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Palynological correlation of the Lewisport Coal Bed (early Desmoinesian) and equivalent coals in the Illinois Basin

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ABSTRACT

Palynological correlation of the Lewisport coal bed and equivalent coal seams in the lower half of the Middle Pennsylvanian (early Desmoinesian) indicates that the coal is more widespread than previously thought. A total of 46 genera and 124 species of spores were identified from 32 sample sites of the Lewisport coal and equivalent coals. The spore assemblages are diverse and are generally dominated by *Lycospora granulata* or *Laevigatosporites globosus*, while *Florinites mediapudens, Punctatosporites minutus, Granasporites medius,* and *Laevigatosporites ovalis* are of secondary importance.

The Lewisport coal, which is in the upper part of the Tradewater Formation of Illinois and Kentucky and the Staunton Formation in Indiana, extends from the eastern part of western Kentucky, where it has been extensively mined, into Indiana and southern Illinois. It is correlated with the Mining City, Western Kentucky (No. 4), Curlew, Cates, Mannington, and Dawson Springs coal beds in western Kentucky, the Buffaloville Coal Member in Indiana, and the O'Nan Coal Bed in southern Illinois. The Lewisport coal is overlain by a fossiliferous marine limestone, here called the Mannington Limestone Member, that has been incorrectly identified as the Curlew Limestone in western Kentucky; the Curlew actually underlies the Lewisport coal. The coal below the Curlew Limestone in western Kentucky is the Empire coal bed in western Kentucky and is equivalent to the Rock Island (No. 1) Coal Member of Illinois and the Minshall Coal

Member in Indiana. The limestone overlying the Buffaloville Coal, which has been incorrectly identified as the Perth Limestone Member, is equivalent to the limestone overlying the Lewisport coal.

Palynological study of subsurface samples in Illinois shows that the Lewisport coal is overlain by a limestone that is younger than the Seville Limestone Member and older than the Mitchellsville Limestone. The Lewisport coal is younger than the Oldtown Coal Bed of southern Illinois, which is equivalent to the Rock Island Coal of the northwestern part of the Illinois Basin, and is older than the Delwood Coal Bed of southern Illinois.

I recommend that the name "Lewisport coal bed" be used for that coal and correlative coals in the Illinois Basin and that the overlying limestone should be called the Mannington Limestone Member.

INTRODUCTION

The Lewisport coal bed and equivalent coals occur in the upper half of the Tradewater Formation in Illinois and Kentucky and in the lower part of the Staunton Formation in Indiana. They are early Desmoinesian (early Westphalian D) in age (Fig. 1), older than the Delwood Coal Bed and younger than the Rock Island (No. 1) Coal Member in Illinois and equivalent coal seams in other parts of the Illinois Basin. Through studies of spore assemblages from many localities in the Illinois Basin (Table 1), it has become apparent that the Lewisport coal is more widespread than earlier thought, extending from western Kentucky into Indiana and southern Illinois. The purpose of this report is to correlate by use of palynology the Lewisport, Western Kentucky (No. 4), Curlew, Mining City, Mannington, Cates, and Dawson Springs coal beds in Kentucky, the

Buffaloville Coal Member in Indiana, and the O'Nan Coal Bed in Illinois. A review of previous correlations of these coal beds is presented following the Introduction.

The Lewisport and equivalent coals are up to 52 inches thick in western Kentucky where they have been mined extensively. Coal reserves of the Dawson Springs coal in the upper Tradewater River area were reported by Hodgson (1963). Coal reserves of the Mining City coal in several counties in the southeastern part of the western Kentucky Coal Field were reported by Mullins and others (1963). The Lewisport and equivalent coals are the fourth most important coal seam in western Kentucky with an average annual production between 1980 and 1990 of 1.5 million tons (Greb and others, 1992). It underlies at least 70 percent of the coal field, and an isopach map of the coal (Greb and others 1992) indicates that it extends without major discontinuities up to at least the Ohio River, which borders Indiana and Illinois. The coal extends northward, as the Buffaloville Coal, into Spencer County (Hutchison, 1959), Dubois County (Hutchison, 1964), and at least as far north as Daviess County (Hutchison, 1971). The extent of the Lewisport coal has not been mapped in southern Illinois because it has not been identified in many places. This may be due to scarcity of outcrops and subsurface records in that part of the Pennsylvanian, cutouts by overlying sandstones, or patchy deposition of the coal in Illinois.

The Lewisport coal is overlain by the fossiliferous Mannington Limestone at almost all the sites sampled. This limestone, which has been commonly referred to as the Curlew Limestone, has been used as a key bed for making correlations in western Kentucky. The true Curlew Limestone and Lead Creek Limestones are below the

Mannington Limestone and Lewisport coal. As these three limestones have a somewhat similar appearance, they have been misidentified at times, which has lead to miscorrelation of coal seams in that part of the stratigraphic sequence.

Samples of the Lewisport and equivalent coals were collected from 32 sites (Fig. 2, Table 1) mostly in the 1970s. Samples were obtained from surface mines, two spoil piles, outcrops, diamond-drill cores, and rotary-drill cuttings from 15 different counties in Illinois, Kentucky, and Indiana, over an area of about 8,000 square miles. Rotary-drill cuttings of coal seams were recovered by coal geologists during drilling between 1942 and 1944 under G. H. Cady's supervision. Coal samples were macerated according to the technique described by Kosanke (1950) and Peppers (1964, 1970) for Illinois Basin coals. The extent of chemical treatment of samples varied because the sources and degree of weathering varied widely. The number of prepared slides of macerated residues that were examined depended on the diversity of the spore assemblages. Additional slides were examined until an entire slide was examined without observing a species that had not been previously observed. At total of 200 or 300 spores were identified for the counts to determine the relative abundance of spore taxa in each maceration.

