
Apiculatasporites cf. *A. spinulistratus* (Loose) Ibrahim	--	--	--	+	--
Calamospora cf. *C. straminea* Wilson and Kosanke	--	--	--	+	+
Cirratriradites annuliformis Kosanke and Brokaw	+	--	--	+	--
C. sp	--	--	+	--	--
Convolutispora sp	--	--	+	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	--	--	+
Cristatisporites indignabundus (Loose) Staplin and Jansonius	+	--	--	+	--
Densosporites sphaerotriangularis Kosanke	--	--	+	--	--
D. triangularis Kosanke	+	--	--	--	--
D. sp	+	--	--	+	+
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	--	--	+	+	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	--	--	+	--
E. zonalis (Loose) Knox	--	--	--	+	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	+	--	+	--
Granulatisporites granularis Kosanke	--	+	--	+	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	--	+	--
L. globosus Schemel	--	+	--	--	--
L. medius Kosanke	--	--	--	+	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	--	--	+	--
L. ovalis Kosanke	--	--	--	+	--
L. sp	+	--	+	--	--
Microreticulatisporites nobilis (Wicher) Knox	--	--	--	+	--
Punctatisporites sinuosus (Artüz) Meves	--	--	--	+	--
P. sp	--	+	+	--	--
Radiizonates(?)	+	+	--	+	--
Raistrickia crocea Kosanke	--	--	+	+	--
Triquitrites protensus Kosanke	--	--	+	--	--
T. sculptilis (Balme) Smith and Butterworth	--	--	--	+	--
T. sp	+	--	--	--	--
Verrucosisporites sp	--	--	--	+	--
Wilsonsonites vesicatus (Kosanke) Kosanke	--	--			
Monosaccate	+	--	+	--	+
Unassigned	--	--	--	+	--

DESCRIPTION OF MATERIAL IN MACERATIONS
661-A, 10.1 cm roof rock.
661-B, 22.8 cm coal.
661-C, 22.8 cm coal.
661-D, 22.8 cm coal.
661-E, 10.1 cm seat rock.

are listed, and abundance counts were made on 660-B and D. Based on this information, the following genera are numerically important:

Densosporites	6.4 percent
Laevigatosporites	43.2
Lycospora	21.7
	71.3 percent

Lycospora has been the dominant palynomorph throughout most of the lower half of the Kanawha Formation. Exceptions to this dominance occur in an unnamed coal bed above the Gilbert coal bed, the Powellton, lower bench of the No. 2 Gas, and the type Cedar Grove coal bed. This increase in numerical importance of *Laevigatosporites* in the lower bench of the Chilton(?) coal bed is due to the increased occurrence of *L. desmoinensis* (Wilson and Coe) Schopf, Wilson, and Bentall and *L. ovalis* Kosanke.

The palynomorphs identified from the upper bench of the Chilton(?) coal bed, from the Harewood section, maceration series 661, are shown in table 29. Preservation

and recovery are poorer than in the lower bench, but still 20 genera and a number of species were identified. Several poorly preserved specimens of what may be *Radiizonates* were observed. Hopefully, it may be possible to subsequently evaluate additional specimens to check on this occurrence. This is important because it could mark the first occurrence of this taxon.

The palynomorphs of the Chilton(?) coal bed, maceration series 660 and 661, are yellowish-brownish in color indicating they have undergone a certain degree of thermal alteration. The same coloration of the palynomorphs is found in the Chilton "A" coal bed.

The Chilton "A" coal bed stratigraphically occurs below the Winifrede and above the Chilton(?) coal beds. The Chilton "A" coal bed has been mined in Logan and Mingo Counties of West Virginia but is thin in the stratotype area. One sample of what is thought to be the thin Chilton "A" coal bed was obtained from the Imperial Colliery Company core 1976-1 near Beech Glen, Fayette County, and assigned to the 614 maceration series. The numerically important genera in the coal sample 614-B are:

Granulatisporites	4.8 percent
Laevigatosporites	48.4
Lycospora	20.0
Wilsonites	4.4
	77.6 percent

From this it is clear that *Laevigatosporites* is the dominant taxon and *Lycospora* is subdominant. The roof sample, 614-A, contains a higher percentage of *Lycospora* and a lower percentage of *Laevigatosporites* as shown in table 30. Palynologically, the Chilton(?) and Chilton "A" coal beds are similar except that *Wilsonites* is more abundant in the Chilton "A" coal bed.

The sample of the thin Chilton "A" coal bed, maceration 662, from the Harewood section at best only represents a small segment of the 614 maceration series and, in point of fact, on the basis of dominant-subdominant taxa, maceration 662-A, is closer to the roof shale of maceration series 614. The palynomorphs of the 662 maceration series are a dark-yellow-brown color and the analysis is shown in table 31. *Lycospora* is poorly preserved, but represents three-fourths of the assemblage.

The Winifrede coal bed from the type locality at Winifrede, Kanawha County, W. Va. Kosanke (1984) is dominated by *Laevigatosporites* with *Densosporites*, *Lycospora*, and *Granulatisporites* in the 9-12 percent range. *Laevigatosporites globosus* Schemel is also numerically important for the first time in the Kanawha Formation.

Two samples of the Winifrede coal bed from northwest of Mammoth, W. Va., were examined. The first of these samples, maceration series 691-A, is from the lower part of the Winifrede and contains abundant and well-preserved palynomorphs. Poor preservation is the rule in macerations 691-B-D, but an abundance count was completed on 691-C as shown in table 32. Maceration 691-A contains 63.5 percent *Densosporites* and almost no arborescent lycopod spores so that the dominant element was herbaceous lycopods. *Densosporites* was not identified from maceration 691-B, and only single specimens were found in maceration 691-C and D. *Densosporites* is abundant in one lower level of the Winifrede coal bed from the type locality. *Lycospora* is dominant in 691-C with 58 percent of the palynomorphs assigned to this taxon. The overall averages for 691-A and C follows:

Densosporites	40.6 percent
Laevigatosporites	23.7
Lycospora	22.8
	87.1 percent

A reversal of dominant taxa occurs in macerations A and C, the productive coal samples of the 691 maceration series. *Densosporites* is the dominant taxon in 691-A, whereas *Lycospora* dominates the assemblage of 691-C. Both taxa are represented in samples of the Winifrede coal bed from the type locality, but this abundance reversal is not well developed in the type Winifrede. In fact, the paucity of *Lycospora* and the *Laevigatosporites globosus* Schemel in the type Winifrede coal bed suggest that a close relationship between samples of the type Winifrede and the 691 maceration series is remote.

The lower part of the Winifrede(?) coal bed from the Harewood section, units 126 through 130, was assigned to maceration series 663. The dominant taxon is *Lycospora*:

Endosporites	8.3 percent
Laevigatosprites	14.5
Lycospora	64.0
	86.8 percent

The taxa identified from the 663 maceration series are shown in table 33. Two somewhat unusual occurrences are the presence of *Granulatisporites granulatus* Ibrahim in the shale parting, 663-D, at the rate of 9 percent, and that of *Endosporites globiformis* (Ibrahim) Schopf, Wilson, and Bentall in the bottom coal sample, 663-E, at the rate of 18 percent. *E. globiformis* (Ibrahim) Schopf, Wilson, and Bentall is fairly abundant in the top coal samples of both the 690 and 691 maceration series.

The top bench of the Winifrede(?) coal bed, unit 131 of the Harewood section, is a canneloid coal and was assigned to maceration 440. This is immediately above the normally banded Winifrede(?) coal bed, maceration series 663. The canneloid coal sample is only 15.2 cm thick. A modest assemblage of palynomorphs was recovered as shown in table 34. *Lycospora* is dominant as shown in the following:

TABLE 30.—*Palynomorphs from the Chilton "A" coal bed in West Virginia*

[Maceration series 614; USGS Paleobotanical loc. No. D6400; 500 specimens counted; +, present but not observed in count or count not attempted]

Taxon	614-A	614-B	614-C
	(percent)		
Acanthotriletes echinatus (Knox) Potonié and Kremp	--	0.8	+
A. sp	0.8	--	--
Ahrenisporites guerickei (Horst) Potonié and Kremp	.4	--	--
Calamospora breviradiata Kosanke	1.6	1.6	--
C. hartungiana Schopf in Schopf, Wilson, and Bentall	.4	--	--
C. cf. *C. liquida* Kosanke	2.0	--	--
C. sp	.8	1.6	--
Cirratriradites annuliformis Kosanke and Brokaw	+	.8	+
C. sp	1.2	--	--
Convolutispora sp	.8	1.2	+
Crassispora kosankei (Potonié and Kremp) Bharadwaj	.4	--	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	1.6	--	--
C. sp	1.2	+	+
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	--	+
D. trianguiaris Kosanke	--	--	+
D. sp	.4	1.6	+
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	+	--	+
D. sp	--	--	+
Endosporites sp	--	--	+
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	2.0	1.6	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	2.4	1.6	--
G. sp	3.6	3.2	+
Knoxisporites sp	.4	.4	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	4.4	3.6	--
L. latus Kosanke	1.2	3.2	--
L. medius Kosanke	1.2	3.2	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	2.0	2.0	--
L. ovalis Kosanke	14.0	32.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	.4	4.4	--
Leiotriletes sp	--	1.6	+
Lophotriletes commissuralis (Kosanke) Potonié and Kremp	.4	--	--
L. cf. *L. gibbosus* (Ibrahim) Potonié and Kremp	--	.4	--
Lycospora granulata Kosanke	5.2	6.0	+
L. micropapillata (Wilson and Coe) Schopf, Wilson and Bentall	1.6	2.4	+
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	.8	+	--
L. punctata Kosanke	12.0	5.6	--
L. spp	14.0	6.0	+
Microreticulatisporites nobilis (Wicher) Knox	--	.4	--
Punctatisporites obesus (Loose) Potonié and Kremp	+	--	--
P. spp	2.0	.8	+
Raistrickia crinita Kosanke	+	--	--
R. cf. *R. pilosa* Kosanke	+	--	--
R. sp	1.2	.4	--
Reticulatisporites sp	--	+	--
Triquitrites bransonii Wilson and Hoffmeister	--	.4	--
T. pulvinatus Kosanke	--	2.4	
T. sculptilis (Balme) Smith and Butterworth	.4	.5	--
T. sp	.4	.4	--
Verrucosisporites sp	--	+	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	1.2	--	--
Wilsonites vesicatus (Kosanke) Kosanke	5.2	4.4	--
W. sp	.4	+	--
Monosaccate	12.0	4.8	+
Unassigned	--	.4	--
	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

614-A, 7.6 cm roof rock. 614-B, 22.8 cm coal. 614-C, 7.6 cm shale, carbonaceous.

TABLE 31.—*Palynomorphs from the Chilton "A" coal bed in West Virginia*

[Maceration series 662; USGS Paleobotanical loc. No. D6538; 200 specimens counted; +, present but not observed in count or count not attempted]

Taxon	662-A (percent)	662-B (percent)
Acanthotriletes triquetrus Smith and Butterworth	0.5	--
A. sp	--	+
Calamospora cf. *C. liquida* Kosanke	.5	--
C. mutabilis (Loose) Schopf, Wilson, and Bentall	1.0	--
C. parva Guennel	--	+
C. sp	1.5	--
Cirratriradites sp	2.0	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	+
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	+
D. sp	1.5	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.5	--
F. sp	.5	--
Granulatisporites sp	.5	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	5.0	+
L. latus Kosanke	1.0	--
L. medius Kosanke	+	--
L. ovalis Kosanke	5.0	+
Leiotriletes cf. *L. sphaerotriangularis* (Loose) Potonié and Kremp	+	--
Lycospora granulata Kosanke	7.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	.5	+
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	19.0	+
L. punctata Kosanke	19.5	+
L. spp	30.0	+
Punctatisporites obesus (Loose) Potonié and Kremp	.5	--
P. sp	1.5	--
Pustulatisporites pustulatus Potonié and Kremp	.5	--
Raistrickia sp	1.0	--
Reticulatisporites reticulatus (Ibrahim) Ibrahim	.5	+
Wilsonites vesicatus (Kosanke) Kosanke	.5	--
Monosaccate	--	+
	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
662-A, = 10.1 cm coal an impure at base.
662-B, = 5.0 cm seatrock.

Laevigatosporites	19.5 percent
Lycospora	65.0
	84.5 percent

The two samples of the Winifrede(?) coal bed from the Harewood section do not show a close relationship to the type Winifrede coal bed. There are some similarities, however, and it is possible that the 691, 663, and even the 440 maceration series are all related parts of the same depositional cycle. Also, part of these maceration series, especially the 691 series, are related to the Winifrede coal bed at the type locality.

The Coalburg coal bed is multibedded and occurs above the Winifrede and below the Lower Stockton coal beds near the top of the Kanawha Formation.

A set of samples initially considered to be an upper bench of the Winifrede coal bed is now considered to represent the Little Coalburg coal bed (T. W. Henry, 1984). These samples were assigned to the 690 maceration series. Palynomorph recovery was reasonably good, and abundance counts were made on five of the six samples as shown in table 35. *Laevigatosporites* and *Lycospora* account for 81.1 percent of the palynomorph assemblage in the coal samples:

Laevigatosporites	37.4 percent
Lycospora	43.7
	81.1 percent

Laevigatosporites globosus Schemel was poorly represented in the 691 maceration series. It plays a more important role in samples of the 690 maceration series, while *L. ovalis* Kosanke accounts for 47 percent of the palynomorphs of maceration 690-E. Both of these species of *Laevigatosporites* occur in significant

TABLE 32.—*Palynomorphs from the Winifrede coal bed in West Virginia*

[Maceration series 691; USGS Paleobotanical loc. No. D6542; 400 specimens counted; +, present but not observed in count or count not attempted]

Taxon	691-A	691-B	691-C	691-D
	(percent)			
Acanthotriletes sp	+	--	--	--
Calamospora breviradiata Kosanke	--	--	1.0	--
C. parva Guennel	--	--	+	--
C. sp. 1	--	+	1.0	--
C. sp	--	--	1.5	+
Cirratriradites maculatus Wilson and Coe	0.5	+	.5	+
Cristatisporites indignabundus (Loose) Staplin and Jansonius	.5	--	--	--
Cyclogranisporites cf. *C. aureus* (Loose) Potonié and Kremp	1.5	+	--	--
C. multigranus Smith and Butterworth	.5	+	.5	--
Densosporites sphaerotriangularis Kosanke	.5	--	--	--
D. triangularis Kosanke	46.0	--	--	--
D. spp	18.0	--	+	+
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	+	--	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	+	+	1.5	+
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	+	--
G. sp	.5	+	.5	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	5.0	+	2.0	--
L. globosus Schemel	1.0	--	1.5	--
L. latus Kosanke	5.0	+	6.0	--
L. medius Kosanke	.5	+	4.5	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	1.0	+	1.5	--
L. ovalis Kosanke	8.0	+	12.5	+
L. vulgaris (Ibrahim) Alpern and Doubinger	4.5	--	.5	--
Lophotriletes microsaetosus (Loose) Potonié and Kremp	--	--	.5	--
Leiotriletes parvus Guennel	--	--	+	--
L. sp	1.0	--	1.0	--
Lycospora granulata Kosanke	.5	+	6.5	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	.5	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	--	10.0	--
L. punctata Kosanke	--	--	10.5	--
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	--	--	.5	--
L. spp	1.5	--	30.0	+
Punctatisporites obesus (Loose) Potonié and Kremp	--	+	.5	--
P. sinuatus (Artüz) Neves	.5	--	--	--
P. sp	--	--	--	+
Radiizonates sp	1.5	+	--	--
Reticulatisporites carnosus (Knox) Neves	--	--	+	--
Triquitrites sculptilis (Balme) Smith and Butterworth	--	+	1.0	--
Vestispora profunda (Wilson and Hoffmeister) Wilson and Venkatachala	--	--	2.5	--
V. sp	--	--	+	--
Monosaccate	1.5	+	1.0	--
Unassigned	.5	--	.5	--
	100.0	--	100.0	--

DESCRIPTION OF MATERIAL IN MACERATIONS

Sandstone roof, no sample.

691-A, 20.3 cm coal.

691-B, 6.3 cm coal and carbonaceous laminae mixed.

691-C, 11.4 cm coal with few thin noncoal laminae.

691-D, 11.4 cm seat rock.