Correlations are based mainly on chronostratigraphic ranges of diagnostic taxa. Many of the stratigraphic ranges of spore species in the Illinois Basin were presented in Peppers (1984). Relative abundance of spore genera and species were also useful in a general way because of major differences in spore abundances between the Lewisport coal and overlying and underlying coal seams. Where coal seams are present above or below the Lewisport coal at the same site their palynological identifications were used to

confirm the correlations. Since this study is part of a larger study of the palynology of coal seams in the Tradewater Formation in the Illinois Basin, I was able to compare palynological data from the Lewisport coal with data from other coals in the formation. Palynological analyses of coal macerations of the Lewisport coal are given in Table 2.

The use of formal names of coals and whether the words "coal" or "coal bed" are capitalized varies among the three states in which the Illinois Basin occurs. The Illinois State Geological Survey (Kosanke and others, 1960) and the Indiana Geological Survey (Shaver and others, 1986) assigned the rank of Member to coals for which type sections have been designated. The rank of minor coals, for example the Reynoldsburg has been reduced to that of a bed because some of them are of very local extent (Nelson and others, 1991). The names are considered proper nouns, therefore, "Coal Bed" is capitalized. The Kentucky and U.S. Geological Surveys designate all coals in Kentucky as coal beds because they consider them informal names. Many of the coal seams do not have formally designated type sections. In the present paper, the names of all coals are either capitalized or not capitalized depending on the practices of the state in which the coal occurs. The name "Lewisport coal bed" is used throughout this paper, however, since it or its correlatives occur throughout the Illinois Basin.

HISTORICAL REVIEW

Owen (1855), who was the first to report in detail on Pennsylvanian rocks in the Illinois Basin, diagrammed a composite geologic column in a report on the geology of the southeastern part of Gallatin County, Illinois, to the stockholders of the Saline Coal and Manufacturing Company. The rocks are best exposed along the Ohio River in Union County, Kentucky, where he indicated that the 4-foot coal with 2 clay partings, named

the Curlew coal, occurs 25 feet above the Curlew limestone. In the following year he placed the position of the Curlew Coal between the 5th and 6th coal from the top of his stratigraphic section in Union County. Owen (1857) then referred to the coal as the "No. 4 coal" and described it as being 15 feet above the Curlew limestone and about 15 feet below the Curlew sandstone. Glenn (1912), who reported on coal beds in the region of the Tradewater River in Kentucky, reproduced Owen's geologic column including the No. 4 coal. Glenn found only a carbonaceous layer near where there was said to be a mine opening into the coal. According to him, the underlying Curlew limestone is represented only by a nodular limestone layer that he thought might be equivalent to a nodular limestone farther east, which overlies a 2-foot-thick coal. Lee (1916) reported that the No. 4 coal is only 3 inches thick at Owen's section and that the underlying Curlew Limestone, whose type section is on Indian Hill, occurs in several benches. Indian Hill is the only place in the Shawneetown Quadrangle where he found the coal.

Kosanke and others (1960) proposed the name O'Nan Coal Member for a coal in southeastern Illinois that they considered correlative with the Curlew coal in western Kentucky. The name of the coal was changed in order to avoid having the name Curlew for both the limestone and coal. The name was derived from Dennis O'Nan Ditch near Indian Hill, Union County, Kentucky. According to Hopkins and Simon (1975) the O'Nan Coal occurs at scattered sites in southern Illinois, but no well documented occurrences of the O'Nan Coal in Illinois has been published. A limestone has been reported at several localities in southern Illinois to be the Curlew Limestone, but the limestone or limestones may actually be younger or older than the Curlew. As a result

coal beds that overlie this limestone might have been mistakenly interpreted to be the O'Nan Coal.

The Dawson Springs (No. 4) Coal (Glenn, 1912) is 46 to 52 inches thick and is overlain by 40 to 45 feet of gray shale, where it is mined near Dawson Springs, Hopkins County, Kentucky. A hard, bluish, fossiliferous limestone that overlies the shale is 2 to 3 feet thick and contains chert nodules. A coarse sandstone, which Crider (1914) thought corresponds to the Curlew sandstone of Owen, overlies the limestone. Glenn (1912) reported the presence of up to 100 feet of sandstone in the vicinity of Dawson Springs, but Crider (1914) noted only about 40 feet of sandstone.

The Empire coal bed was named for a coal mined near the town of Empire in Christian County, Kentucky (Glenn, 1912). Crider (1914), who reported on the geology of the Dawson Springs Quadrangle, stated that the Empire is the lowest workable coal seam, except for a "sub-conglomerate coal", that is mined near Empire. The "sub-conglomerate coal" is just above the base of the Pennsylvanian. The Empire coal is overlain by hard gray shale, averages 44 inches in thickness, is clean, and contains little sulfur (Glenn, 1912; Crider, 1914). Note the relationship between a dark gray shale roof and low-sulfur coal. A band of channel coal was reported in at least one mine. According to Crider, the Empire coal is slightly thinner than the Dawson Springs (No. 4) coal near Dawson Springs, Kentucky. A hard, fossiliferous limestone occurs 30 to 45 feet above the coal, and a sandstone 40 to 50 feet thick that Crider (1914) thought may be equivalent to the Curlew sandstone, occurs about 25 feet above the limestone.

Since two coal seams have been mined just west of Empire, there was some uncertainty about which one had been called Empire coal. In the Whittington pit (Table

1), the lower coal (maceration 2175 A-B) is about 35 feet below the upper one, and I correlate it with the Rock Island Coal of Illinois based on unpublished palynological data. The upper, thinner coal (maceration 2175-C, Table 2) is correlated with the Lewisport coal and is discussed later. Both coals are overlain by fossiliferous limestones. Glenn (1912) reported the presence of a coal up to 3 feet thick about 37 feet above the Empire coal at the old Empire shaft. He thought that the upper coal is equivalent to a 3-foot coal about 50 feet above the lower coal mined at Mannington. Samples of the Empire coal that were chemically analyzed as reported by Crider (1914) came from a depth of 100 feet in shaft mines of the area. This depth supports identification of the lower coal as the Empire. Williams and others (1982) also considered the Empire coal to be older than the Mannington and western Kentucky (No. 4) coals. They called the limestone that overlies the Empire coal, the Empire Limestone, and the Curlew Limestone was shown as overlying the Mannington coal.

The name Mannington coal bed was used (Crider, 1915b) for the coal approximately 4 feet thick that is mined near the town of Mannington, about 4 miles north-northeast of Empire. Glenn (1912, p. 60) stated that the fossiliferous limestone called the Mannington limestone is exposed in the road about 35 feet above the coal mined at the Terry Mine. This limestone is the one incorrectly mapped as the Curlew Limestone above the western Kentucky No. 4 coal (Kehn, 1977). Thus, I am calling the limestone that overlies the Mannington, Lewisport and correlatives coal seams, the Mannington Limestone Member. Examination of this and other exposures of the limestone should be made before final designation is made, and a type section is selected.

The Cates coal bed was named for a coal mined by S. F. Cates north of Gray's Branch, about ¼ mile west of the Red Hill-White Plains Road in Christian County Kentucky (Crider, 1915b). Although the Cates coal is palynologically correlated with the Lewisport coal and Dawson Springs coal, some coal seams that have been called Cates coal are actually older. For example, a coal identified as the Cates along the Green River Parkway at mile posts 25.5 and 28.5 in the Morgantown Quadrangle (Gildersleeve, 1972), Butler County, Kentucky, has a palynological assemblage that is older than the assemblage in the Lewisport coal (unpublished data).

The Mining City coal bed, named by Crider (1915a) is mined in the vicinity of Mining City and along Green River in Butler County. Wanless (1939) stated that it is about 30 feet above the Curlew Limestone.

The Lewisport coal was named for a coal mined 1.5 miles from the Ohio River near the town of Lewisport, Hancock County, in the northern part of the western Kentucky coal field (Owen, 1856, p. 181). Since this is the first known published name for this coal seam, I am designating the coal and its correlative coals, the Lewisport coal bed. Locally the Lewisport coal was called the "Red Ash coal" because it usually produced a red ash when it was burned (Crider, 1913). Chisholm (1931) and Williams and others (1982) called the limestone over the Lewisport coal, the Lewisport Limestone, but neither designated a type section.

The Buffaloville coal was named by Franklin and Wanless (1944) for a coal mined in NE NW, sec. 9, T.5S., R.5W. at Buffaloville, Spencer County, Indiana; however, the mine was not formally designated as the type section. Its name was formalized to Buffaloville Coal Member by Shaver and others (1970). In the Buffaloville area the coal is up to a

little over 4 feet thick and is overlain by about 1 foot of shale and 2 feet of argillaceous, fossiliferous, marine limestone. In their illustration of the stratigraphic section, Franklin and Wanless (1944) indicated that the Buffaloville Coal overlies the Curlew Limestone. Hutchison (1959) and Shaver and others (1986) concluded that the coal is equivalent to the Minshall Coal Member, which is below the Curlew Limestone (now called Perth Limestone Member in Indiana).

Previous Correlations of the Lewisport Coal and Equivalent Coals

Wanless (1939) correlated the Curlew coal with the Mining City coal (Fig. 3) and concluded that they are above the Curlew Limestone, which is equivalent to the Seville Limestone Member in Illinois and the Minshall Limestone Member (now called Perth Limestone Member) in Indiana (Fig. 1). He interpreted the Dawson Springs coal as older than the Curlew Limestone and equivalent to the Mannington, Empire, Topmiller, Dunbar, and Smith coal beds in western Kentucky and perhaps the Murphysboro Coal Bed in Illinois. It is now known that the Dunbar and Smith coals are older, and that the Murphysboro Coal is younger than the Dawson Springs coal (Peppers and Popp, 1979). Wanless (1939) also correlated the Lewisport coal with the Stonefort Coal (now called Wise Ridge Coal Member). Crider (1914) and McFarland (1943) correlated the Dawson Springs coal with the Empire coal. In their illustration of the stratigraphic section containing the Buffaloville Coal, Franklin and Wanless (1944) indicated that in southern Indiana the coal overlies the Curlew Limestone and is equivalent to Coal II of Price (1899a, b). Hutchinson (1959) and Shaver and others (1986) interpreted the Buffaloville Coal as equivalent to the Minshall Coal Member and older than the Curlew Limestone.