TABLE 33.—*Palynomorphs from the Winifrede(?) coal bed, lower bench, in West Virginia*

[Maceration series 663; USGS Paleobotanical loc. No. D6539; 600 specimens counted, +, present but not observed in count or count not attempted]

Taxon	663-A	663-B	663-C	663-D	663-E	663-F
				(percent)		
Acanthotriletes echinatus (Knox) Potonié and Kremp	--	--	--	1.5	--	--
A. sp	--	--	--	--	0.5	--
Apiculatisporis sp	--	--	--	--	.5	+
Calamospora mutabilis (Loose) Schopf Wilson, and Bentall	--	0.5	--	--	1.0	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	.5	--	1.5	--	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	--	+	4.0	--	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	2.0	+	.5	2.0	--
C. multigranus Smith and Butterworth	--	--	--	--	1.0	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	1.0	--	--	--	--
D. triangularis Kosanke	+	1.0	--	.5	--	--
Dictyotriletes sp	+	--	--	--	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	4.0	--	4.0	18.0	--
E. zonalis (Loose) Knox	--	--	--	--	+	--
E. sp	+	--	--	--	--	--
Florinites sp	--	--	--	--	1.0	--
Granulatisporites granulatus Ibrahim	--	--	--	9.0	1.0	--
G. pallidus Kosanke	--	--	--	--	1.0	--
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	--	--	1.0	+
G. sp	+	--	--	--	1.0	
Knoxisporites rotatus Hoffmeister, Staplin, and Malloy	--	--	--	--	--	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	+	5.0	+	1.0	5.0	+
L. globosus Schemel	--	--	--	--	+	--
L. latus Kosanke	--	2.0	--	--	1.0	--
L. medius Kosanke	+	1.0	--	1.0	1.0	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	5.0	+	5.0	3.0	+
L. ovalis Kosanke	+	2.0	+	2.0	4.0	--
Leiotriletes sp.	--	--	--	--	1.0	+
Lycospora granulata Kosanke	+	12.0	+	10.0	10.0	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	7.0	--	14.0	3.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	20.0	+	8.0	8.0	+
L. punctata Kosanke	+	16.0	+	5.0	16.0	--
L. spp	+	16.0	+	29.0	19.0	+
Murospora kosankei Somers	--	--	--	--	--	+
Punctatisporites sp	--	2.0	--	--	--	+
Radiizonates difformis (Kosanke) Staplin and Jansonius	--	--	--	--	--	+
Raistrickia cf. *R. pilosa* Kosanke	--	--	--	1.0	--	--
Spackmanites facierugosus Habib	--	1.0	--	--	--	--
Wilsonites sp	--	--	--	1.0	.5	--
Monosaccate	+	1.0	--	1.0	--	--
Unassigned	--	1.0	--	1.0	.5	--
	--	100.0	--	100.0	100.0	--

DESCRIPTION OF MATERIAL IN MACERATIONS

663-A, 10.1 cm roof rock.
663-B, 19.0 cm coal.
663-C, 11.4 cm shale parting.
663-D, 11.4 cm shale parting.
663-E, 16.5 cm coal in part bone.
663-F, 7.6 cm seat rock.

TABLE 34.—*Palynomorphs from the Winifrede(?) coal bed in West Virginia*

[Maceration series 440; USGS Paleobotanical loc. No. D6546; 200 specimens counted]

Taxon	440 (percent)
Acanthotriletes echinatus (Knox) Potonié and Kremp	0.5
A. sp	.5
Calamospora mutabilis (Loose) Schopf, Wilson, and Bentall	1.0
C. straminea Wilson and Kosanke	1.0
Cirratriradites maculatus Wilson and Coe	1.5
Crassispora kosankei (Potonié and Kremp) Bharadwaj	.5
Granulatisporites granularis Kosanke	1.5
G. sp	2.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	5.0
L. latus Kosanke	.5
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	3.5
L. ovalis Kosanke	10.0
L. vulgaris (Ibrahim) Alpern and Doubinger	.5
Lophotriletes sp.	1.0
Lycospora granulata Kosanke	11.0
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	9.5
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	9.5
L. punctata Kosanke	11.5
L. spp	24.5
Punctatisporites sp	.5
Raistrickia sp	.5
Triquitrites pulvinatus Kosanke	1.0
T. sculptilis (Balme) Smith and Butterworth	.5
T. sp	.5
Verrucosisporites sp	.5
Wilsonites sp	.5
Monosaccate	1.0
	100.0

DESCRIPTION OF MATERIAL IN MACERATION
440, 15.2 cm canneloid coal.

numbers in the type Winifrede coal bed. However, *L. punctatus* Kosanke occurs for the first time in a parting in the 690 series while *Radiizonates* is present in the 690, 691, and 663 series. These taxa do not occur in the Winifrede coal bed from the type locality.

Two samples of the Coalburg coal bed from the Harewood section of the proposed Pennsylvanian System stratotype in West Virginia were available for study and assigned to 439 and 666 maceration series. The lower part of the Coalburg coal, maceration series 666, is 207.6 cm thick including five relatively thin partings. Fifteen samples, including roof and seat, were prepared and abundance counts were completed on seven of these samples as shown in table 36. Recovery and preservation in these samples are better than observed in many samples of the Kanawha Formation thus far discussed, even though the noncoal samples did not yield sufficiently to warrant abundance counts. Thirty-four genera were identified from the 666 maceration series as shown in table 36. Only two genera, *Laevigatosporites* and *Lycospora*, are numerically important in the seven coal samples that yield abundant palynomorphs:

Laevigatosporites	54.1 percent
Lycospora	19.7
	73.8 percent

In addition, *Florinites* is present and, overall, is slightly above the three-percent level; *Radiizonates* is observed slightly above the 2.5 percent level, *Zosterosporites triangularis* Kosanke is represented only in the seat and roof rock samples; and *Trihyphaecites triangularis* Peppers, occurs in coal sample 666-F. *Trihyphaecites* has not been observed in older coal beds of the Kanawha Formation.

The upper bench of the Coalburg coal bed, maceration series 439, unit 158 of the Harewood section,

TABLE 35.—*Palynomorphs from the Little Coalburg coal bed in West Virginia*

[Maceration series 690; USGS Paleobotanical loc. No. D6541; 1,000 specimens counted; +, present but not observed in count or count not attempted]

Taxon	690-A	690-B	690-C	690-D	690-E	690-F
	(percent)					
Acanthotriletes sp	0.5	--	0.5	--	0.5	--
Alatisporites sp	--	--	--	+	--	--
Anapiculatisporites spinosus (Kosanke) Potonié and Kremp	+	.5	--	--	--	--
Apiculatisporis sp	.5	--	--	--	--	--
Calamospora breviradiata Kosanke	--	--	1.0	--	--	1.0
C. mutabilis (Loose) Schopf, Wilson, and Bentall	--	--	1.0	--	--	--
C. parva Guennel	--	--	--	+	--	--
C. sp	.5	--	1.0	--	--	--
Cirratriradite sp	.5	--	.5	+	--	1.0
Crassispora kosankei (Potonié and Kremp) Bharadwaj	1.0	.5	--	--	--	--
Cyclogranisporites cf. *C. minutus* Bharadwaj	--	--	+	--	--	--
C. sp	--	--	2.5	--	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	1.0	1.5	--	--	--	.5
D. triangularis Kosanke	--	1.5	--	--	--	--
D. sp	1.0	1.5	--	--	--	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	+	.5	--	--	.5	--
D. castaneaeformis (Horst) Sullivan	--	.5	--	--	--	--
D. falsus Potonié and Kremp	--	--	.5	--	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	10.0	--	2.0	--	--	--
E. sp	4.5	--	--	--	3.0	.5
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	1.0	1.0	5.5	+	.5	2.0
F. cf. *F. millotti* Butterworth and Williams	.5	.5	2.0	--	--	--
Granulatisporites adnatoides (Potonié and Kremp) Smith and Butterworth	--	--	--	--	--	1.0
G. pallidus Kosanke	.5	--	+	--	1.5	--
G. sp.	1.0	.5	1.0	--	1.0	1.0
Knoxisporites sp	--	--	--	+	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	2.5	1.0	2.5	--	7.5	.5
L. globosus Schemel	--	16.5	2.5	--	2.5	--
L. latus Kosanke	3.5	1.0	1.0	--	3.5	3.0
L. medius Kosanke	1.0	2.0	6.5	+	4.0	3.0
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	.5	33.0	4.0	--	3.5	1.5
L. ovalis Kosanke	6.5	3.5	12.5	+	47.0	3.0
L. punctatus Kosanke	--	.5	--	--	--	--
L. vulgaris (Ibrahim) Alpern and Doubinger	1.0	--	1.0	--	12.5	--
Leiotriletes priddyi (Berry) Potonié and Kremp	.5	--	.5	--	--	--
Lophotriletes sp.	1.0	1.0	--	+	--	--
Lycospora granulata Kosanke	4.5	3.5	2.0	--	1.0	9.0
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	.5	3.0	9.5	--	2.0	2.5
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	6.0	1.0	5.0	+	--	6.0
L. punctata Kosanke	10.5	1.0	7.5	+	.5	22.0
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	3.0	.5	.5	+	--	2.5
L. sp. 5	--	--	--	+	--	--
L. spp	28.0	11.5	21.0	+	6.0	33.0
Punctatisporites sp	1.5	--	--	+	.5	1.0
Radiizonates cf. *R. rotatus* (Kosanke) Staplin and Jansonius	1.5	.5	2.5	--	--	1.0
R. sp	3.0	10.5	--	--	--	--
Triquitrites sculptilis (Balme) Smith and Butterworth	+	.5	--	--	--	--
T. sp	--	.5	.5	--	--	--
Verrucosisporites sp.	.5	--	--	--	--	--
Vestispora cf. *V. costata* Spode in Smith and Butterworth	1.5	--	--	--	--	--
V. fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	.5	--	--	--	--	1.0
V. sp	+	--	--	+	--	1.0
Wilsonites delicata (Kosanke) Kosanke	--	--	.5	--	--	1.0
W. sp	--	.5	--	--	1.0	1.0
Monosaccate	--	--	1.0	--	1.0	1.0
Unassigned	--	--	--	+	.5	--
	100.0	100.0	100.0	--	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

690-A, 6.3 cm coal.
690-B, .9 cm parting.
690-C, 35.5 cm coal.
690-D, 30.4 cm parting.
690-E, 31.7 cm coal in part bone.
690-F, 30.4 cm coal.

TABLE 36.—*Palynomorphs from the Coalburg coal bed, lower bench in West Virginia*

[Maceration series 666; USGS Paleobotanical loc. No. D6398; 1,400 specimens counted; +, present but not observed in count or count not attempted]

Taxon	666-A	666-B	666-C	666-D	666-E	666-F	666-G	666-H	666-I	666-J	666-K	666-L	666-M	666-N	666-O
	(percent)														
Acanthotriletes echinatus (Knox) Potonié and Kremp	+	--	--	0.5	--	0.5	0.5	--	--	--	--	0.5	--	1.5	--
Ahrensisporites guerickei (Horst) Potonié and Kremp	--	--	--	.5	+	--	--	--	--	--	--	--	--	--	--
Alatisporites punctatus Kosanke	--	--	--	--	--	--	--	--	--	--	--	--	.5	--	--
A. trialatus Kosanke	--	--	--	+	--	--	--	--	--	--	--	--	--	1.0	--
Apiculatisporis cf. *A. latigranifer* (Loose) Potonié and Kremp	+	3.0	+	+	--	--	--	--	--	--	--	--	--	--	--
A. sp	--	--	--	+	--	--	--	--	--	--	--	--	--	--	--
Calamospora liquida Kosanke	--	--	--	+	--	--	--	--	--	--	--	--	--	--	--
C. mutabilis (Loose) Schopf, Wilson, and Bentall	--	--	--	.5	--	--	--	--	--	--	--	--	--	--	--
C. parva Guennel	--	.5	--	2.0	--	--	--	--	--	--	--	1.5	--	--	--
Cirratriradites annuliformis Kosanke and Brokaw	--	--	--	+	--	--	--	--	--	--	--	--	--	--	--
C. saturni (Ibrahim) Schopf, Wilson, and Bentall	+	.5	--	1.5	--	.5	--	--	--	--	--	.5	--	1.0	--
C. sp	+	--	--	.5	--	--	--	--	--	--	+	--	--	--	+
Converrucosisporites armatus (Dybova and Jachowicz) Smith and Butterworth	--	--	--	1.5	--	--	--	+	--	--	--	--	--	--	--
Convolutispora florida Hoffmeister, Staplin and Malloy	--	--	--	--	--	--	--	--	1.0	--	--	--	--	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	--	1.0	--	--	--	--	+	--	+	--	--	--	--
Cristatisporites indignabundus (Loose) Staplin and Jansonius	--	--	--	--	+	--	--	--	--	--	--	--	--	--	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	+	--	1.0	--	2.0	1.0	+	1.0	--	--	1.0	+	.5	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	--	--	5.5	--	--	2.0	--	--	--	--	1.0	+	--	--
D. sphaerotriangularis Kosanke	--	--	--	--	--	--	.5	--	--	--	--	--	--	--	--
D. triangularis Kosanke	--	+	--	+	+	--	--	--	--	--	--	--	--	--	--
D. sp	--	.5	+	--	+	--	--	--	--	--	+	--	--	--	--
Dictyotriletes reticulocingulum (Loose) Smith and Butterworth	--	--	--	--	--	--	--	--	+	--	--	--	--	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	--	--	1.0	--	1.5	--	+	3.5	+	--	--	--	--	--
E. zonalis (Loose) Knox	--	--	--	.5	--	--	--	.5	--		+	--	--	--	--
E. sp	--	.5	--	--	--	--	--	+	--	--	--	--	--	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	+	5.0	--	4.0	+	2.5	2.0	--	+	+	--	2.5	--	+	--
F. triletus Kosanke	--	--	--	+	--	--	--	--	--	--	--	--	--	--	--
F. sp	--	2.5	--	2.0	--	1.0	.5	--		+	--	--	--	--	.5
Granulatisporites granulatus Ibrahim	--	.5	--	1.0	--	--	--	--	--	--	--	--	--	--	--
G. pallidus Kosanke	--	4.0	--	4.0	--	1.0	.5	--	1.5	--	--	--	--	--	+
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	+	--	--	--.5	+	--	--	--	+	--	--	2.0	--	--	--
G. spp	--	--	--	--	--	1.0	1.0	--	--	--	--	2.0	--	--	+
Knoxisporites sp	--	--	--	--	--	.5	--	--	--	--	--	--	--	--	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	+	1.5	+	5.5	--	2.5	2.5	--	1.0	--	+	5.0	--	4.0	+
L. globosus Schemel	+	1.0	--	1.5	--	1.0	22.5	--	.5	+	--	2.5	--	3.5	--
L. latus Kosanke	--	3.0	--	.5	--	+	.5	--	.5	+	--	2.5	--	2.5	--
L. medius Kosanke	+	1.5	--	9.0	--	1.0	2.0	--	1.5	+	+	7.5	+	4.5	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	+	17.0	+	11.0	+	22.5	47.0	+	2.5		+	13.0	+	47.5	--
L. ovalis Kosanke	+	1.0	+	13.5	+	3.5	4.5	--	1.5	+	+	10.5	--	17.0	+
L. punctatus Kosanke	--	--	--	--	--	--	--	--	--	--	--	+	--	--	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	+	--	1.5	--	1.0	--	--	.5	--	--	1.5	--	1.0	--
Leiotriletes priddyi (Berry) Potonié and Kremp	--	2.0	--	.5	--	--	1.0	--	1.0	--	--	.5	--	+	--
L. sp	--	3.5	--	--	--	--	--	--	--	--	--	--	--	--	--
Lophotriletes sp	--	--	--	+	--	--	--	--	--	--	--	--	--	--	--
Lycospora granulata Kosanke	--	4.5	--	.5	--	3.0	1.5	--	1.5	--	--	.5	--	2.0	--

L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	2.5	--	1.0	--	24.0	1.0	+	9.5	+	--	6.5	--	4.0	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	+	2.0	--	.5	--	4.0	--	+	5.0	+	--	1.5	--	--	--
L. punctata Kosanke	--	1.5	--	8.0	--	3.0	.5	--	17.0	+	--	2.0	+	--	+
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	--	+	--	--	+	1.5	1.5	--	23.0	+	--	5.0	--	--	--
L. spp	--	9.5	+	6.0	+	14.0	1.0	+	18.5	--	+	11.5	+	3.0	--
Microreticulatisporites nobilis (Wicher) Knox	--	--	--	.5	--	.5	--	--	--	--	--	--	--	--	--
Pityosporites westphalensis Williams	--	--	--	--	--	--	1.5	--	--	--	--	--	--	--	--
Punctatisporites obesus (Loose) Potonié and Kremp	+	3.0	--	.5	--	--	--	--	2.0	--	--	--	--	--	--
P. spp	--	1.0	--	--	--	.5	--	--	1.0	--	--	+	--	--	+
Pustulatisporites cf. *P. pustulatus Potonié* and Kremp	+	--	--	--	--	--.5	--	--	--	--	--	--	--	--	--
Radiizonates cf. *R. aligerens* (Knox) Staplin and Jansonius	--	--	--	--	--	--	--	--	--	--	--	.5	--	--	--
R. faunus (Ibrahim) Smith and Butterworth	--	--	--	+	--	2.0	1.5	--	+	--	--	1.0	--	--	--
R. tenuis (Loose) Butterworth and Smith in Butterworth	--	--	--	--	--	--	.5	--	--	--	--	--	--	--	--
R. sp	--	--	--	.5	--	--	2.0	+	3.0	+	+	8.0	+	.5	+
Raistrickia crocea Kosanke	+	1.0	--	.5	--	.5	--	--	--	--	--	2.0	--	--	--
R. pilosa Kosanke	--	--	--	--	--	+	--	--	--	--	--	--	--	--	--
R. cf. *R. superba* (Ibrahim) Schopf, Wilson, and Bentall	+	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Reticulatisporites reticulatus (Ibrahim) Ibrahim	--	--	--	--	--	--	--	--	--	--	--	1.0	--	2.0	--
R. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	+	--
Trihyphapcites triangularis Peppers	--	--	--	--	--	.5	--	--	--	--	--	--	--	--	--
Triquitrites cf. *T. crassus* Kosanke	--	--	--	--	--	--	--	--	--	--	--	.5	--	--	--
T. sculptilis (Balme) Smith and Butterworth	+	3.0	--	3.0	--	--	--	--	.5	--	--	--	--		1.0
T. sp	+	--	--	.5	--	.5	--	--	--	--	--	1.5	--	--	--
Verrucosisporites verrucosus (Ibrahim) Ibrahim	--	6.5	--	--	--	.5	+	--	--	--	--	--	--	--	--
V spp	--	--	--	--	--	.5	--	--	1.0	--	--	.5	--	2.0	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	--	+	1.0	--	.5	--	--	--	--	--	--	--	--	--
V. pseudoreticulata Spode in Smith and Butterworth	--	1.5	--	--	--	--	--	--	--	--	--	--	--	--	--
V. sp	--	1.5	--	2.5	--	--	--	--	--	--	+	.5	--	--	--
Wilsonites delicatus (Kosanke) Kosanke	--	--	--	--	--	--	.5	--	--	--	--	--	--	--	--
W. vesicatus (Kosanke and Brokaw) Spode in Smith and Butterworth	--	8.0	--	.5	--	1.0	--	--	--	--	--	--	--	--	--
W. sp	--	--	--	--	--	--	--	--	--	--	--	--	--	--	+
Zosterosporites triangularis Kosanke	+	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Monosaccate	--	7.0	--	3.0	+	--	.5	--	1.0	--	--	2.0	--	.5	+
Unassigned	--	--	--	1.0	--	--	--	--	.5	--	--	1.0	--	.5	--
	--	100.0	--	100.0	--	100.0	100.0	--	100.0	--	--	100.0	--	100.0	--

DESCRIPTION OF MATERIAL IN MACERATIONS

666-A, 6.3 cm roof rock.
666-B. 13.9 cm coal.
666-C, 2.5 cm parting.
666-D, 15.2 cm coal.
666-E, 3.8 cm parting.
666-F, 28.5 cm coal.
666-G, 28.5 cm coal.
666-H, 11.4 cm parting with coal laminae.
666-I, 2.5 cm coal.
666-J, 5.0 cm parting, black coaly shale.
666-K, 10.1 cm parting.
666-L, 20.3 cm coal, top 2.54 cm impure.
666-M 16.5 cm parting.
666-N, 35.0 cm coal.
666-O, 10.1 cm seat rock.