According to Shaver and others (1986), the limestone overlying the Lewisport coal in northwestern Kentucky is either correlative with or older than the Curlew Limestone.

Kosanke and others (1960) correlated the Mining City coal with the No. 4 coal of western Kentucky, Indiana Coal II (name discontinued; Shaver and others, 1970) and the O'Nan Coal in southeastern Illinois (Fig. 3), all younger than the Curlew Limestone and equivalents. However, they considered the Cates, Mannington, and Empire coals (from youngest to oldest) to be older than the Curlew Limestone.

Kehn and others (1967) stated that the coal mined near Dawson Springs had been called the Dawson Springs No. 6 coal bed because it was thought that the coal correlated with the Davis No. 6 coal near the Ohio River. They changed the number of the Dawson Springs coal to the No. 4 coal because it is now known that the Dawson Springs coal is older than the Davis coal. Since the No. 5 coal of Owen had been replaced by the No. 6 or Davis coal by Lee (1916), Kehn and others (1967) substituted the No. 5 coal for Owen's No. 4 coal above the Curlew Limestone. The coal below the Curlew Limestone near the Ohio River was designated the No. 4 coal and was correlated by Kehn and others (1967) with the Dawson Springs coal because they thought that it underlies the Curlew Limestone farther to the east. However, Kehn (1974) later designated the coal above the Curlew Limestone in the Dekoven and Saline Mines Quadrangles as the "No. 4 or Curlew coal bed of Owen (1857)" and the coal below the limestone as the No. 4 coal bed and "the same as the No. 4 coal in the Providence Quadrangle (Kehn, 1966)."

The No. 4 coal was correlated with the Rock Island Coal of Illinois by Rice and others (1979). Williams and others (1982), in their stratigraphic framework of coal-

bearing strata in western Kentucky, correlated the Mannington coal with the No. 4 and Mining City coals of Western Kentucky, which they thought lay beneath the Curlew Limestone. They did not mention the Dawson Springs coal. They also tentatively correlated the Mining City coal with the Lewisport coal. Williams and others (1982), using geophysical logs, correlated the limestone overlying the Mannington coal with the Curlew Limestone in diamond-drill core Gil 15, about a mile from the type section of the Curlew Limestone (Fig. 2h).

Peppers and Popp (1979) erroneously considered the Curlew Limestone to be younger than the Seville and Perth Limestones. Unpublished palynological studies had revealed that the Mining City and Dawson Springs coals are younger than the Rock Island (No. 1) and Minshall Coals. Since the Curlew Limestone was mapped by the U.S. and Kentucky Geological Surveys as overlying the Mining City and Dawson Springs coals, I assumed that the Curlew Limestone must also be younger than the Seville Limestone, which overlies the Rock Island Coal. No coal directly underlies the Curlew Limestone at its type section, but diamond drill hole Gil 15 (Williams and others 1982) less than a mile away contains a coal at 392 feet, about 10 feet below the Curlew Limestone. Palynological analysis of the coal indicates that it is equivalent to the Rock Island Coal (Peppers, in preparation). Another coal in the same core about 30 feet above the Curlew Limestone is correlated with the Lewisport coal and is discussed later. Shepard (1980) studied the sedimentology of the sequence between the Mannington coal (Dawson Springs) and the overlying limestone, which was thought to be the Curlew Limestone in Hopkins and Christian Counties, Kentucky. He suggested that the limestone overlying the Mannington coal might be equivalent to an upper bed of the Curlew Limestone at its

type section. Hodgson (1963) in his report on coal reserves of the Dawson Springs coal indicated that the coal is overlain by the Curlew Limestone. The No. 4 coal was also incorrectly shown to lie below the Curlew Limestone in several geologic quadrangle maps in western Kentucky prepared by the U.S. Geological Survey including the Dekoven and Saline Mines, Dalton, Providence, Cromwell, Saint Charles, Morgantown, South Hill, Shady Grove, and Greenville Quadrangles. Gildersleeve (1972, 1975) also correlated the No. 4 coal in the Morgantown and Cromwell Quadrangles with the Dunbar and Topmiller coals, which are below the Dunbar Limestone and older than the Rock Island Coal (Fig. 1). In the Morgantown Quadrangle, the No. 4 coal is shown as occurring 20 feet below a "Marker coal bed" that underlies the Curlew Limestone. The Mining City coal and the overlying limestone were thought to be about 80 feet above the Curlew Limestone.

Several studies of fusulinids in the Curlew Limestone and in younger and older limestones have a bearing on the correlation of the Lewisport coal in the Illinois Basin. The presence of ***Fusulinella iowensis*** in the type section of the Curlew Limestone confirmed to Thompson and Riggs (1959) that it is nearly the same age as the Seville Limestone. Douglass (1979) stated that the Curlew Limestone at its type section contains an Atokan fusulinid fauna known from the Seville Limestone in Illinois and the Perth Limestone in Indiana. Douglass (1987) identified ***Beedeina leei*** in a limestone about 15 feet above the No. 4 coal at several outcrops and drill holes, and noted that since the ***B. leei*** zone is younger than the Curlew Limestone, the limestone above the No. 4 coal must be younger than the Curlew Limestone. Douglass (1987) thought the limestone might correlate with a limestone in Illinois incorrectly identified as the "Curlew Limestone in

Saline County" (now called Mitchellsville Limestone) or the Creal Springs Limestone. Thompson and Shaver (1964) accepted, with reservation, the correlation by the Indiana Geological Survey of the limestone over the Buffaloville Coal with the Perth Limestone; however, they obtained no information from their fusulinid and ostracod studies that supported that conclusion. Guennel believed that similar spore assemblages occur in the Buffaloville and Minshall Coals (personal communication in Shaver and others, 1970).