TABLE 37.—*Palynomorphs from the Coalburg coal bed, upper bench, in West Virginia*

[Maceration series 439; USGS Paleobotanical loc. No. D6545; 200 specimens counted; +, present but not observed in count]

Taxon	439 (percent)
Acanthotriletes echinatus (Knox) Potonié and Kremp	1.0
Calamospora sp	1.0
Cingulatisporites cf. *C. loricatus* (Loose) Butterworth and Smith in Butterworth	1.0
Cristatisporites indignabundus (Loose) Staplin and Jansonius	1.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	6.0
L. globosus Schemel	12.0
L. latus Kosanke	1.0
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	4.0
L. ovalis Kosanke	1.0
L. punctatus Kosanke	1.0
L. vulgaris (Ibrahim) Alpern and Doubinger	1.0
Lycospora granulata Kosanke	1.0
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	1.0
L. punctata Kosanke	1.0
L. sp	1.0
Microreticulatisporites concavus Butterworth and Williams	+
Punctatisporites sp	+
Radiizonates difformis (Kosanke) Staplin and Jansonius	9.0
R. faunus (Ibrahim) Smith and Butterworth	23.0
R. tenuis (Loose) Butterworth and Smith in Butterworth	12.0
R. spp	19.0
Verrucosisporites verrucosus (Ibrahim) Ibrahim	3.0
	100.0

DESCRIPTION OF MATERIAL IN MACERATION
439, 22.8 cm coal.

yielded a most unusual palynomorph assemblage in that *Lycospora* accounts for only 4 percent of the assemblage as shown in table 37. The numerically important genera are:

Laevigatosporites	26.0 percent
Radiizonates	63.0
	89.0 percent

The presence of *Radiizonates* at the rate of 63 percent in the upper bench of the Coalburg coal bed marks the maximum occurrence (acme-zone) of this taxon. Preservation of specimens of *Radiizonates* leaves much to be desired so far as species identification is concerned. The range zone of *Radiizonates* is restricted to the upper part of the Kanawha Formation and the lower part of the Charleston Sandstone in the area of the proposed Pennsylvanian System stratotype.

The Lower Stockton coal bed occurs between the Coalburg coal bed below and the Stockton coal bed above. A sample of this coal bed from units 165 of the Harewood section was collected and assigned to the 438 maceration series. *Lycospora* is the dominant taxon as shown in the following:

Calamospora	4.7 percent
Laevigatosporites	18.0
Leiotriletes	7.5
Lycospora	57.7
	87.9 percent

The presence of *Leiotriletes parvus* Guennel at the rate of 7.5 percent is the maximum abundance for this taxon in the Kanawha Formation, and *Calamospora* occurring at the rate of 4.7 percent is worthy of note. *Radiizonates*, the dominant taxon in the upper bench of the Coalburg coal bed below, is reduced in abundance to the one percent level as shown in table 38.

The Stockton coal bed occurs a few meters below the Kanawha Black Flint in much of the area of the proposed Pennsylvanian System stratotype. The Kanawha Black Flint is an excellent marker bed in this area. Kosanke (1984) reported on the palynomorph content of the Stockton coal bed, units 62 through 64 of the Mammoth West section, maceration series 566, in which *Laevigatosporites* and *Lycospora* were codominant and *Densosporites* and *Radiizonates* were approximately equal subdominants. One additional set of samples of the Stockton coal bed was collected at the Harewood

TABLE 38.—*Palynomorphs from the Lower Stockton coal bed in West Virginia*

[Maceration series 438; USGS Paleobotanical loc. No. D6632; 400 specimens counted; +, present but not observed in count or count not attempted]

Taxon	438-A	438-B	438-C
		(percent)	
Acanthotriletes triguetrus Smith and ButterHorth	4.0	1.0	--
Alatisporites hexalatus Kosanke	1.0	--	--
Apiculatisporis abditus (Loose) Potonié and Kremp	--	.5	--
Calamospora breviradiata Kosanke	5.0	1.0	--
C. parva Guennel	2.0	1.5	--
C. pedata Kosanke	--	.5	--
Cirratriradites saturni (Ibrahim) Schopf, Wilson, and Bentall	--	1.0	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	1.0	1.0	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	.5	--
Densosporites sp.	1.0	--	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	--	.5	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	1.0	--	+
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	.5	--
Granulatisporites sp	3.0	1.0	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	4.0	5.0	--
L. globosus Schemel	--	--	+
L. latus Kosanke	1.0	--	--
L. medius Kosanke	--	4.0	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	1.0	2.5	+
L. ovalis Kosanke	7.0	9.0	+
L. vulgaris (Ibrahim) Alpern and Doubinger	+	1.0	--
L. sp. 1	--	1.5	+
Leiotriletes parvus Guennel	8.0	7.0	+
Lycospora granulata Kosanke	5.0	7.0	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	2.0	.5	--
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	1.0	--
L. punctata Kosanke	10.0	2.5	--
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	13.0	8.0	--
L. spp	28.0	38.5	--
Punctatisporites obliquus Kosanke	--	--	+
Radiizonates cf. *R. difformis* (Kosanke) Staplin and Jansonius	+	.5	--
	1.0	1.5	--
Vestispora pseudoreticulata Spode in Smith and Butterworth	--	1.0	--
Monosaccate	2.0	.5	--
	100.0	100.0	--

DESCRIPTION OF MATERIAL IN MACERATIONS
438-A, 20.3 cm coal.
438-B, 20.3 cm coal.
438-C, 7.6 cm bone coal.

section and assigned to the 437 maceration series. It is from unit 175 of the Harewood section in Fayette County, W. Va., and consists of 22.8 cm of coal and 11.4 cm of seat rock. Contrary to previously discussed samples of the Kanawha Formation, the coal sample did not yield palynomorphs as readily as the seat-rock sample. The numerically important genera in the coal sample, maceration 437-A, are:

Crassispora	5.0 percent
Laevigatosporites	26.0
Lycospora	55.0
	86.0 percent

In the seat rock sample, the most abundant species identified is *Lycospora punctata Kosanke*, whereas, in the coal sample above the seat rock, *L. micropapillata* (Wilson and Coe) Schopf, Wilson, and Bentall is the most abundant species. The coal sample, maceration 437-A, resembles most closely maceration 566-E, the Stockton coal bed, previously reported by Kosanke (1984) except that *Laevigatosporites* is less abundant in 566-E than in 437-A. The palynomorphs identified in the 437 maceration series are shown in table 39.

A previously mined coal bed occurring locally above the Stockton coal bed and below the Kanawha Black Flint in the Charleston, W. Va. area is considered to be a rider coal of the Stockton coal bed. Two such sets of samples were collected. One of these, the Stockton Rider(?) coal bed, maceration series 567, was collected

TABLE 39.—*Paynomorphs from the Stockton coal bed in West Virginia*

[Maceration series 437; USGS Paleobotanical loc. No. D 6544; 400 specimens counted; +, present but not observed in count]

Taxon	437-A (percent)	437-B (percent)
Acanthotriletes sp	1.0	1.0
Apiculatisporis abditus (Loose) Potonié and Kremp	--	+
Calamospora breviradiata Kosanke	+	--
C. sp	1.0	+
Crassispora kosankei (Potonié and Kremp) Bharadwaj	5.0	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	1.0	+
Densosporites triangularis Kosanke	--	1.0
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	1.0	--
Granulatisporites pallidus Kosanke	--	1.0
G. sp	1.0	1.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	6.0	+
L. globosus Schemel	1.0	3.0
L. latus Kosanke	1.0	--
L. medius Kosanke	2.0	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	12.0	4.0
L. ovalis	4.0	2.0
Leiotriletes parvus Guennel	1.0	--
Lycospora brevijuga Kosanke	--	2.0
L. granulata Kosanke	5.0	5.0
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	26.0	18.0
L. punctata Kosanke	11.0	36.0
L. spp	13.0	25.0
Punctatisporites obliquus Kosanke	2.0	+
Radiizonates faunus (Ibrahim) Smith and Butterworth	1.0	1.0
Raistrickia cf. *R. lowellensis* Peppers	1.0	--
R. sp	1.0	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	1.0	--
V. sp	2.0	--
Verrucosisporites sp	+	--
Unassigned		
	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

437-A, 22.8 cm coal.

437-B, 11.4 cm seat rock.

on the northern city limits of Charleston, and abundance counts were obtained from all five segment samples as shown in table 40. *Laevigatosporites minutus* (Ibrahim) Schopf, Wilson, and Bentall, *Denosporites triangularis* Kosanke, and *Lycospora micropapillata* (Wilson and Coe) Schopf, Wilson, and Bentall are abundant in at least one segment sample. Species of *Radiizonates* are present to the extent of 8 percent in 567-D as shown on table 40. The following genera are numerically important in the coal samples:

Densosporites	14.3 percent
Laevigatosporites	33.3
Lycospora	36.6
	84.2 percent

The second set of the Stockton Rider(?) coal bed, maceration series 452, is from the Greenbrier Street section in Charleston. This is a single sample of a thin coal with a shale parting that is difficult to place stratigraphically based on the identified palynomorphs other than it surely is in this part of the section. This is because it does not contain either *Densosporites triangularis* Kosanke or *Radiizonates* spp. so prominent in the 567 maceration series. The following genera are numerically important:

Crassispora	7.2 percent
Laevigatosporites	30.0
Lycospora	47.7
	84.8 percent

The identified taxa are shown in table 41, and the abundance recorded for *Laevigatosporites ovalis* Kosanke and *Lycospora punctata* Kosanke are worth noting.

TABLE 40.—*Palynomorphs from the Stockton Rider(?) coal bed in West Virginia*

[Maceration series 567; USGS Paleobotanical loc. No. D6576; 1,000 specimens counted]

Taxon	567-A	567-B	567-C	567-D	567-E
	(percent)				
Acanthotriletes echinatus (Knox) Potonié and Kremp	1.0	--	--	--	--
A. triquetrus Smith and Butterworth	--	2.0	--	--	--
Alatisporites sp	--	--	--	1.0	--
Anapiculatisporites cf. *A. hispidus* Butterworth and Williams	--	--	1.0	--	--
Calamospora breviradiata Kosanke	--	--	1.0	--	1.0
C. sp	1.0	--	--	--	1.0
Cirratriradites sp	--	.5	--	--	--
Convolutispora sp	--	1.0	--	--	--
Converrucosisporties sp.	--	--	--	1.0	--
Crossispora kosankei (Potonié and Kremp) Bhardawaj	2.0	1.5	--	--	1.0
C. sp	1.0	--	1.0	--	--
Densosporites triangularis Kosanke	--	1.0	--	23.0	--
D. sp	--	--	--	19.0	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	1.0	2.0	--	2.0
E. cf. *E. zonalis* (Loose) Knox	2.0	--	--	--	--
E. sp	--	--	1.0	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	3.0	1.0	--	--	2.0
Granulatisporites granulatus Ibrahim	--	.5	3.0	1.0	--
G. sp	4.0	1.5	3.0	1.0	1.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	1.0	1.0	--	--	--
L. globosus Schemel	--	1.5	--	21.0	6.0
L. latus Kosanke	--	.5	--	--	--
L. medius Kosanke	1.0	1.0	3.0	4.0	6.0
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	1.0	9.0	1.0	11.0	24.0
L. ovalis Kosanke	4.0	2.5	2.0	2.0	7.0
L. vulgaris (Ibrahim) Alpern and Doubinger	--	1.5	--	--	--
L. sp	1.0	--	--	--	2.0
Leiotriletes sp	--	1.0	1.0	--	1.0
Lycospora granulata Kosanke	1.0	4.5	--	--	3.0
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	7.0	22.5	44.0	1.0	7.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	3.5	1.0	--	--
L. punctata Kosanke	1.0	6.5	10.0	--	5.0
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	--	1.0	1.0	--	2.0
L. sp	60.0	28.0	23.0	1.0	25.0
Punctatisporites sp	--	.5	--	1.0	1.0
Radiizonates deformis (Kosanke) Staplin and Jansonius	--	--	--	6.0	--
R. faunus (Ibrahim) Smith and Butterworth	--	.5	--	2.0	--
Raistrickia cf. *R. saetosa* (Loose) Schopf, Wilson, and Bentall	--	.5	--	--	--
R. sp	--	.5	--	1.0	--
Torispora securis Balme	--	.5	--	2.0	--
Triquitrites sclptilis (Balme) Smith and Butterworth	--	1.0	2.0	1.0	2.0
Verrucosisporites verrucosus (Ibrahim) Ibrahim	--	.5	--	--	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	3.0	1.5	--	--	1.0
Monsaccate	6.0	.5	--	1.0	--
	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

567-A, 15.1 cm roof rock.

567-B, 30.4 cm coal excluding 2.54 cm shale in middle of sample.

567-C, 2.5 cm parting sample from above.

567-D, 30.4 coal.

567-E, 30.4 coal and bone coal.

TABLE 41.—*Palynomorphs from the Stockton Rider(?) coal bed in West Virginia*

[Maceration series 452; USGS Paleobotanical loc. No. D6552; 250 specimens counted; +, present but not observed in count]

Taxon	452 (percent)
Acanthotriletes cf. *A. triquetrus* Smith and Butterworth	1.6
Apiculatasporites spinulistratus (Loose) Ibrahim	+
Calamospora breviradiata Kosanke	2.0
C. sp.	.8
Cirratriradites annuliformis Kosanke and Brokaw	.8
Crassispora kosankei (Potonié and Kremp) Bharadwaj	7.2
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	2.8
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.8
G. sp.	.4
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	.4
L. globosus(?) Schemel	.4
L. latus Kosanke	1.6
L. medius Kosanke	1.2
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	6.0
L. ovalis Kosanke	20.0
L. vulgaris (Ibrahim) Alpern and Doubinger	.4
Lycospora granulata Kosanke	2.0
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	5.2
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	3.6
L. punctata Kosanke	14.0
L. sp.	22.8
Punctatisporites sp.	.4
Raistrickia crocea Kosanke	+
R. cf. *R. pilosa* Kosanke	+
R. rubida Kosanke	.4
R. sp.	.4
Triquitrites sp.	.4
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	.8
V. profunda (Wilson and Hoffmeister) Wilson and Venkatachala	2.0
Monosaccate	1.6
	100.0

DESCRIPTION OF MATERIAL IN MACERATION

452, 20 cm coal with 2.5 cm shale parting.

PALYNOMORPHS FROM THE CHARLESTON SANDSTONE

The Charleston Sandstone was named by Campbell and Mendenhall (1896) and mapped in this area by Campbell (1901). This formation forms the upper part of the Middle Pennsylvanian Series in the area of the proposed Pennsylvanian System stratotype. The Charleston Sandstone was named for exposures near Charleston, Kanawha County, and is stratigraphically above the Kanawha Formation and below the Conemaugh Formation. The terminology employed by Englund and others (1979) and by Henry (1984) for stratigraphic units previously included in the Allegheny Formation in the stratotype area is used in this report. Additional modifications were suggested by H. H. Arndt (written commun., 1981) and by T. W. Henry (written commun., 1984) that have helped to utilize the palynomorph data most effectively.

The Charleston Sandstone is a massive unit composed of alluvial-plain and other terrestrial deposits. The marine environment was in proximity to the stratotype area, but alternation of marine and nonmarine beds does not exist in the stratotype. This condition contrasts to the underlying Kanawha Formation and to most other coal-bearing sequences in the United States that correlate with the Charleston Sandstone. With continuous terrestrial deposition, plant life in the stratotype area was not periodically wiped out by a series of marine transgressions. It was more or less continuous with

periods of ideal environmental conditions resulting in formation of coal beds. This contrasts markedly with areas in which the vegetation was periodically wiped out with perhaps marginal taxa unable to compete with changing environmental conditions. While differing environmental conditions must have influenced the vegetation, Kosanke (1984) in a previous investigation established that the palynomorphs extracted from coal beds of the Charles Sandstone were basically comparable to those of other areas.