Glenn (1912) described the Curlew Limestone at its type section, which he established, as consisting of two limestone beds separated by 15 feet of shale. Other exposures nearby reveal a third limestone about 60 feet above the bottom limestone (Greb and others, 1992). The name Curlew Limestone has since been applied to the lowest, most persistent limestone. Williams and others (1982) named the upper limestone of Glenn the Beulah Limestone and correlated it with a limestone above the Mannington Limestone that overlies the Lewisport coal.

PALYNOLOGY OF COAL BEDS

Western Kentucky

Dawson Springs Coal

The Dawson Springs coal was sampled at four sites east and northwest of Dawson Springs, Hopkins County (Table 1): maceration 1788 A-D from an outcrop about 1 mile to the northwest (Fig. 2a), macerations 1268 Y and 1861 from 2 cores drilled 4 miles to the east, and maceration 1268 X from a strip mine 5 miles to the east of Dawson Springs (Fig. 2a).

The coal of macerations 1788 A-D is overlain by 25 feet of medium gray shale and siltstone, which in turn is overlain by dense fossiliferous limestone. The coal, which was sampled by Tom Kehn (formerly U. S. Geological Survey), was divided into three main benches (each 15 inches thick) and a 4-inch top bench of shaley coal (Fig. 4). The bottom bench (maceration 1788 A, Table 2a) is dominated by *Lycospora,* which is divided between *L. granulata* (21 percent), *L. pellucida* (20 percent), and *L. micropapillata* (12 percent). *Laevigatosporites globosus, Laevigatosporites ovalis* and *L. desmoinesensis*, (grouped together because the two species are similar except for size) *Calamospora breviradiata,* and *Florinites mediapudens* are almost equally represented, each accounting for 5.7 to 6.7 percent of the spore assemblage. In the middle bench (maceration 1788 B) *Laevigatosporites globosus* (31 percent) and *Florinites mediapudens* (24 percent) are more abundant than *Lycospora* (22 percent). The most abundant species in the upper main bench (maceration 1788 C) is *Florinites mediapudens* (36 percent) followed by *Lycospora granulata* (22 percent),

Laevigatosporites globosus (12 percent), *Laevigatosporites ovalis* and *L. desmoinesensis* (9 percent), and *Granasporites medius* (11 percent). In the shaley coal of the top bench (maceration 1788 D), *Lycospora granulata* is greatly reduced in abundance to 5.5 percent; *F. mediapudens* at 21 percent remains the most abundant species followed closely by *Laevigatosporites ovalis* and *L. desmoinesensis* at 20.5 percent. *L. globosus* is still a significant component (12.5 percent), and *Pilosisporites (Acanthotriletes) aculeolatus*, which is seldom abundant, accounts for 11 percent of the spore assemblage.

Lycospora was most frequently observed in macerations 1268 X and Y (Table 2a), accounting for 42.5 percent and 52.5 percent, respectively. *Laevigatosporites globosus, L. ovalis, Florinites mediapudens, Granasporites medius* and *Calamospora breviradiata* make up most of the rest of the spore assemblages. The coal of maceration 1861 (Fig. 5, Table 2a) probably represents mostly the upper part of the Dawson Springs coal because *Laevigatosporites globosus* (19.5 percent), *L. ovalis* and *L. desmoinesensis* (14 percent), *Florinites mediapudens* (18.5 percent), and *Granasporites medius* (7.5 percent) are abundant, whereas *Lycospora* amounts to only 22.5 percent of the spore population.

A coal seam mined in the vicinity of Empire, Christian County, Kentucky was sampled at six sites (Table 1). At several open-pit mines near Empire, two coal seams were mined; the upper coal is the Dawson Springs (Lewisport coal), and the lower coal is the Empire.

Two coal seams were sampled in 1974 at the Whittington pit about .5 mile northwest of Empire (Fig. 2d). The cut exposed a 32-inch-thick coal seam overlain by 10 to 15 feet of shale and then 6 feet of sandy oolitic limestone. A 14-inch coal in the highwall was about 33 feet above the lower coal. Since the upper coal was at the top of the exposure, the presence of an overlying limestone at that site could not be determined. Palynology of the lower coal or Empire coal (macerations 2175 A-B, unpublished data) indicates that it correlates with the Rock Island (No. 1), Assumption, Litchfield, and Oldtown Coals in Illinois and the Minshall Coal in Indiana. The Empire coal was also mined at the Walker Mine about 2 miles west of Empire (Table 1) and the White Brothers Mine about 2.7 miles west of Empire (Trace, 1977). The limestone bed above the Empire coal, which Greb and others (1992) called the Empire Limestone, should be equivalent to the Curlew Limestone in Kentucky, the Seville Limestone in Illinois, and the Perth Limestone in Indiana.