The named coal beds of the Charleston Sandstone occurring in the area of the proposed Pennsylvanian System stratotype in ascending order are:

Stockton "A"
Little No. 5 Block
Lower No. 5 Block
Upper No. 5 Block
No. 6 Block

The Stockton "A" coal bed, maceration series 571, is a thin bed occurring a short distance above the Kanawha Black Flint. The coal bed, from the Mammoth West section of Kanawha County, was reported in part by Kosanke Kosanke in press (1984). A complete listing of identified taxa is shown in table 42. *Lycospora* is the dominant genus in the coal sample (571-A) and *Endosporites* and *Laevigatosporites* the subdominant.

A set of samples of the Stockton "A" coal bed from the Harewood section located in Fayette County, were assigned to maceration series 668. Abundant palynomorphs were extracted from the coal samples and the numerically important genera are as follows:

Laevigatosporites	37.0 percent
Lycospora	31.9
Radiizonates	9.0
	77.9 percent

Almost all specimens of *Radiizonates* occurring in the 668 maceration series are in the top coal sample. The taxa and their abundance are given in table 43.

A sample of thin coal thought to represent the Stockton "A" coal was collected from the Cannelton section and assigned to maceration 443. The identified palynomorphs and their abundance are shown in table 44. The palynomorphs identified are those common to this part of the stratigraphic column and may represent a segment of maceration series 571.

The numerically important genera are as follows:

Densosporites	10.5 percent
Laevigatosporites	27.5
Lycospora	48.5
	81.0 percent

Samples of the Little No. 5 Block coal bed assigned to the 451 maceration series are from the Mammoth West section, northwest of Mammoth. These samples are similar in many respects to maceration series 552 (Little No. 5 Block coal bed) previously reported by Kosanke (1984). The numerically important genera in the coal samples (A, C, and E) of the 451 maceration series are:

Densosporites	8.5 percent
Laevigatosporites	40.8
Lycospora	19.0
Torispora	11.8
	80.1 percent

Radiizonates occurs at the rate of only 1.3 percent in the coal samples, but is much more abundant in the parting samples 451-B and 451-D. *Lycospora* is significantly reduced in abundance from the Stockton "A" coal beds below, and a fragment of *Zosterosporites* was found in a parting sample (451-D). *Zosterosporites triangularis* Kosanke was previously reported by Kosanke (1984) from both the Lower and Upper No. 5 Block coal beds in this area. There is also a significant increase in the abundance of *Laevigatosporites punctatus* Kosanke. The taxa and their abundance identified in the 451 maceration series are given in table 45.

The Little No. 5 Block coal bed in the Cannelton section, Kanawha County, is benched; the lower bench is assigned to the 445 maceration series. Numerically, the important genera are:

Laevigatosporites	56.0 percent
Lycospora	31.0
Torispora	3.5
	90.5 percent

The absence of *Radiizonates* in the lower bench of the Little No. 5 Block coal bed, maceration 445, table 46, is in part similar to the scarcity of this genus in maceration 451-E.

The upper bench of the Little No. 5 Block coal bed in the Cannelton section, maceration 444, table 47, contains an abundance of *Radiizonates* as shown in the following important genera:

Laevigatosporites	43.0 percent
Lycospora	15.8
Radiizonates	18.0
Torispora	12.4
	89.2 percent

This generic abundance summary is similar to that reported by Kosanke (1984) for maceration series 434, the Little No. 5 Block coal bed from the Semet-Solvay mine at Harewood, northeast of Boomer, Fayette County, W. Va.

Both *Laevigatosporites* and *Lycospora*, in the lower bench of the Little No. 5 Block coal bed, maceration 445, are more abundant than in samples of the same coal bed from Mammoth Townsite (maceration series 451). This is also true of the upper bench of the Little

TABLE 42.—*Palynomorphs from the Stockton "A" coal bed in West Virginia*

[Maceration series 571; USGS Paleobotanical loc. No. D6050; 600 specimens counted; +, present but not observed in count]

Taxon	571-A	571-B	571-C
		(percent)	
Acanthotriletes echinatus (Knox) Potonié and Kremp	0.5	2.0	2.5
A. sp	--	1.0	--
Alatisporites hoffmeisterii Morgan	--	--	+
Apiculatisporis sp	+	+	--
Calamospora breviradiata Kosanke	--	.5	--
C. mutabilis (Loose) Schopf, Wilson, and Bentall	--	.5	--
C. straminea Wilson and Kosanke	--	+	--
C. sp	.5	.5	1.5
Cirratriradites saturni (Ibrahim) Schopf, Wilson, and Bentall	+	1.5	.5
Convolutispora sp	.5	1.5	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	+	3.0	2.0
Cyclogranisporites sp	--	.5	2.5
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	.5	2.5
D. sphaerotriangularis Kosanke	--	1.0	+
D. triangularis Kosanke	--	3.0	2.5
D. sp	--	3.0	2.5
Dictyotrilates bireticulatus (Ibrahim) Smith and Butterworth	--	--	2.5
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	22.5	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	1.0	1.0	5.0
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	2.5	.5
G. spp	+	3.0	2.0
Laevigatosporites desmoinensis (Wilson and Coa) Schopf, Wilson, and Bentall	3.5	1.5	2.0
L. globosus Schemel	--	4.0	5.0
L. latus Kosanke	1.0	.5	1.5
L. medius Kosanke	1.0	2.5	3.5
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	8.5	27.5	16.5
L. ovalis Kosanke	7.5	2.5	6.5
L. punctatus Kosanke	.5	1.0	2.0
L. vulgaris (Ibrahim) Alpern and Doubinger	.5	.5	2.0
Leiotriletes sp.	--	1.0	.5
Lycospora brevijuga Kosanke	--	1.0	--
L. granulata Kosanke	14.5	2.0	1.0
L. micropapillata (Wilson and Coe) Schopf, Wilson. and Bentall	2.0	3.5	5.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	1.5	7.0	--
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	4.0	--	3.0
L. rugosa Schemel	--	2.0	6.0
L. spp	25.5	13.5	19.0
Microreticulatisporites nobilis (Wicher) Knox	--	+	--
M. sp	+	.5	--
Punctatisporites sp	--	+	--
Pustulatisporites pustulatus (Knox) Potonié and Kremp	+	--	+
Radiizonates sp.	--	--	.5
Raistrickia cf. *R. saetosa* (Loose) Schopf, Wilson, and Bentall	--	.5	--
Reticulatisporites carnosus (Knox) Neves	--	+	--
Triquitrites bronsonii Wilson and Hoffmeister	+	--	--
T. crassus Kosanke	--	+	--
Vestispora pseudoreticulata Spode in Smith and Butterworth	.5	--	.5
Wilsonites sp	+	+	--
Monosaccate	--	1.0	.5
Unassigned	.5	--	.5
	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATION

571-A, = 20.3 cm coal.

571-B, = 21.3 cm shale, black.

571-C, = 7.6 cm seat rock.

TABLE 43.—*Palynomorphs from the Stockton "A" coal bed in West Virginia*

[Maceration series 668; USGS Paleobotanical loc. No. D6560; 600 specimens counted; +, present but not observed in count or count not attempted]

Taxon	668-A	668-B	668-C	668-D	668-E
			(percent)		
Acanthotriletes echinatus (Knox) Potonié and Kremp	+	1.0	--	--	--
Alatisporites sp	--	--	--	1.0	--
Apiculatisporis sp	--	2.0	--	--	--
Calamospora cf. *C. mutabilis* (Loose) Schopf, Wilson, and Bentall	--	--	1.0	--	--
C. sp	--	--	+	1.0	--
Cirratriradites saturni (Ibrahim) Schopf, Wilson, and Bentall	--	--	3.0	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	+	--	4.0	4.0	--
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	2.0	1.0	1.0	--
Densosporites triangularis Kosanke	--	6.0	--	--	--
D. sp	--	2.0	--	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	--	1.0	2.0	--
F. sp	--	1.0	--	--	+
Granulatisporites granulatus Ibrahim	--	2.0	2.0	2.0	--
G. sp	+	1.0	3.0	1.0	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	9.0	4.0	4.0	--
L. globosus Schemel	--	4.0	1.0	1.0	--
L. latus Kosanke	--	4.0	3.0	3.0	--
L. medius Kosanke	--	1.0	4.0	1.0	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	--	13.0	15.0	12.0	--
L. ovalis Kosanke	+	6.0	15.0	6.0	--
L. punctatus Kosanke	--	1.0	--	--	--
L. striatus Alpern	--	--	+	--	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	--	6.0	1.0	--
Leiotriletes sp	--	--	--	1.0	--
Lycospora brevijuga Kosanke	--	--	1.0	--	--
L. granulata Kosanke	+	2.0	8.0	3.0	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+	1.0	15.0	33.0	+
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	+	1.0	--	1.0	--
L. punctata Kosanke	+	2.0	2.0	3.0	--
L. spp	--	2.0	10.0	10.0	+
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	+	--	--	2.0	--
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	--	+	--
P. sp	+	--	--	--	--
Radiizonates faunus (Ibrahim) Smith and Butterworth	--	8.0	--	+	--
R. sp	--	22.0	--	--	+
Raistrickia sp	--	--	+	--	--
Torispora securis Balme	--	--	--	2.0	--
T. sp	+	--	--	1.0	--
Verrucosisporites sp	--	--	1.0	--	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	--	--	+	--
V. pseudoreticulata Spode in Smith and Butterworth	--	--	--	2.0	--
V. sp	--	--	+	1.0	--
Monosaccate	--	1.0	--	1.0	--
Unassigned	+	1.0	--	--	--
		100.0	100.0	100.0	--

DESCRIPTION OF MATERIAL IN MACERATIONS

668-A, 12.7 cm roof rock.
668-B, 25.4 cm coal.
668-C, 25.4 cm coal.
668-D, 27.9 cm coal.
668-E, 12.7 cm coal rash zone between 668-B-C.

TABLE 44.—*Palynomorphs from the Stockton "A" coal bed in West Virginia*

[Maceration series 443; USGS Paleobotanical loc. No. D6548; 200 specimens counted]

Taxon	443 (percent)
Acanthotriletes triquetrus Smith and Butterworth	1.5
Calamospora breviradiata Kosanke	1.5
Cappisporites distortus Urban	.5
Cirratriradites sp	.5
Crassispora kosankei (Potonié and Kremp) Bharadwaj	.5
Cyclogranisporites sp	2.0
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	5.5
D. sphaerotriangularis Kosanke	.5
D. triangularis Kosanke	1.5
D. sp	3.0
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	1.0
E. sp	.5
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	2.0
Granulatisporites sp	.5
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	2.0
L. globosus Schemel	4.0
L. medius Kosanke	3.0
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	6.5
L. ovalis Kosanke	7.5
L. punctatus Kosanke	3.0
L. vulgaris (Ibrahim) Alpern and Doubinger	1.5
Leiotriletes parvus Guennel	1.5
Lycospora granulata Kosanke	12.5
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	2.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	10.0
L. punctata Kosanke	5.5
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	3.5
L. spp.	15.0
Raistrickia sp.	.5
Reticulatisporites cf. *R. carnosus* (Knox) Neves	.5
Unassigned	.5
	100.0

DESCRIPTION OF MATERIAL IN MACERATION

443, 20.3 cm coal.

No. 5 Block coal bed maceration series 444 from the Cannelton section.

The Lower No. 5 Block coal bed is similar to the Little No. 5 Block coal bed in that a number of taxa are common to both beds. This is not to be unexpected because of the close vertical proximity and the apparent similarity of paleoecological conditions. There are differences between these two coal beds, but they are primarily abundance differences. *Lycospora* varies in abundance in the coal beds of the Kanawha Formation from less than 5 percent to more than 80 percent, but overall is the most abundant taxon. Thus, *Lycospora* is basically the dominant palynomorph of the Kanawha Formation. There is a reduction in abundance of *Lycospora* in coal beds in the lower part of the Charleston Sandstone to a point where the genus represents less than seven percent in maceration series 749, the Lower No. 5 Block coal bed from the highwall of Cannelton Industries, Inc., surface mine in Kanawha County. A summary of the numerically important genera of the coal samples of maceration series 749 follows:

Densosporites	6.4 percent
Granulatisporites	2.4
Laevigatosporites	42.7
Lycospora	6.8
Radiizonates	2.3
Torispora	23.4
	81.0 percent

TABLE 45.—*Palynomorphs from the Little No. 5 Block coal bed in West Virginia*

[Maceration series 451; USGS Paleobotanical loc. No. D6551; 1,250 specimens counted; +, present but not observed in count]

Taxon	451-A	451-B	451-C	451-D	451-E
			(percent)		
Alatisporites hexalatus Kosanke	+	+	.8	--	--
A. cf. *A. trialatus* Kosanke	--	--	--	.4	--
Calamospora breviradiata Kosanke	.4	--	--	.4	--
C. hartungiana Schopf in Schopf, Wilson and Bentall	--	--	--	.4	--
C. sp	.8	.4	.4	.4	1.6
Cirratriradites annuliformis Kosanke and Brokaw	--	--	.8	.4	--
C. sp	.4	.4	--	--	--
Convolutispora sp	1.6	.8	1.6	.4	+
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	+	1.2	.4	7.2
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	10.0	.8	--	--	2.4
D. sphaerotriangularis Kosanke	1.6	--	.4	.4	1.2
D. triangularis Kosanke	2.8	--	.4	.8	3.2
D. spp	--	1.2	--	--	2.4
Dictotriletes bireticulatus (Ibrahim) Smith and Butterworth	--	--	--	--	.8
D. castaneaeformis (Horst) Sullivan	--	--	--	.8	--
Endosporites plicatus Kosanke	--	1.2	.8	+	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	1.2	--	2.0	.8
Granulatisporites granularis Kosanke	+	.4	1.2	1.2	1.6
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	+	.4	--	2.0	3.2
G. spp	1.2	+	.4	5.6	1.6
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	7.2	2.8	1.6
L. globosus Schemel	7.6	11.2	6.0	10.8	6.4
L. latus Kosanke	.4	.4	--	.8	+
L. medius Kosanke	1.6	2.0	4.4	1.6	1.6
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	12.0	12.0	6.4	11.2	9.6
L. ovalis Kosanke	10.4	7.6	14.4	11.2	9.6
L. punctatus Kosanke	11.6	10.8	14.4	5.2	4.8
L. vulgaris (Ibrahim) Alpern and Doubinger	+	--	.8	--	--
L. sp	--	.4	--	--	--
Leiotriletes parvus Guennel	--	--	--	--	2.4
Lycospora granulata Kosanke	3.2	.4	3.6	2.4	4.8
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	1.6	--	1.2	.4	3.2
L. pellucida (Wicher) Schopf Wilson, and Bentall—*L. pseudoannulata* Kosanke	--	.4	5.6	2.4	.8
L. punctata Kosanke	--	.8	3.2	1.6	1.6
L. spp	5.6	2.4	14.4	13.6	10.4
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	--	--	--	--	+
Murospora sp	--	--	--	.4	--
Punctatisporites latigranifer (Loose) Schopf, Wilson, and Bentall	.4	--	--	--	--
P. minutus (Kosanke) Peppers	+	--	--	--	--
P. obesus (Loose) Potonié and Kremp	.4	1.6	--	.4	--
P. spp	--	1.2	1.2	2.0	1.6
Radiizonates difformis (Kosanke) Staplin and Jansonius	--	10.4	3.6	1.6	--
R. sp	+	4.8	.4	--	.8
Raistrickia spp	--	--	--	.4	.8
Reticulatisporites sp	--	.4	--	--	--
Torispora securis Balme	25.2	20.4	5.2	11.2	8.0
Triquitrites cf T. arculatus Wilson and Coe	--	--	--	--	--
T. exiquus Wilson and Kosanke	--	--	--	.4	--
T. sculptilis (Balme) Smith and Butterworth	.4	--	--	--	1.6
T. sp	.4	--	--	.4	.4
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	--	--	--	1.2	1.6
V. cf. *V. levigata* Wilson and Venkatachala	--	--	--	--	.8
Wilsonites vesicatus (Kosanke) Kosanke	--	3.2	--	--	.8
Zosterosporites sp	--	--	--	.4	--
Monosaccate	--	1.6	--	2.0	.8
Unassigned	.4	1.2	--	--	--
	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATIONS

451-A, 10.1 cm coal. 451-B, 7.6 cm parting. 451-C, 9.5 cm coal. 451-D, 15.2 cm parting. 451-E, 19.0 cm coal.

TABLE 46.—*Palynomorphs from the Little No. 5 Block coal bed, lower bench, in West Virginia*

[Maceration series 445, USGS Paleobotanical loc. No. D6550; 200 specimens counted]

Taxon	
Alatisporites trialatus Kosanke	0.5
Calamospora breviradiata Kosanke	1.5
C. hartungiana Schopf in Schopf, Wilson, and Bentall	
C. sp	.5
Cyclogranisporites aureus (Loose) Potonié and Kremp	1.5
Densosporites sp	.5
Endosporites sp	.5
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	1.0
Granulatisporites sp	1.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson and Bentall	2.5
L. globosus Schemel	7.5
L. medius Kosanke	4.5
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	22.5
L. ovalis Kosanke	15.5
L. punctatus Kosanke	2.0
L. vulgaris (Ibrahim) Ibrahim	1.5
Lycospora granulata Kosanke	7.0
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	3.5
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	2.0
L. punctata Kosanke	5.0
L. spp	13.5
Microreticulatisporites sp	.5
Punctatisporites sp.	.5
Raistrickia crinita Kosanke	.5
R. cf. *R. grovensis* Schopf in Schopf, Wilson, and Bentall	.5
Torispora securis Balme	3.5
Verrucosisporites sp	.5
	100.0

DESCRIPTION OF MATERIAL IN MACERATION
445, 35.5 cm coal.