The Dawson Springs coal (maceration 2175 C, Table 2a, Fig. 5) at the Whittington pit has a diverse spore assemblage that is dominated by ***Laevigatosporites globosus*** (36.5 percent) and ***Lycospora granulata*** (25 percent). ***Punctatosporites minutus*** (7.5 percent), ***Granasporites medius*** (7 percent), ***Punctatisporites minutus*** (6 percent), and ***Laevigatosporites ovalis*** (5 percent) are about equally represented.

At an open pit mine about .5 miles west of Empire and about 1000 feet west of the Whittington pit, a coal 23 inches thick is overlain by about 9 feet of shale and then 8 feet of medium gray argillaceous and very fossiliferous marine limestone. The coal is underlain by a thin underclay and sandy limestone containing water-worn fossils. The

coal (maceration 2176, Table 2a) is palynologically correlated with the Lewisport coal, therefore, the underlying sandy limestone is probably equivalent to the Curlew Limestone that overlies the lower coal in the Whittington pit; the upper limestone is the Mannington Limestone. In the Dawson Springs coal ***Laevigatosporites globosus*** (36.5 percent) is at almost the same abundance as at the Whittington pit, but ***Lycospora granulata*** (19.5 percent) and ***Granasporites medius*** (4 percent) are slightly less abundant (Table 2a). ***Punctatosporites minutus*** (11.5 percent), ***Punctatisporites minutus*** (8 percent), and ***Laevigatosporites ovalis*** (7 percent) are slightly more abundant than in the coal at the Whittington pit.

In the Ligon Mine about 2 miles northwest of Empire (Fig. 2d), an upper 12-inch bench (maceration 1146 A, Table 2a) and a lower 12-inch bench (maceration 1146 B, Table 2a) of the Dawson Springs coal were sampled. The coal is overlain by shale and a fossiliferous limestone. ***Laevigatosporites globosus*** increases in abundance from 29 percent in the lower bench to 41 percent in the upper bench. ***Lycospora granulata*** is more than twice as abundant in the lower bench at 26 percent as in the upper bench, in which it amounts to 11 percent. ***Granasporites medius*** increases slightly from 13 percent in the upper bench to 17 percent in the upper bench. ***Florinites mediapudens*** (8 percent) is a significant constituent in the upper bench, and ***Densosporites sphaerotriangularis*** (7 percent) is limited to the upper half of the coal.

The Dawson Springs and Empire coals were not exposed at the Walker Mine (Old Bell Mine) about 2 miles west of Empire (Fig. 2d), but Robert Trace and Thomas Kehn of the U.S. Geological Survey and others from the Kentucky and Illinois Geological

Surveys collected a large number of pieces of the upper coal from around the site. Trace was mapping the geology of the Dawson Springs Southeast Quadrangle (1977) and had followed the progress of the mine, therefore, he knew the location of the upper and lower seams within the mine. I correlated the lower coal to the Oldtown and Rock Island Coals of Illinois (unpublished). The upper coal, which was correlated to the Lewisport coal, was reported to be 10 feet below a thin-bedded, fossiliferous limestone about 10 feet thick. In maceration 2178 (Table 2a) ***Laevigatasporites globosus*** at 37.5 percent of the spore assemblage, ***Lycospora granulata*** at 14.5 percent and ***Granasporites medius*** at 16.5 percent are at about the same abundance as at the Ligon Mine.

At the White Brothers Mine about 2.5 miles west of Empire (Fig. 2d) the spore assemblage in the Lewisport coal (maceration 1880, Table 2a) is also dominated by ***Laevigatosporites globosus*** and ***Lycospora granulata*** at 41 percent and 17.5 percent, respectively. ***Granasporites medius*** (10 percent), ***Laevigatosporites ovalis*** and ***L. desmoinesensis*** (11 percent), and ***Florinites mediapudens*** (6.5 percent) make up most of the remainder of the spore assemblage.

Lycospora granulata (21 percent) is almost as abundant as ***Laevigatosporites globosus*** (25 percent) in the coal (maceration 2186, Table 2a) at the abandoned Black Gold Mine about 4 miles northwest of Empire (Fig. 2d). ***Punctatosporites minutus*** (14.5 percent) is a significant part of the spore assemblage, and ***Florinites mediapudens*** (8 percent) and ***Granasporites medius*** (6.5 percent) are well represented. Silicified fossil wood occurs in the coal at this location.

Cates Coal Bed

The Cates coal was sampled from an abandoned strip mine .5 miles southwest of Red Hill, Christian County, and about 1 mile south of Cates Mine, which is no longer accessible. The strip mine is also about 4 miles east of Mannington. The coal is 12 inches thick and underlies 4 feet of shale and 2 feet of argillaceous, fossiliferous limestone that had been correlated with the Curlew Limestone (Wanless, 1939, Palmer, 1968). The gray shale between the coal and limestone thickens toward the northwest to about 30 feet in the type area of the Cates coal. *Lycospora granulata* at 28 percent is the most abundant species in the Cates coal (maceration 2252, Fig. 5). *Punctatisporites minutus* at 13.5 percent and *Laevigatosporites globosus* at 12 percent are almost equally represented.