The identified taxa and their abundance in the 749 maceration series is shown in table 48. Only two species of *Lycospora* were identified from these samples of the Lower No. 5 Block coal bed.

Similar analyses of the Lower No. 5 Block coal bed were discussed by Kosanke (1984) for maceration series 435, 446, and 553. In these samples of the Lower No. 5 Block coal bed, *Laevigatosporites* is dominant, followed by *Torispora* and (or) *Densosporites*. *Radiizonates* and *Lycospora* are next in numerical importance. Subsequently, both *Radiizonates* and *Densosporites* become extinct within the Charleston Sandstone of the stratotype area.

Several sets of samples of the Upper No. 5 Block coal bed were reported by Kosanke (1984). The benched character of this bed was displayed in some of these samples. Where the bed was benched, the upper bench marked the first appearance of *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala in the coal beds of the proposed Pennsylvanian System stratotype. Two additional samples, one of the lower and one of the upper bench of the No. 5 Block coal bed were collected from the highwall of the Cannelton Industries, Inc., surface mine located northeast of Cannelton. The sample of the lower bench was assigned to maceration 685 and is similar in many respects to another sample of the coal (Kosanke, 1984). *Radiizonates* is absent from the lower bench of the Upper No. 5 Block coal bed (maceration 685) as was reported for maceration 574 by Kosanke (1984). Also, *Triquitrites* is present at the rate of 8 percent, and *Lycospora* continues to be reduced in abundance as shown in the following genera:

Crassispora	4.4 percent
Florinites	14.0
Laevigatosporites	39.2
Lycospora	10.4
Torispora	13.6
Triquitrites	8.0
	89.6 percent

TABLE 47.—*Palynomorphs from the Little No. 5 Block coal bed, upper bench, in West Virginia*

[Maceration series 444; USGS Paleobotanical loc. No. D6549; 500 specimens counted; +, present but not observed in count or count not attempted]

Taxon	444-A	444-B	444-C
		(percent)	
Acanthotriletes triquetrus Smith and Butterworth	--	+	--
A. sp	0.4	0.4	--
Apiculatisporis abditus (Loose) Potonié and Kremp	--	.8	--
Calamospora breviradiata Kosanke	--	1.6	--
C. sp	--	.8	--
Cirratriradites annuliformis Kosanke and Brokaw	--	+	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	.4	2.8	+
Cyclogranisporites multigranus Smith and Butterworth	--	.4	--
C. sp	--	+	--
Densosporites triangularis Kosanke	.4	--	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	.4	--	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	1.2	--
E. zonalis (Loose) Knox	.4	--	
E. sp	--	.8	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	1.2	--
Granulatisporites granularis Kosanke	--	.4	--
G. cf. *G. pallidus* Kosanke	--	.8	--
G. sp	--	.4	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	2.4	5.6	--
L. globosus Schemel	11.2	6.8	--
L. latus Kosanke	.8	1.2	--
L. medius	1.2	.8	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	6.8	17.6	--
L. punctatus Kosanke	5.6	2.8	--
L. ovalis Kosanke	8.0	14.0	+
L. vulgaris (Ibrahim) Alpern and Doubinger	.4	1.2	--
Leiotriletes sp.	.8	+	--
Lycospora granulata Kosanke	--	13.2	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	.4	1.6	--
L. punctata Kosanke	--	6.4	+
L. spp	--	10.0	+
Microreticulatisporites concavus Butterworth and Williams	.4	.4	--
Punctatisporites obliquus Kosanke	--	.4	--
Pustulatisporites sp	--	.4	--
Radiizonates difformis (Kosanke) Staplin and Jansonius	19.6	.4	--
R. faunus (Ibrahim) Smith and Butterworth	2.8	--	--
R. sp	11.6	1.6	--
Raistrickia cf. *R. pilosa* Kosanke	--	.4	--
R. sp	--	.8	--
Torispora securis Balme	24.4	.4	--
Triquitrites exiquus Wilson and Kosanke	--	.8	--
T. sculptilis (Balme) Smith and Butterworth	+	--	--
T. sp	--	.8	--
Verrucosisporites sp	1.2	--	--
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	+	1.6	--
Wilsonites delicatus (Kosanke) Kosanke	--	+	--
Monosaccate	.4	.4	--
Unassigned	--	+	--
	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS

444-A, 28.5 cm coal.

444-B, 28.5 cm coal.

444-C 3.8 cm seat rock.

TABLE 48.—*Palynomorphs from the Lower No. 5 Block coal bed, upper and lower benches, in West Virginia*

[Maceration series 749, USGS Paleobotanical loc. No. D6561; 1,500 specimens counted, +, present but not observed in count]

Taxon	749-A	749-B	749-C	749-D	749-E	749-F
	(percent)					
Acanthotriletes echinatus (Knox) Potonié and Kremp	--	--	--	--	--	1.0
A. triquetrus Smith and Butterworth	--	--	1.0	2.0	--	3.0
A. sp	--	--	--	--	+	--
Calamospora parva Guennel	--	--	1.0	--	--	--
C. sp	1.0	--	--	1.0	--	2.0
Cirratriradites saturni (Ibrahim) Schopf, Wilson, and Bentall	--	+	--	--	1.0	2.0
C. sp	--	0.4	--	--	--	--
Convolutispora sp	--	--	--	1.0	--	1.0
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	--	--	--	--	1.0
Cyclogranisporites aureus (Loose) Potonié and Kremp	--	2.0	--	--	--	--
C. multigranus Smith and Butterworth	--	--	--	--	1.0	1.0
C. sp	--	--	+	--	--	--
Densosporites annulatus (Loose) Schopf, Wilson, and Bentall	--	.4	--	--	--	--
D. sphaerotriangularis Kosanke	--	1.2	3.0	--	--	--
D. triangularis Kosanke	11.0	4.5	6.0	1.0	--	3.0
D. sp	6.0	3.2	2.0	6.0	1.0	2.0
Dictyotriletes castaneaeformis (Horst) Sullivan	--	--	--	2.0	--	2.0
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	--	.4	1.0	--	--	--
E. sp	1.0	+	--	--	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	--	--	--	3.0	--
F. sp	--	+	1.0	1.0	--	--
Granulatisporites granularis Kosanke	--	--	+	5.0	2.0	3.0
G. verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	--	--	--	--	3.0
G. sp	--	--	2.0	--	1.0	9.0
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	3.0	.8	8.0	1.0	6.0	2.0
L. globosus Schemel	*14.0*	*11.2*	*5.0*	*2.0*	*6.0*	*6.0*
L. latus Kosanke	5.0	.4	2.0	--	--	--
L. medius Kosanke	1.0	2.0	2.0	2.0	2.0	2.0
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	15.0	17.6	5.0	14.0	13.0	12.0
L. ovalis Kosanke	6.0	2.8	13.0	5.0	13.0	4.0
L. punctatus Kosanke	5.0	15.2	6.0	11.0	9.0	7.0
L. vulgaris (Ibrahim) Alpern and Doubinger	--	.4	1.0	--	--	--
Lycospora granulata Kosanke	2.0	--	2.0	1.0	1.0	2.0
L. punctata Kosanke	6.0	.4	3.0	--	7.0	2.0
L. spp	6.0	1.2	5.0	--	7.0	4.0
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	--	--	--	--	3.0	--
Punctatisporites obesus (Loose) Potonié and Kremp	--	--	--	3.0	--	--
P. sp	--	+	2.0	1.0	1.0	--
Radiizonates difformis (Kosanke) Staplin and Jansonius	--	--	--	--	--	3.0
R. cf. *R. faunus* (Ibrahim) Smith and Butterworth	--	.8	--	--	--	--
R. sp	--	--	3.0	1.0	1.0	2.0
Torispora securis Balme	16.0	34.0	24.0	30.0	11.0	10.0
Triquitrites exiguus Wilson and Kosanke	--	--	--	--	--	2.0
T. pulvinatus Kosanke	--	--	--	--	2.0	3.0
T. sculptilis (Balme) Smith and Butterworth	--	--	--	--	+	2.0
T. sp	--	--	--	--	2.0	2.0
Verrucosisporites sifati (Ibrahim) Smith and Butterworth	--	--	--	4.0	--	--
V. sp.	1.0	.4	--	1.0	1.0	1.0
Vestispora sp	--	--	--	--	2.0	--
Wilsonites vesicatus (Kosanke) Kosanke	--	--	--	3.0	--	1.0
Zosterosporites triangularis Kosanke	--	--	--	--	+	2.0
Monosaccate	--	.4	1.0	2.0	4.0	2.0
Unassigned	1.0	--	1.0	--	+	1.0
	100.0	100.0	100.0	100.0	100.0	100.0

DESCRIPTION OF MATERIAL IN MACERATION

749-A, 20.3 cm coal, impure.
749-B, 58.4 cm coal.
749-C, 62.2 cm coal.
749-D, 15.2 cm coal, impure.
749-E, 35.5 cm shale, silty, gradational to coal.
749-F, 45.7 cm coal.

TABLE 49.—*Palynomorphs from the Upper No. 5 Block coal bed, lower bench, in West Virginia*

[Maceration series 685; USGS Paleobotanical loc. No. D6563; 250 specimens counted; +, present but not observed in count]

Taxon	685 (percent)
Acanthotriletes mosaicus Potonié and Kremp	0.4
Alatisporites sp	+
Apiculatisporites sp	+
Calamospora sp	1.2
Cirratriradites cf. *C. maculatus* Wilson and Coe	.4
Crassispora kosankei (Potonié and Kremp) Bharadwaj	4.4
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	.8
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	14.0
Granulatisporites granularis Kosanke	.8
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	.8
L. globosus Schemel	1.6
L. latus Kosanke	2.0
L. medius Kosanke	6.8
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	16.8
L. ovalis Kosanke	10.0
L. punctatus Kosanke	.4
L. vulgaris (Ibrahim) Alpern and Doubinger	.8
Leiotriletes sp.	.4
Lycospora granulata Kosanke	3.6
L. punctata Kosanke	1.2
L. spp	5.6
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	1.6
Punctatisporites mundus Kosanke	.4
P. obliquus Kosanke	.8
P. spp	1.6
Raistrickia crocea Kosanke	.4
R. spp	.8
Torispora securis Balme	13.6
Triquitrites arculatus Wilson and Coe	+
T. cf. *T. bransonii* Wilson and Hoffmeister	+
T. crassus Kosanke	.4
T. cf. *T. minutus* Alpern	2.4
T. pulvinatus Kosanke	.8
T. spp	4.4
Verrucosisporites sp.	.8
Vestispora fanestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	.4
	100.0

DESCRIPTION OF MATERIAL IN MACERATION
685, 20.3 cm coal.

The palynomorphs and their abundance identified in the 685 maceration series are shown in table 49.

Samples of the No. 5 Block(?) coal bed, Greenbrier section, stop 21 of Arndt (1979), represent here the lower bench of the Upper No. 5 Block coal bed. These samples were assigned to macerations series 453, and the palynomorphs and abundance data are given in table 50. The numerically important genera of the coal samples of the 453 maceration series are:

Laevigatosporites	43.2 percent
Lycospora	25.0
Torispora	15.8
	84.0 percent

The palynomorph assemblage of the 453 maceration series is very similar to that of the lower bench of the Upper No. 5 Block coal bed, maceration series 685. The dominant and subdominant taxa are the same in both the 453 and 685 maceration series. Further,

TABLE 50.—*Palynomorphs from the Upper No. 5 Block coal bed, lower bench, in West Virginia*

[Maceration series 453; USGS Paleobotanical loc. No. D6633; 500 specimens counted, +, present but not observed in count or count not attempted]

Taxon	453-A	453-B	453-C	453-D
		(percent)		
Alatisporites hexalatus Kosanke	--	0.8	--	--
A. triangularis Kosanke	+	+	--	+
Calamospora hartungiana Schopf in Schopf, Wilson, and Bentall	--	--	1.2	--
C. parva Guennel	--	.8	--	--
C. sp	--	.4	--	--
Cirratriradites annuliformis Kosanke and Brokaw	--	.8	--	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	--	1.2	.4	+
Cyclogranisporites sp	--	--	--	+
Densosporites triangularis Kosanke	+	--	1.2	--
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	--	--	.4	--
Endosporites globiformis (Ibrahim) Schopf, Wilson, and Bentall	+	2.0	.4	+
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	--	2.4	--	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	--	3.2	--	+
G. sp	+	1.6	2.0	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	+	2.8	--	--
L. globosus Schemel	+	2.4	7.6	--
L. latus Kosanke	--	.4	+	--
L. medius Kosanke	--	2.8	3.2	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	+	1.2	15.6	+
L. ovalis Kosanke	+	19.6	22.8	+
L. punctatus Kosanke	--	6.0	2.0	+
L. vulgaris (Ibrahim) Alpern and Doubinger	--	--	+	--
Lycospora granulata Kosanke	--	4.8	1.2	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	--	7.6	1.2	+
L. punctata Kosanke	+	.8	2.0	+
L. spp	--	16.8	15.6	+
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	--	.4	.8	--
Mooreisporites inusitatus (Kosanke) Neves	--	+	--	--
Punctatisporites spp	--	2.4	3.6	--
Raistrickia crinita Kosanke	--	+	--	--
R. sp	+	.4	--	+
Reinschospora sp	--	.4	--	--
Reticulatisporites cf. *R. adhearens* Kosanke	--	--	.4	--
R. sp	--	.4	--	--
Torispora securis Balme	--	15.6	16.0	--
Triquitrites arculatus Wilson and Coe	--	+	--	--
T. cf. *T. bransonii* Wilson and Hoffmeister	--	.8	--	--
T. pulvinatus Kosanke	+	--	.4	+
T. spinosus Kosanke	--	+	--	--
T. sp	--	+	1.6	--
Verrucosisporites sp.	--	--	--	+
Vestispora fenestrata (Kosanke) Spode in Smith and Butterworth	--	.4	.4	--
Wilsonites vesicatus (Kosanke) Kosanke	--	.4	--	--
Monosaccate	+	.4	--	+
	--	100.0	100.0	--

DESCRIPTION OF MATERIAL IN MACERATIONS

453-A, 10.1 cm roof rock.
453-B, 19.0 cm coal.
453-C, 19.0 cm coal.
453-D, 6.3 cm seat rock.
453-E, rider coal sample barren.

TABLE 51.—*Palynomorphs from the upper No. 5 Block coal bed, upper bench, in West Virginia*

[Maceration series 454; USGS Paleobotanical loc. No. D6634; 500 specimens counted; +, present but not observed in count or count not attempted

Taxon	454-A	454-B (percent)	454-C
Acanthotriletes cf. *A. triquetrus* Smith and Butterworth	--	+	--
Alatisporites sp	+	--	--
Apiculatisporis sp	--	0.4	--
Calamospora breviradiata Kosanke	+	.4	+
C. hartungiana Schopf in Schopf, Wilson, and Bentall	0.4	--	--
Cirratriradites annuliformis Kosanke and Brokaw	--	+	+
Convolutispora sp	1.6	.4	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	2.4	2.0	+
Dictyotriletes bireticulatus (Ibrahim) Smith and Butterworth	.4	.4	--
Endosporites formosus Kosanke	5.2	1.2	+
E. plicatus Kosanke	.8	--	--
E. sp	2.4	--	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	+	2.0	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson and Bentall	1.2	.4	--
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson and Bentall	3.6	4.4	+
L. globosus Schemel	2.0	1.2	--
L. latus Kosanke	--	2.8	--
L. medius Kosanke	2.8	3.2	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	4.4	23.6	--
L. ovalis Kosanke	23.2	28.8	+
L. vulgaris (Ibrahim) Alpern and Doubinger	2.0	3.6	--
Lycospora granulata Kosanke	15.6	3.2	--
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	6.0	1.6	--
L. punctata Kosanke	6.4	3.6	--
L. sp.	13.6	5.6	--
Punctatisporites spp	1.6	2.0	--
Raistrickia sp	.4	--	--
Reticulatisporites cf. *R. lacunosa* Kosanke	.4	--	--
Torispora securis Balme	+	4.8	+
Triquitrites pulvinatus Kosanke	--	.4	--
T. sculptilis (Balme) Smith and Butterworth	--	1.6	--
T. spp	1.2	1.6	+
Vestispora sp	+	--	--
Wilsonites vesicatus (Kosanke) Kosanke	1.6	--	--
Monsaccate	.4	.4	+
Unassigned	.4	.4	+
	100.0	100.0	--

DESCRIPTION OF MATERIAL IN MACERATIONS

454-A, 17.7 cm coal. 454-B, 17.7 cm coal. 454-C, 6.3 cm seat rock.

Radiizonates has not been identified from the lower bench of the Upper No. 5 Block coal bed and is likewise absent from the 453 maceration series.