Mining City Coal Bed

Several samples of the coal mined near Mining City were studied. The Mining City coal is correlated with the Lewisport coal, but *Lycospora* is more abundant at the expense of *Laevigatosporites globosus* in the Mining City coal than in the Dawson Springs coal in the Dawson Springs area. For example, the upper 20 inches of coal (maceration 1799, Table 2b) in an outcrop .75 mile northeast of Mining City (Fig. 2e) contains 44 percent *Lycospora granulata* and 15 percent *Laevigatosporites globosus*. *Laevigatosporites ovalis* is third in abundance with 14 percent. In the bottom 10 inches of coal (maceration 54, Table 2b) *Lycospora granulata* is 46 percent of the spore assemblage, whereas *Laevigatosporites globosus* accounts for only 5.5 percent and is less abundant than *L. ovalis* (12 percent), *Florinites mediapudens* (10

percent), ***Granasporites medius*** (9 percent) and ***Calamospora breviradiata*** (6.5 percent).

The Mining City coal at the abandoned Jessup Brothers Mine about 1 mile southwest of Mining City (Fig. 2e) is about 42 inches thick and is overlain by 3 feet of gray, calcareous, fossiliferous shale and 18 inches of argillaceous, fossiliferous limestone. ***Lycospora granulata*** and ***Laevigatosporites globosus*** are the most abundant spores in maceration 2172 C of the Mining City coal (Table 2b, Fig. 5) at 37.5 percent and 30.5 percent, respectively. ***Laevigatosporites ovalis*** and ***Florinites mediapudens*** make up about 7 percent each of the spore assemblage.

The Jessup Brothers Mine is also my reference section for Kentucky No. "4a" and "Marker" coal beds that I sampled in October 1974 with Allen Williamson and John Beard of the Kentucky Geological Survey. The lower coal, which was called the "4a coal" in Peppers and Popp (1979), is 60 feet below the Mining City coal. What was thought to be the "Marker coal," is 25 feet below the Mining City coal. Peppers and Popp correlated the No. 4a coal with the Tarter Coal Member of Illinois and the Lower Block Coal Member of Indiana. Williams and others (1982), however, stated that the physical stratigraphy does not support this correlation. Apparently, the names had been reversed so that the first coal below the Mining City should have been called the No. "4a" and the lower coal the "Marker coal." Regardless of the names, the first coal below the Mining City coal at this site is correlated with the Ice House coal bed of western Kentucky, the Willis Coal Bed of Illinois, and the Upper Block Coal Member of Indiana. The second coal below the Mining City coal is correlated with the Tarter Coal of Illinois and the

Lower Block Coal in Indiana. No coal equivalent to the Empire coal was found between the Mining City coal and the No. "4a" coal.

The Mining City coal southwest of the Green River Bridge at the northwest corner of the Morgantown Quadrangle in Butler County (Fig. 2f) is only 15 inches thick, and the upper part, which is shaley, grades into hard black shale. Maceration 2182 is unusual because it is greatly dominated by *Lycospora granulata* at 62.5 percent. *Laevigatosporites globosus* and *Punctatosporites minutus* are the second and third most abundant species with 16 percent and 8 percent of the spore population, respectively.

Two samples of the Mining City coal were collected along the Green River Parkway in Butler County. The coal (maceration 2184, Table 2b) at mile post 29 (Fig. 2f) is 22 inches thick and is overlain by 6 inches of shale and then 2 benches of argillaceous fossiliferous limestone up to 18 inches thick separated by 2 to 3 feet of gray shale. At mile post 29.5 (Fig. 2f) the coal (maceration 2183) is 36 to 39 inches thick and is overlain by 8 feet of silty gray shale and about 50 feet of sandstone. In maceration 2183 *Lycospora granulata* (45 percent) and *Laevigatosporites globosus* (32 percent) are more abundant than in maceration 2184, which contains 35.5 percent *L. granulata* and 26 percent *L. globosus*. *Granasporites medius*, *Laevigatosporites ovalis* and *Punctatosporites minutus* are relatively more abundant in maceration 2184 (Table 2b, Fig. 4) than in maceration 2183.

Farther to the north in Ohio County and along the Green River Parkway, two coals occur below a cherty fusulinid-bearing limestone. An 18-inch-thick coal is about 3 feet

below the cherty limestone and 10 feet above a 9-inch-thick coal. The lower coal (maceration 2180 A, Fig. 5) is correlated with the Mining City and Lewisport coals, and the upper coal is tentatively correlated with the Bancroft coal bed. The spore assemblage in the Mining City coal is dominated by three taxa that are almost equally represented: ***Laevigatosporites globosus*** (27.5 percent), ***Lycospora granulata*** (23 percent), and ***Granasporites medius*** (20 percent). ***Endosporites globiformis*** with 9 percent is unusually abundant for the Lewisport coal.

Lewisport Coal Bed

The Lewisport coal, which is correlated with the Dawson Springs, Mining City, and Mannington coals was sampled at about 3 miles southeast of Lewisport, Hancock County, Kentucky. The bottom 24-inch-thick bench (maceration 2257 B, Table 2b) has most of its spore population distributed among ***Endosporites globiformis*** at 17 percent, ***Laevigatosporites globosus*** and ***Lycospora granulata*** both at 14.5 percent, ***Laevigatosporites ovalis*** at 12 percent, and ***Florinites mediapudens*** and ***Calamospora breviradiata*** both at 8 percent. The upper 28-inch-thick bench (maceration 2257 C, Table 2b) is greatly dominated by ***Laevigatosporites globosus*** with 56.5 percent of the spore assemblage. Taxa of secondary importance are ***Florinites mediapudens*** (13 percent), ***Lycospora granulata*** (12 percent), and ***Laevigatosporites ovalis*** (8.5 percent).