Samples of the No. 5 Block(?) coal bed of Arndt (1979) from the intersection I-77 and I-79 are assigned to the maceration series 454, and they represent the upper bench of the Upper No. 5 Block(?) coal bed. They are similar to those of the 453 maceration series with respect to the dominant and subdominant genera. *Torispora* is sharply reduced in abundance in the 454 maceration series. This reduction in abundance of *Torispora* has been observed in other samples of the upper bench of the Upper No. 5 Block coal bed (Kosanke, 1984). *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala has characteristically been present in the upper bench of the Upper No. 5 coal bed and is absent from the 454 maceration series. Based on the evidence at hand, samples of the 454 maceration series (table 51)

TABLE 52.—*Palynomorphs from the Upper No. 5 Block coal bed, upper bench, in West Virginia*

[Maceration series 684, USGS Paleobotanical loc. No. D6562; +, present but not observed in count]

Taxon	684
Cirratriradites sp.	+
Cyclogranisporites sp.	+
Densosporites triangularis Kosanke	+
D. sp.	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	+
L. globosus Schemel	+
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	+
L. ovalis Kosanke	+
L. punctatus Kosanke	+
Lycospora granulata Kosanke	+
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	+
L. spp.	+
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	+
Punctatisporites sp.	+
Thymospora pseudothiessenii (Kosanke) Wilson and Venkatachala	+
Triquitrites sp.	+
Monosaccate	+

DESCRIPTION OF MATERIAL IN MACERATION

684 55.8 cm coal, top 20 cm impure

appear to be somewhat younger than those of the 453 maceration series and possibly older than the upper bench of the No. 5 Block coal bed. The following genera are numerically important in the coal samples of the 454 maceration series:

Endosporites	4.8 percent
Laevigatosporites	52.8
Lycospora	27.8
Torispora	2.4
	87.8

A second sample of the upper bench of the No. 5 Block coal bed (maceration 684) did not yield abundant palynomorphs. However, *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala was identified along with other taxa that are known to occur in the upper bench of the Upper No. 5 Block coal bed. The taxa identified from maceration 684 are shown in table 52.

In a previous investigation, Kosanke (1984) discussed the palynomorph content of benches of the Upper No. 5 Block coal bed from the highwall of the Harewood No. 5 Block strip mine. These samples were assigned to macerations 554-B-D (D6041), and the mine is located about 4 km north of Boomer, Fayette County, W. Va. About 10 m above the Upper No. 5 Block coal bed in the highwall of this mine an unnamed coal bed was collected and assigned to maceration 554-A. The presence of species of *Densosporites* and *Radiizonates* in 554 A, B, and D and the absence of *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala causes concern that these samples are not to be considered precisely equivalent to the Upper No. 5 Block coal bed but slightly older.

In a previous investigation, Kosanke (1984) identified the palynomorphs from a single block of the No. 6 Block coal (maceration 603). This block of coal yielded abundant palynomorphs of *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala and the first identification of *Schopfites dimorphus* Kosanke in coal beds from the stratotype. This information, together with other palynomorphs from the sample, suggested that the No. 6 Block coal is equivalent to the Lower Kittanning coal bed of the Allegheny Group of southern Pennsylvania and eastern Ohio.

The No. 6 Block coal bed is benched in the highwall of the Cannelton Industries, Inc., surface mine located northeast of Cannelton. The lower bench, maceration 686, yielded abundant and well-preserved palynomorphs with the following genera numerically important:

Florintes	6.4 percent
Laevigatosporites	46.0
Lycospora	10.0
Thymospora	27.2
	89.6 percent

The taxa and their abundance identified in maceration 686 are shown in table 53. *Shopfites dimorphus* Kosanke is present as was the case in maceration 603, and *Thymospora* is also well represented. Most likely the sample of No. 6 Block(?) coal previously examined (maceration 603) came from the lower bench of the No. 6 Block coal bed.

TABLE 53.—*Palynomorphs from the No. 6 Block coal bed, lower bench, in West Virginia*

[Maceration series 686; USGS Paleobotanical loc. No. D6564; 250 specimens counted; +, present but not observed in count]

Taxon	686 (percent)
Alatisporites varius Kosanke	0.4
Calamospora spp	1.6
Cirratriradites sp	+
Crassispora kosankei (Potonié and Kremp) Bharadwaj	+
Cyclogranisporites spp.	1.6
Florinites antiquus Schopf in Schopf, Wilson and Bentall	6.4
Granulatisporites sp	+
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	1.6
L. globosus Schemel	11.2
L. latus Kosanke	1.2
L. medius Kosanke	1.6
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	20.8
L. ovalis Kosanke	2.8
L. punctatus Kosanke	5.6
L. vulgaris (Ibrahim) Alpern and Doubinger	1.2
Leiotriletes sp	.8
Lycospora granulata Kosanke	2.8
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	.8
L. spp	6.4
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	+
Mooreisporites inusitatus (Kosanke) Neves	+
Punctatisporites obliquus Kosanke	.8
P. sp	.4
Raistrickia crinita Kosanke	.4
R. subcrinita Peppers	+
R. sp	+
Schopfites dimorphus Kosanke	+
Thymospora pseudothiessenii (Kosanke) Wilson and Venkatachala	27.2
Torispora securis Balme	.8
Triquitrites pulvinatus Kosanke	.4
T. spp	1.2
Verrucosisporites sp	+
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	+
Wilsonites sp	1.2
Monosaccate	.4
Unassigned	.8
	100.0

DESCRIPTION OF MATERIAL IN MACERATION

686 45.7 cm coal.

The upper bench of the No. 6 Block coal bed did not yield as diversified an assemblage as the lower bench, but the taxa identified are consistent with the position of the Lower Kittanning coal bed. The following genera are numberically important in maceration 687.

Laevigatosporites	30.4 percent
Lycospora	46.0
Thymospora	6.0
Torispora	12.4
	94.8 percent

Lycospora, which has been markedly reduced in abundance throughout much of the Charleston Sandstone, is the most abundant taxon in the upper bench of the No. 6 Block coal bed as shown in table 54.

Shopfites, present in the lower bench of this coal bed, is absent from the upper bench. This genus seems to have a propensity for occurring in the lower segments of some coal beds.

Because no unbenched samples of the No. 6 Block coal bed were available for study, the two benches were

TABLE 54.—*Palynomorphs from the No. 6 Block coal bed, upper bench, in West Virginia*

[Maceration series 687; USGS Paleobotanical loc. No. D6565; 250 specimens counted; +, present but not observed in count]

Taxon	687 (percent)
Apiculatisporites sp	+
Calamospora breviradiata Kosanke	0.8
Cirratriradites annuliformis Kosanke and Brokaw	+
Crassispora sp	.8
Laevigatosporites globosus Schemel	5.2
L. medius Kosanke	.8
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	13.2
L. ovalis Kosanke	3.2
L. punctatus Kosanke	8.0
Leiotriletes sp	.4
Lycospora granulata Kosanke Kosanke	6.4
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	1.2
L. punctata	6.4
L. spp	32.0
Monoletes sp	+
Punctatisporites obliquus Kosanke	.4
P. spp	1.2
Raistrickia crinita Kosanke	+
R. sp	.4
Torispora securis Balme	12.4
Thymospora pseudothiessenii (Kosanke) Wilson and Venkatachala	6.0
Triquitrites crassus Kosanke	+
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	+
Monosaccate	.8
Unassigned	.4
	100.0

DESCRIPTION OF MATERIAL IN MACERATION
685, 55.8 cm coal.

combined with the following genera that are numerically significant:

Florinites	3.2 percent
Laevigatosporites	31.9
Lycospora	27.4
Thymospora	14.0
Torispora	6.6
	83.1 percent

These percentages appear to be compatible with those of the Lower Kittanning coal bed in that overall *Laevigatosporites* and *Lycospora* are the most abundant taxa and of nearly equal abundance. Published analyses of the palynomorph content of the Lower Kittanning coal bed by Habib in Pennsylvania (1966) and by Gray in Ohio and Pennsylvania (1967) are similar to the content of the No. 6 Block coal bed. Also, there is similarity with the palynomorph content of the Princess No. 6 coal bed of northeastern Kentucky (Kosanke, 1973).

A carbonaceous shale sample and a coal sample were collected from different localities northwest of Mammoth, Kanawha County, and assigned to the 544 and 802 maceration series, respectively. These samples and two others to be discussed subsequently were thought initially, by Arndt Arndt in Englund and others (1979), to possibly be related to the Upper Freeport coal bed. Arndt (oral commun., 1983) considered these stratigraphic units equivalent to the No. 6 Block coal bed or younger. Both the carbonaceous shale, maceration 544, and the coal, maceration 802 yielded reasonably abundant assemblages, which were poorly preserved. These two assemblages are similar with some differences in abundance that might be related to sample lithology. The numerically important genera of these two samples are:

	544	802
Laevigatosporites	18.0	24.8 percent
Lycospora	51.2	67.6
Torispora	23.6	2.8
	92.8	95.2 percent

TABLE 55.—*Palynomorphs from a carbonaceous shale 0.8 km northwest of Mammoth, West Virginia*

[Maceration series 544; USGS Paleobotanical loc. No. D6519; 250 specimens counted; +, present but not observed in count

Taxon	544 (percent)
Alatisporites sp	+
Calamospora sp	0.8
Cirratriradites annuliformis Kosanke and Brokaw	.8
Crassispora kosankei (Potonié and Kremp) Bjaradwaj	3.6
Densosporites sp	+
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	+
Granulatisporites sp	.4
Laevigatosporites desmoinensis (Wilson and Coe) Schopf, Wilson, and Bentall	.4
L. globosus Schemel	8.4
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	3.2
L. ovalis Kosanke	2.4
L. punctatus Kosanke	3.6
Lycospora granulata Kosanke	3.6
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	.4
L. punctata Kosanke	7.2
L. spp	40.4
Punctatisporites sp	.4
Raistrickia cf. *R. crinita* Kosanke	.4
R. sp	+
Spackmanites(?)	+
Thymospora pseudothiessenii (Kosanke) Wilson and Venkatachala	+
Torispora securis Balme	23.6
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	.4
Wilsonites sp	+
	100.0

DESCRIPTION OF MATERIAL IN MACERATION

544, 22.5 cm carbonaceous shale.

Lycospora is not abundant in the lower and upper benches of the Upper No. 5 Block coal bed or in the lower bench of the No. 6 Block coal bed previously discussed. *Lycospora* increased sharply in abundance in the upper bench of the No. 6 Block coal bed (maceration 687) to 46 percent of the assemblage. The palynomorphs identified from macerations 544 and 802 are given in tables 55 and 56.

A sample taken from a thin unnamed coal bed that occurs about 30 m above the Upper No. 5 Block coal on the Left Fork of Kelley's Creek in Kanawha County, W. Va. was assigned to maceration 449. Preservation is better in this sample than in either the 544 or 802 maceration series. The numerically important genera of the 449 maceration series are:

Camptotriletes	8.4 percent
Laevigatosporites	25.2
Lycospora	43.6
	77.2 percent

The presence of *Camptotriletes* at the rate of 8.4 percent suggests there is a difference between the coals of the 544 and 449 maceration series. Also, the presence of *Triquitrites* in 449 at the rate of more than 4 percent further points to the difference. The identified taxa and abundance are given in table 57.

A second sample of coal from this unnamed coal bed together with roof and seat rock samples were collected from the same general locality as the 449 maceration series. This locality is stop 20C of Englund and others (1979). These samples were assigned to macerations 681-A-C as shown in table 58. Abundant palynomorphs were recovered from maceration 681-A and B. *Lycospora* and *Laevigatosporites* are the most abundant genera in the coal sample 681-B as shown below.

Laevigatosporites	32.0 percent
Lycospora	50.5
	82.5 percent

Camptotriletes is present in both the roof and coal samples, and there is a similarity between macerations 449 and 681. The identified taxa and their abundance are given in table 58.

TABLE 56.—*Palynomorphs from an unnamed coal bed 2.5 km northwest of Mammoth, West Virginia*

[Maceration series 502; USGS Paleobotanical loc. No. D6743; 250 specimens counted; +, present but not observed in count]

Taxon	802 (percent)
Calamospora breviradiata Kosanke	+
Cirratriradites annuliformis Kosanke and Brokaw	.4
C. sp	.8
Crassispora kosankei (Potonié and Kremp) Bharadwaj	1.6
Densosporites sp.	+
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.4
Granulatisporites sp	.8
Laevigatosporites globosus Schemel	7.2
L. latus Kosanke	+
L. medius Kosanke	2.0
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	6.0
L. ovalis Kosanke	3.6
L. punctatus Kosanke	6.0
Lycospora granulata Kosanke	8.8
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	2.0
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	2.0
L. punctata Kosanke	18.4
L. spp	36.4
Punctatisporites sp	.4
Raistrickia cf. *R. crinita* Kosanke	.4
R. sp	+
Thynospora pseudothiessenii (Kosanke) Wilson and Venkatachala	+
Torispora securis Balme	2.8
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	+
	100.0

DESCRIPTION OF MATERIAL IN MACERATION

802 20.3 cm coal.

The palynological assemblages suggest the unnamed coal beds are stratigraphically younger than the No. 6 Block coal bed.

PALYNOMORPHS RANGE ZONES AND ABUNDANCE STUDIES OF THE COAL BEDS AND ADJACENT STRATA OF THE MIDDLE PENNSYLVANIAN SERIES

Figure 4 illustrates the known occurrences of selected taxa from the Kanawha Formation and the Charleston Sandstone of the Middle Pennsylvanian Series of the proposed Pennsylvanian System Stratotype of West Virginia. *Stenozonotriletes bracteolus* (Butterworth and Williams) Smith and Butterworth (pl. 1, fig. 7), *Schulzospora rara* Kosanke (pl. 2, fig. 8), and *Procoronaspora* sp. 1 (pl. 1, fig. 3) are restricted to the lower part of the Kanawha Formation. *Laevigatosporites minutus* (Ibrahim) Schopf, Wilson, and Bentall (pl. 2, fig. 11) and *L. medius* Kosanke occur first in the Gilbert(?) coal bed near the base of the Kanawha Formation (fig. 1). *Laevigatosporites* sp. 1 (pl. 2, figs. 13,14) originiates within the Eagle coal bed, and *Pityosporites westphalensis* Williams (pl. 3, figs. 5–7) is found first in the Eagle "A" coal bed. Starting with the Chilton(?) coal bed and continuing throughout the Kanawha Formation and the Charleston Sandstone, a number of taxa appear to originate. *Laevigatosporites globosus* Schemel (pl. 2, fig. 12), *L. punctatus*, Kosanke, *Radiizonates faunas* (Ibrahim) Smith and Butterworth (pl. 1, figs. 11,12), *Zosterosporites triangularis* Kosanke (pl. 1, figs. 9,10), *Torispora securis* Balme (pl. 2, fig. 18; pl. 3, figs. 1–4), *Thymospora pseudothiesseni* (Kosanke) Wilson and Venkatachala (pl. 2, fig. 17), and *Schopfites* cf. *S. dimorphus* Kosanke (pl. 1, figs. 1,2) are especially valuable in correlation studies.

The periodic abundance of *Densosporites* spp. in the Douglas(?), lower bench of the Powellton(?), Cedar Grove, and Winifrede(?) coal beds and the corresponding

TABLE 57.—*Palynomorphs from an unnamed coal bed just south of Slabcamp Hollow, West Virginia*

[Maceration series 449; USGS Paleobotanical loc. No. D6566; 250 specimens counted]

Taxon	449 (percent)
Calamospora pedata Kosanke	0.4
C. sp	2.4
Camptotriletes cf. *C. bucculentus* (Loose) Potonié and Kremp	8.4
Convolutispora sp	.8
Crassispora kosankei (Potonié and Kremp) Bharadwaj	2.4
Cyclogranisporites multigranus Smith and Butterworth	.4
C. sp	.4
Endosporites zonalis (Loose) Knox	.4
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	2.0
Granulatisporites sp	2.0
Laevigatosporites globosus Schemel	3.6
L. latus Kosanke	.8
L. medius	.8
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	12.4
L. ovalis Kosanke	6.0
L. punctatus Kosanke	1.6
Leiotriletes sp	1.2
Lycospora granulata Kosanke	6.4
L. micropapillata (Wilson and Coe) Schopf, Wilson, and Bentall	2.4
L. pellucida (Wicher) Schopf, Wilson, and Bentall—*L. pseudoannulata* Kosanke	1.2
L. punctata Kosanke	6.4
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	.4
L. spp	26.8
Microreticulatisporites sulcatus (Wilson and Kosanke) Smith and Butterworth	.4
Punctatisporites sp	.4
Raistrickia sp	+
Thymospora pseudothiessenii (Kosanke) Wilson and Venkatachala	1.6
Torispora securis Balme	1.2
Triquitrites pulvinatus Kosanke	3.2
T. sp	1.2
Verrucosisporites sp.	.4
Vestispora fenestrata (Kosanke and Brokaw) Spode in Smith and Butterworth	1.2
Monosaccate	.8
	100.0

DESCRIPTION OF MATERIAL IN MACERATION

449 13.9 cm coal.

diminution of *Lycospora* is important because *Densosporites* is thought to be related to herbaceous lycopod plants. Thus, at these intervals of the Kanawha Formation, the dominant arborescent lycopod plants, as typified by the palynomorph genus *Lycospora*, are largely replaced by a herbaceous flora. Chaloner Chaloner 1958b(1958b) described a small heterosporous lycopod cone from a plant compression from the Upper Carboniferous of Scotland under the name of *Selaginellites canonbiensis*. The microspores were assignable to *Densosporites* and were similar to *D. loricatus*. Subsequently, Bharadwaj (1958) reinvestigated the heterosporous lycopsid cone *Porostrobus zeilleri* Nothorst and assigned the microspores to *Densosporites*.

Leisman 1970) described *Sporangiostrobus kansanensis* from Kansas and Iowa coal balls. *S. kansanensis* is bisporangiate according to Leisman, and "the microspores are of the densospore type and extremely variable." Courvoisier and Phillips (1975), in a study of spores contained in fructifications and dispersed spores, compared the microspores of *Sporangiostrobus kansanensis* Leisman to the dispersed spore *Radiizonates difformis* (Kosanke) Staplin and Jansonius. Courvoisier

TABLE 58.—*Palynomorphs from an umnamed coal bed, stop 20C of Englund and others (1979), 1.3 km northwest of Ward, West Virginia*

[Maceration series 681; USGS Paleobotanical loc. No. D6567; 400 specimens counted; +, present but not observed in count

Taxon	681-A	681-B	681-C
	(percent)		
Calamospora hartungiana Schopf in Schopf, Wilson, and Bentall	0.5	--	--
C. sp	.5	--	--
Camptotriletes cf. *C. bucculentus* (Loose) Potonié and Kremp	2.0	0.5	--
Cirratriradites annuliformis Kosanke and Brokaw	1.5	2.0	--
Convolutispora sp	1.0	+	--
Crassispora kosankei (Potonié and Kremp) Bharadwaj	7.0	+	--
Florinites antiquus Schopf in Schopf, Wilson, and Bentall	.5	2.5	--
F. millotti Butterworth and Williams	--	+	--
Granulatisporites verrucosus (Wilson and Coe) Schopf, Wilson, and Bentall	.5	1.5	--
Laevigatosporites crassus Peppers	.5	--	--
L. desmoinensis (Wilson and Coe) Schopf, Wilson. and Bentall	--	1.0	--
L. globosus Schemel	6.5	2.5	--
L. latus Kosanke	--	1.0	--
L. medius Kosanke	2.0	3.5	--
L. minutus (Ibrahim) Schopf, Wilson, and Bentall	5.5	18.0	--
L. ovalis Kosanke	2.5	5.0	--
L. punctatus Kosanke	4.0	1.0	--
L. vulgaris (Ibrahim) Alpern and Doubinger	--	+	--
Leiotriletes sp	--	.5	--
Lycospora brevijuga Kosanke	--	1.5	--
L. granulata Kosanke	--	5.0	--
L. punctata Kosanke	13.5	9.0	--
L. pusilla (Ibrahim) Schopf, Wilson, and Bentall	4.5	--	--
L. subjunga Bhardwaj	3.5	10.0	--
L. spp	34.5	25.0	+
Punctatisporites obliquus Kosanke	--	3.5	--
Raistrickia sp	--	+	--
Thymospora cf. *T. Pseudothiessenii* (Kosanke) Wilson and Venkatachala	--	2.5	--
Torispora securis Balme	6.0	2.0	--
Trihyphaecites triangularis Peppers	+	--	--
Triquitrites cf. *T. crassus* Peppers	--	1.0	--
T. sp	2.0	.5	--
Monosaccate	--	1.0	--
Unassigned	2.5	--	--
	100.0	100.0	

DESCRIPTION OF MATERIAL IN MACERATIONS
681-A, 15.2 cm roof rock.
681-B, 26.6 cm coal, impure at top.
681-C, 15.5 cm seat rock.

and Phillips (1975) questionably assigned specimen 116 of *Sporangiostrobus kansanensis* to the Greenbush Coal Member of the Spoon Formation of Illinois. Leisman (1970) thought that *S. kansanensis*, because of its size, was borne on an arborescent plant or alternatively for various reasons was "indicative of a plant of small stature rather than an arborescent plant like *Lepidodendron*." Phillips and others (1983) considered the parent plants of *Radiizonates* to be herbaceous.

The unnamed coal bed, maceration series 674, in the lower part of the Kanawha Formation, figure 2, contains a dominance of *Endosporites globiformis* (Ibrahim) Schopf, Wilson, and Bentall. Chaloner (1953, 1958a) associated this palynomorph with heterosporous, arborescent lycopods. However, DiMichele and others (1979) reported on permineralized specimens of *Polysporia* contained specimens of *E. globiformis* (Ibrahim) Schopf, Wilson, and Bentall. They believed *Polysporia* was a herbaceous lycopod and that "the existence of such a low vegetation in the late Des Moinesian suggests that late Pennsylvanian wetlands from which *Endosporites*-rich coals were derived may have

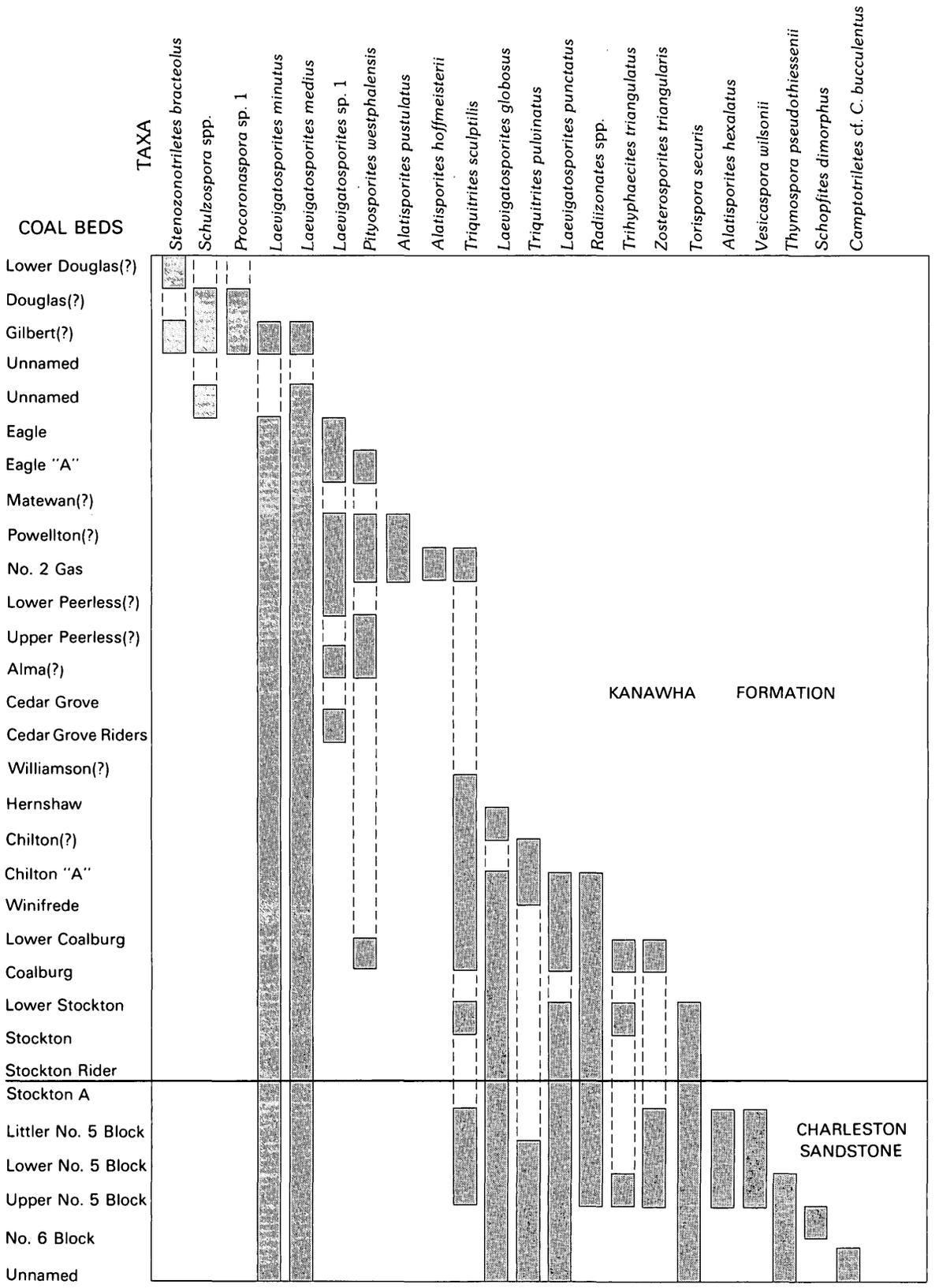

FIGURE 4.—Range zones of selected taxa occurring in coal beds of the Kanawha Formation and Charleston Sandstone of the proposed Pennsylvanian System stratotype of West Virginia. The range zones of palynomorph taxa together with abundance ratios of certain taxa are useful in correlation studies of coal beds.

been largely marshes in contrast to tree fern forests which generally characterize the Missourian of the Illinois Basin."

The presence of *Endosporites globiformis* (Ibrahim) Schopf, Wilson, and Bentall (pl. 2, fig. 10) in this unnamed coal bed together with periodic abundance of *Densosporites* in several coal beds in the Kanawha Formation suggests an alternation of the coal-swamp environment containing abundant arborescent plants with the marshlandherbaceous environment.

Near the top of the Kanawha Formation in the upper bench of the Coalburg coal bed, *Radiizonates* spp. dominates the palynomorph assemblages as shown in table 37. If *Sporangiostrobus kansanensis* Leisman, with spores similar to *Radiizonates difformis* (Kosanke) Staplin and Jansonius is herbaceous as suggested by Phillips and others Phillips and others (1983), the upper bench of the Coalberg coal bed may been formed under a marshland environment.

Lycospora is the most abundant palynomorph taxon in the Lower Stockton, Stockton, and Stockton Rider(?) coal beds, just below the Kanawha Charleston boundary, and through the Stockton "A" coal bed at the base of the Charleston Sandstone. *Laevigatosporites* dominates the palynomorph assemblages of the Block coal beds as shown in figure 5 except for the upper bench of the No. 6 Block coal bed and the unnamed coals above the No. 6 Block coal bed. In these beds *Lycospora* is the dominant palynomorph. Gray (1967) reported on the palynomorph content the Lawrence, Lower Kittanning, Strasburg, and Middle Kittanning coal beds of western Pennsylvanian and eastern Ohio. He found *Schopfites* in the Lower Kittanning through the Middle Kittanning coal beds, and he also noted that *Lycospora* and *Laevigatosporites* were the two most abundant taxa in these beds.

Habib (1966), in a detailed study of the palynomorphs of the Lower Kittanning coal bed of western Pennsylvania, described two new genera and a number of new species. He recognized *Schopfites* regularly although he indicated this taxon was not abundant. He recognized differences in palynomorph assemblages where the coal bed was overlain directly by marine facies as contrasted to where the coal bed was overlain by freshwater facies.

I have examined a series of coal samples from western Pennsylvania that include the interval of the Lower Kittanning though the Upper Freeport coal beds. These generally follow the established pattern of *Schopfites* and *Thymospora* in the Lower Kittanning coal bed with *Lycospora* and *Laevigatosporites* dominating the palynomorph assemblages. Also, *Crassispora*, with the typical equatorial thickening rather than the distal thickening of the spore coat of *Cappasporites*, is modestly abundant in the samples of the Upper Freeport coal bed. Peppers (1970) reported a modest abundance of *Crassispora* in both the Jamestown and Allenby coals, which occur between the Herrin No. 6 and the Danville No. 7 Coal Member in the upper part of the Carbondale Formation of Illinios. Peppers and others (1983) transferred some palynomorphs previously assigned to *Crassispora* to *Cappasporites*.

The palynomorph assemblages of the coal beds of the Charleston Sandstone are dominated by *Lycospora* and *Laevigatosporites* as shown in figure 5. In addition, *Torispora securis* Balme, *Alatisporites hexalatus* Kosanke, *Vesicaspora wilsonii* (Schemel) Wilson and Venkatachala, *Thymospora psendothiessenii* (Kosanke) Wilson and Venkatachala, *Schopfites dimorphus* Kosanke, *Spackmanites facierugosus* Habib, *Camptotrilets* cf. *C. bucculentus* (Loose) Potonié and Kremp and others are useful in correlation studies.

Kosanke (1950) indicated a significant change in palynomorph assemblages in Illinois between the Reynoldsburg and the Willis-Tarter coal beds. This change is maked by the termination of *Schulzospora* by the time of Reynoldsburg coal bed and an abundance of *Radiizonates* in the Willis-Tarter coal bed. In the proposed Pennsylvanian System stratotype of West Virginia, the last occurrence of *Schulzospora* is in an unnamed coal bed below the Eagle coal bed and the first occurrence of *Radiizonates* is in the Chilton "A" coal bed well above the Eagle coal bed. This interval, the extinction of *Schulzospora* and the first occurrence of *Radiizonates*, is significantly longer in the Appalachians than in the Illinois Basin and contains many more coal beds. This interesting facet of this investigation should be explored in much greater detail subsequently.

CONCLUSIONS

The palynomorph content of the coal beds and adjacent strata of the Middle Pennsylvanian Series of the proposed Pennsylvanian System stratotype in West Virginia was investigated in detail. The coal beds of the Kanawha Formation are generally dominated by palynomorphs assignable to *Lycospora* and *Laevigatosporites* with periodic dominance of *Densosporites*, *Endosporites*, or *Radiizonates*. This suggests that, during the Kanawha Formation, the normal, basically arborescent swamp vegetation was replaced periodically by a marshlike environment characterized by an abundance of herbaceous plants, the parent plants of *Densosporites*, *Endosporites*, and *Radiizonates*.

At the base of the Kanawha Formation, *Laevigatosporites* represents less than 5 percent of the palynomorph assemblage, but continues to become

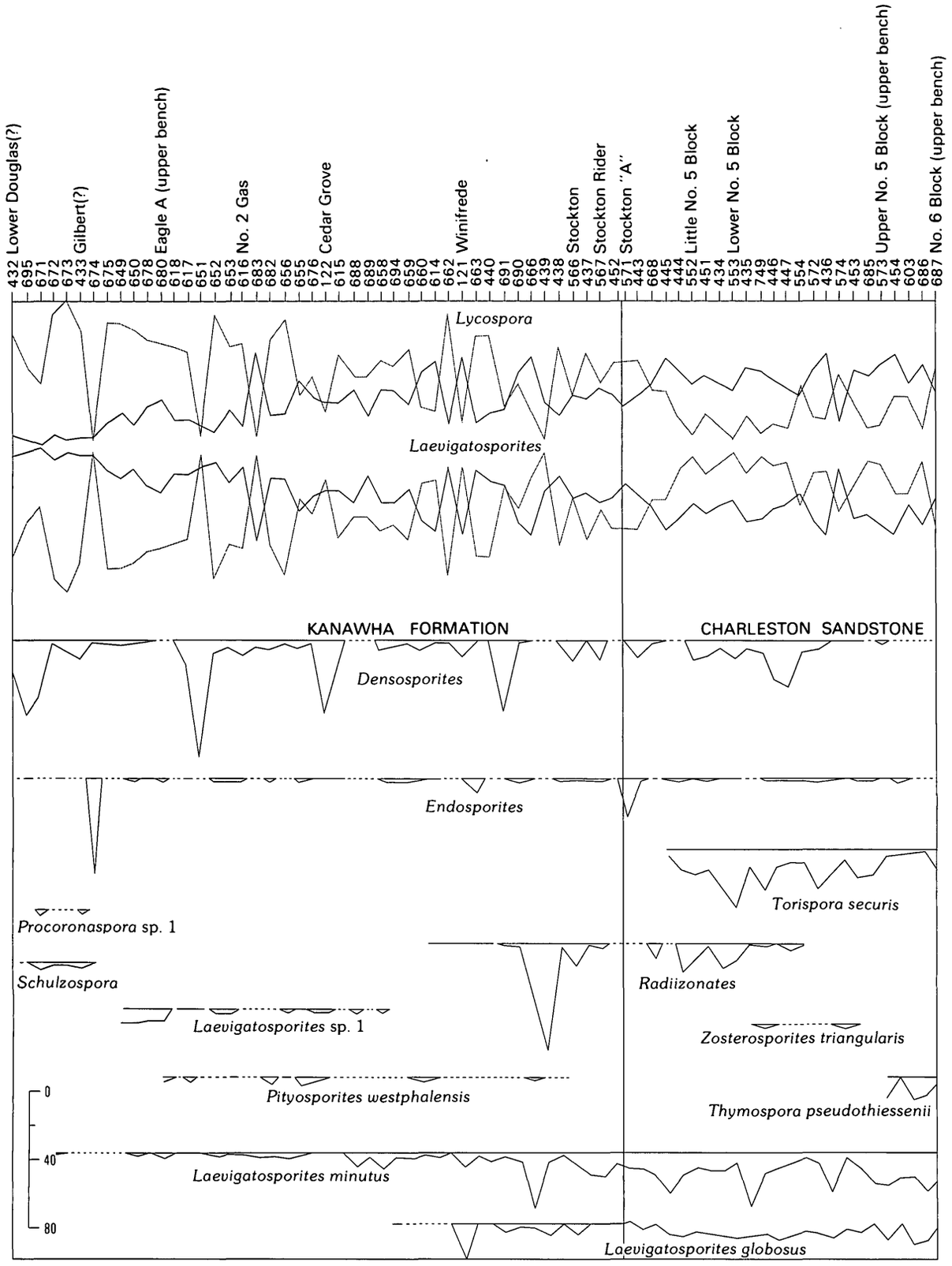

FIGURE 5.—Abundance of selected taxa occurring in coal beds of the Kanawha Formation and Charleston Sandstone of West Virginia. The names of the coal beds and maceration numbers are shown to the left. *Lycospora* and *Laevigatosporites* are the two dominant palynomorph genera of the Kanawha Formation. This is shown by the bimodal abundance curves for these two genera. In addition, *Endosporites* also interrupts the dominance of *Lycospora* and *Laevigatosporites* in the first unnamed coal bed above the Gilbert coal bed near the base of the Kanawha Formation. *Laevigatosporites* becomes the dominant taxon in the basal part of the Charleston Sandstone, but *Lycospora* becomes more abundant in the upper part of the Charleston Sandstone. The periodic abundance of *Densosporites*, *Endosporites*, and *Radiizonates* clearly indicates an interruption of the dominance of arborescent plants by herbaceous plants.

increasingly more abundant in the younger coal beds, dominating the lower part of the Charleston Sandstone. In the Little, Lower, and Upper No. 5 Block coal beds, and even the lower bench of the No. 6 Block coal bed, *Laevigatosporites* dominates the assemblage. In the upper bench of the No. 6 Block coal bed and in the unnamed coal beds above, *Lycospora* clearly is the dominant taxon.

There are a number of taxa that apparently originated and became exinct during the Middle Pennsylvanian Series of the stratotype. These are depicted in figures 4 and 5. In addition, there are new taxa that are listed in the tables as unassigned or in some cases just as species. In all cases these are not abundant, but conceivably could prove important for correlation purposes if they ultimately proved to be consistently present.

The Middle Pennsylvanian Series of the proposed stratotype contains numerous coal beds and is more complete than some corresponding sections elsewhere in the United States. The stratotype constitutes the standard for the Pennsylvanian System. As far as palynomorphs are concerned, they were readily extracted from coal beds with more or less conventional methods for the Middle Pennsylvanian Series, although at times the preservation of some of the taxa was poorer than desired. This was true of most of the seat and roof rock samples. Hopefully the findings will prove of value in establishing a standard for the Middle Pennsylvanian Series.

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PLATES 1-3

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PLATE 1

Figures 1-2. *Schopfites* cf. *S. dimorphus* Kosanke

1. D6115, maceration 603, single grain mount slide 1, 116.5×12.0, equatorial view, maximum diameter 84 microns and negative number 4012.
2. D6619, Lower Kittanning coal bed, Pennsylvania, maceration 550-B, slide 3, 98.9×20.0, equatorial view, maximum diameter 98 microns and negative number 3306.

Figure 3. *Procoronaspora* sp. 1, D6553, maceration 671-B, slide 2, 115.3×20.4, proximal view, maximum diameter 33 microns and negative number 4752.

Figure 4. *Procoronaspora* sp. 2, D6530, maceration 671-B, slide 7, 118.6×17.9, oblique proximal view, maximum diameter 34 microns and negative number 4783.

Figure 5. *Spackmanites* sp. 1, D6520, maceration 674, slide 8, 108.4×20.7, proximal view, maximum diameter 43 microns and negative number 4817.

Figure 6. *Camptotriletes* cf. *C. bucculentus* (Loose) Potonie and Kremp, D6566, maceration 449, slide 1, 102.6×21.0, proximal view, maximum diameter 44 microns and negative number 4758.

Figure 7. *Stenozonotriletes bracteolus* (Butterworth and Williams) Smith and Butterworth, D6033, maceration 433-A, slide 1, 97.9×3.1, proximal view, maximum diameter 44 microns and negative number 4291.

Figure 8. *Stenozonotriletes* sp. 1, D6522, maceration 682-B, slide 5, 114.5×14.1, proximal view, maximum diameter 29 microns and negative number 3837.

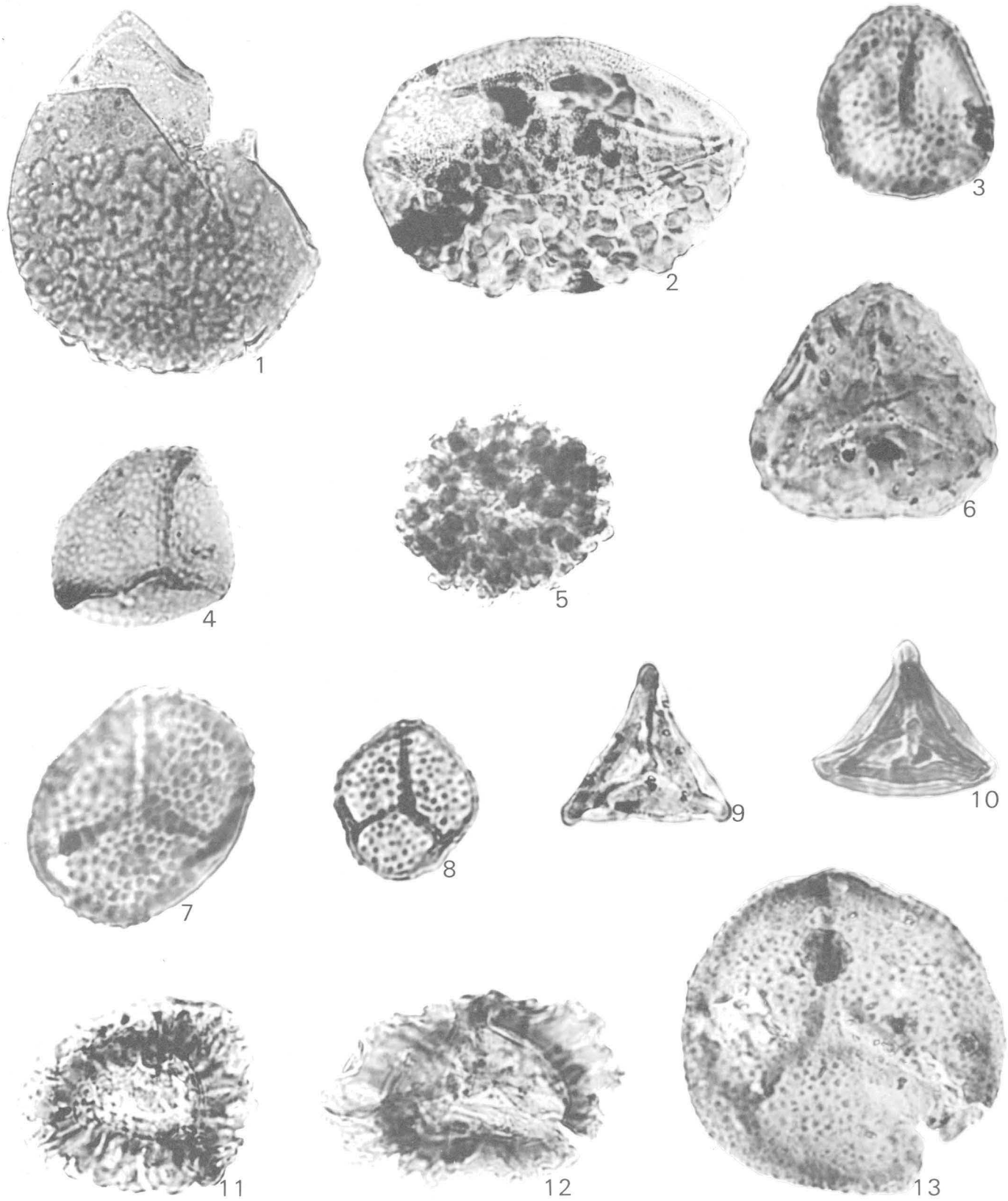
Figures 9-10. *Zosterosporites triangularis* Kosanke

9. D6113, maceration 574B, slide 3, 102.2×6.6, proximal view, maximum diameter 31 microns and negative number 4813.
10. D6398, maceration 666-A, slide 3, 106.4×13.6, proximal view, maximum diameter 28 microns and negative number 4064.

Figures 11-12. *Radiizonates faunus* (Ibrahim) Smith and Butterworth

11. D6576, maceration 567-B, slide 2, 116.3×3.0, proximodistal view, maximum diameter 44 microns and negative number 4811.
12. D6398, maceration 666-L, slide 2, 114.3×3.3, proximodistal view, maximum diameter 58 microns and negative number 4114.

Figure 13. *Cappasporites distortus* Urban, D6528, maceration 650-E, slide 1, proximal view, maximum diameter 58 microns and negative number 4402.



SCHOPFITES, PROCORONASPORA, SPACKMANITES, CAMPTOTRILETES, STENOZONOTRILETES, ZOSTEROSPORITES, RADIIZONATES, AND *CAPPASPORITES*

PLATE 2

Figure 1. *Lycospora micropapillata* (Wilson and Coe) Schopf, Wilson, and Bentall, D6050, maceration 571-B, slide 1, 100.9×20.7, distal view, maximum diameter 20 microns and negative number 4774.

Figure 2. *Lycospora pusilla* (Ibrahim) Schopf, Wilson, and Bentall, D6050, maceration 571-C, slide 1, 105.0×11.7, proximal view, maximum diameter 27 microns and negative number 4024.

Figure 3. *Lycospora* sp. 1, D6404, maceration number 678-B, slide 3, 115.7×8.3, proximal view, maximum diameter 38 microns and negative number 4136.

Figure 4. *Lycospora* sp. 2, D6403, maceration 680, slide 4, 103.2×22.9, proximal view, maximum diameter 40 microns and negative number 3941.

Figure 5. *Lycospora* sp. 3, D6529, maceration 652-C, slide 4, 114.4×3.7, proximodistal view, maximum diameter 33 microns and negative number 4411.

Figure 6. *Lycospora* sp. 4, D6531, maceration 653-D, slide 3, 118.8×6.2, proximal view, maximum diameter 29 microns and negative number 4424.

Figure 7. *Lycospora* sp. 5, D6541, maceration 690-Err, slide 1, 119.8×22.3 proximal view, maximum diameter 28 microns and negative number 4308. The letter designation rr following maceration number of letter indicates the sample has been rerun.

Figure 8. *Schulzospora rara* Kosanke, D6620, Lower Pennsylvanian black fissle shale, eastern Kentucky, maceration 23, slide 4, 99.5×23.3, proximal view, maximum diameter 87 microns and negative number 3213.

Figure 9. *Hymenospora*(?) sp. 1, D6234, maceration 616-B, slide 1, 120.5×3.7, proximal view, maximum diameter 50 microns and negative number 4201.

Figure 10. *Endosporites globiformis* (Ibrahim) Schopf, Wilson, and Bentall, D6050, maceration 571-A, slide 2, 104.7×13.7, proximal view, maximum diameter 84 microns and negative number 4045.

Figure 11. *Laevigatosporites minutus* (Ibrahim) Schopf, Wilson, and Bentall, D6523, maceration 676-D, slide 11, 120.3×12.6, oblique proximal view, maximum diameter 27 microns and negative number 4807.

Figure 12. *Laevigatosporites globosus* Schemel, D6621, maceration 450-B, slide 7, 113.3×8.8, oblique proximal view, maximum diameter 28 microns and negative number 4805.

Figure 13. *Laevigatosporites* sp. 1, D6403, maceration 680, slide 4, 119.5×17.0, oblique proximal view, maximum diameter 28 microns and negative number 3831.

Figure 14. *Laevigatosporites* sp. 1, D6401, maceration 649-E, slide 4, 114.4×5.6, nearly proximal view, maximum diameter 31 microns and negative number 3873.

Figure 15. *Laevigatosporites striatus* Alpern, D6397, maceration 615-A, slide 2, 104.7×11.7, nearly proximal view, maximum diameter 57 microns and negative number 4197.

Figure 16. *Laevigatosporites* sp. 2, D6401, maceration 649-E, slide 1, 105.2×9.4, equatorial view, maximum diameter 44 microns and negative number 4132.

Figure 17. *Thymospora pseudothiessenii* (Kosanke) Wilson and Venkatachala, D6517, maceration 686, slide 7, 106.5×15.4, oblique proximal view, maximum diameter 32 microns and negative number 4103.

Figure 18. *Torispora securis* Balme, D6111, maceration 435-Crr, slide 4, 104.2×3.7, proximal view, maximum diameter 47 microns and negative number 4803. The letter designation rr following maceration number of letter indicates the sample has been rerun.

LYCOSPORA, *SCHULZOSPORA*, *HYMENOSPORA*(?), *ENDOSPORITES*, *LAEVIGATOSPORITES*, *THYMOSPORA*, AND *TORISPORA*

PLATE 3

Figures 1-3. *Torispora securis* Balme

1. D6111, maceration 435-C, slide 3, 102.0×19.2, proximal view, maximum diameter 47 microns and negative number 4800.
2. D6621, maceration 450-B, slide 1, 111.1×20.5 oblique proximal view, maximum diameter 34 microns and negative number 4804.
3. D6111, maceration 435-C, slide 1, 117.6×4.9, oblique proximal view, maximum diameter 44 microns and negative number 4801.

Figure 4. Unassigned trilete spore with distal thickening, D6110, maceration 553-B, slide 5, 101.0×15.3, equatorial view, maximum diameter 55 microns and negative number 4261.

Figures 5-7. *Pityosporites westphalensis* Williams

5. D6523, maceration 676-D, slide 2, 121.3×5.1 oblique equatorial view, maximum diameter 58 microns and negative number 3883.
6. D6523, maceration 676-D, slide 10, 112.9×15.6, distal view, maximum diameter 42 microns and negative number 4808.
7. D6532, maceration 655-D, slide 1, 111.9×6.0, equatorial view, maximum diameter 65 microns and negative number 3875.

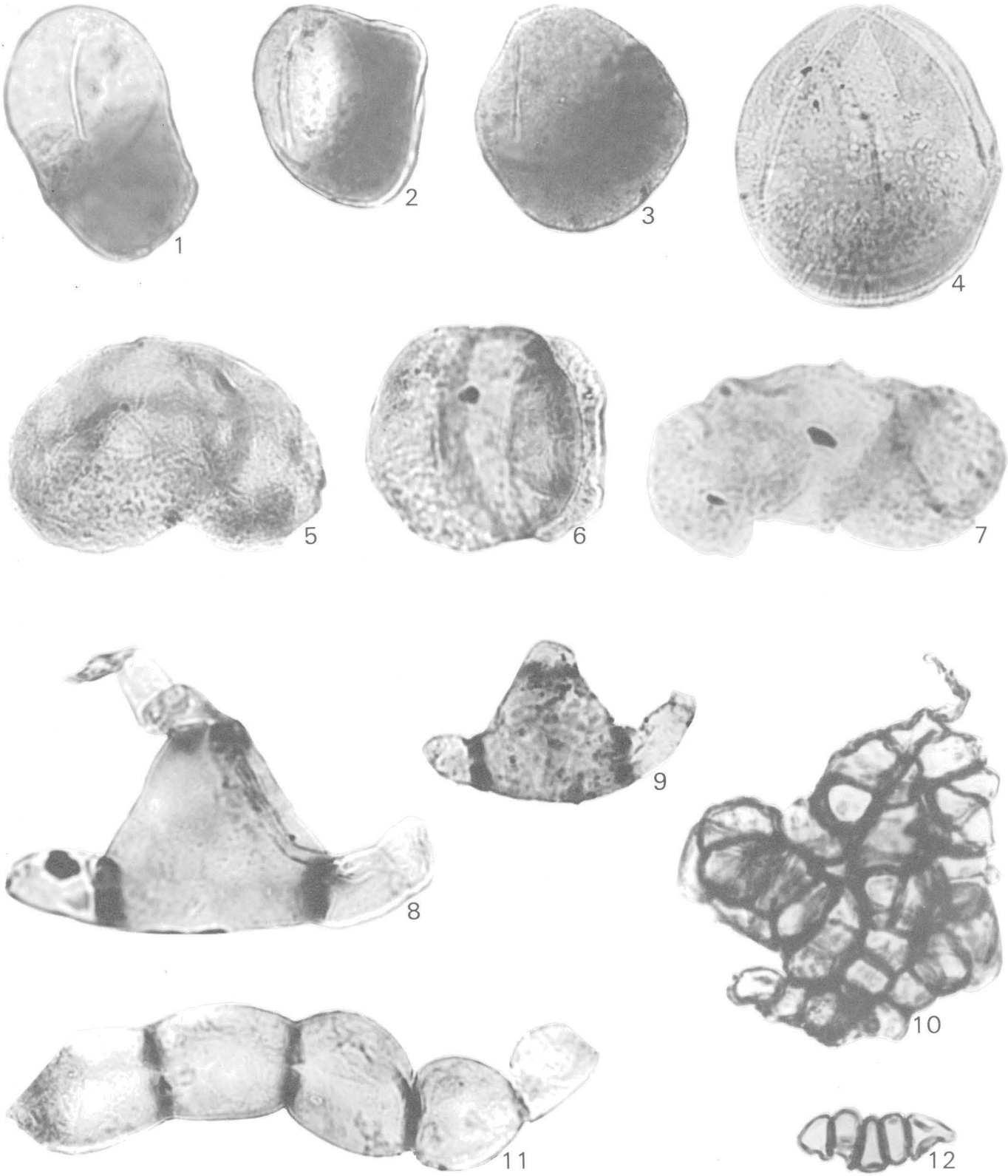
Figures 8-9. *Trihyphaecites triangularis* Peppers

8. D6567, maceration 681-A, slide 1, 104.5×3.3, maximum overall diameter 78 microns and negative number 4549.
9. D6113, maceration 574-A, slide 2, 98.8×10.2, maximum overall diameter 49 microns and negative number 4329.

Figure 10. Fungal cells D6033, maceration 433-C, slide 2, 106.8×12.3, dimensions 77X64 microns and negative number 4738.

Figure 11. Septate fungal hyphae D6050, maceration 571-A, slide 3, 108.53.3, overall length 168 microns and negative number 4781.

Figure 12. Fungal cells, D6530, maceration 651-C, slide 1, 110.5×13.6, length 30 microns and negative number 4755.



TORISPORA, TRILETE SPORE, *PITYOSPORITES*, *TRIHYPHAECITES*, FUNGAL CELLS, AND FUNGAL HYPHAE