The Lewisport coal at 1.5 miles east southeast of Knottsville, Daviess County (Fig. 2g), was divided into three 9-inch benches. All three benches are dominated by ***Lycospora granulata*** at about the same relative abundance, which ranges from 39.5 to

44.5 percent (Fig. 5). ***Laevigatosporites globosus*** is less common (17.5 percent) in maceration 2079 A of the lower one-third than in the middle (28 percent) and upper one-third (31.5 percent). ***Punctatosporites minutus*** is well represented at 11 percent in the lower bench and 12.5 percent in the middle bench. ***Florinites mediapudens, Laevigatosporites ovalis***, and *Calamospora breviradiata* make up most of the remainder of the spore assemblages.

Red Ash Coal Bed

The Red Ash coal, which is correlated with the Lewisport coal, was sampled at an abandoned strip mine 1 mile southeast of Knottsville, Daviess County (Fig. 2g). Maceration 2203 has an unusually large percentage (20.5 percent) of ***Florinites mediapudens*** for the Lewisport coal (Table 2c). Other species that are typically abundant in the Lewisport include *Lycospora granulata* (28.5 percent), ***Laevigatosporites globosus*** (16 percent), ***Laevigatosporites ovalis*** and ***L. desmoinesensis*** (11.5 percent), and ***Punctatosporites minutus*** (5.5 percent).

O'Nan Coal Bed

The O'Nan coal (Curlew coal of Owen) was sampled in two benches from its type location at Indiana Hill, Dekoven Quadrangle, Union County, Kentucky (Fig. 2h). The coal is deeply weathered. It occurs about 20 feet above the Curlew Limestone, which has its type section along the southern end of Indian Hill. The coal is 2.5 inches thick and grades upward into 1.5 inches of black coaly shale. ***Lycospora granulata*** dominates the spore assemblage in the upper (maceration 1958 D) and lower half of the coal (maceration 1958 C, Table 2), by 48 percent and 28.5 percent respectively.

Laevigatosporites ovalis and *L. desmoinesensis* are second in abundance with 17.5 percent of the spore assemblage in the lower bench and 16 percent in the upper bench. *Florinites mediapudens* at 13 percent is abundant in the lower bench but amounts to only 4.5 percent in the upper bench.

Williams and others (1982) included in one of their cross-sections diamond drill core Gil 15 drilled in Union County near Indian Hill (Fig. 2h), the type locality of the Curlew Limestone. The Curlew Limestone is at a depth of 373 to 381 feet in the core. A 6-inch-thick coal (maceration 2567 H) at about 342 feet is correlated with the Lewisport coal. Its spore assemblage (Fig. 6) is rather evenly divided among the three most abundant taxa: *Laevigatosporites globosus* (30.5 percent), *Punctatosporites minutus* (24.5 percent), and *Lycospora granulata* (23.5 percent).

Indiana

Buffaloville Coal Member

Guennel (1958) did not include the Buffaloville Coal in his palynological study of the Pottsville coals of Indiana, but he felt that there is little difference in the spore assemblages from the two coals (Shaver and others, 1970). When I visited the Buffaloville area in 1972, no exposures of the coal could be found at the stratigraphic section of the coal described by Franklin and Wanless (1944) in a strip mine about .8 mile northwest of Buffaloville or elsewhere in the immediate area. Numerous pieces of coal were collected from mine spoil piles .5 mile southwest of Buffaloville. Although samples collected from spoil piles are not as reliable as channel samples, they provide the only means at this time of determining the identification of the coal from as close as

possible to the type section. Ashley (1899) reported that the Buffaloville coal, which he designated Coal III, was the only coal extensively mined in the area. Coal IIIa, about 40 feet above Coal III, occasionally gets up to 1 foot in thickness and was opened at only a few places. Franklin and Wanless (1944, geologic section 5) indicated that the Buffaloville Coal at the type section is blocky and overlain by black, sheety shale. A fossiliferous limestone, probably correlative to what is called the Mannington Limestone in this report, is 3.5 feet above the coal.

Palynological analysis of maceration 1951 (Table 2c, Fig. 6) indicates that the Buffaloville Coal is correlative with the Lewisport coal. The spore assemblage is dominated by ***Laevigatosporites globosus*** (48.5 percent) and ***Lycospora granulata*** (15 percent). ***Florinites mediapudens*** (12 percent), ***Laevigatosporites ovalis*** and ***L. desmoinesensis*** (8 percent), ***Granasporites medius*** (5 percent) and ***Punctatosporites minutus*** (4.5 percent) are well represented.

Franklin and Wanless (1944) gave the location of their geologic section 6 containing the Buffaloville Coal, which I sampled, as S½ sec. 19, T.3S., R.5W., southeast of Holland, Du Bois County, in the Whittrock strip pit. The location of the Whittrock Mine was given by Price (1899a) as sec. 25, T.3S., R.6W.; and Hutchison (1964) gave the same location, but spelled it Whitrock. Price (1899a) called the strip mine which Franklin and Wanless described as their geologic section 6, the Frick Mine. Hutchison (1964) did not record a name for the mine called Whittrock by Franklin and Wanless (1944) but indicated that the Frick mines were in the Mariah Hill Coal Member in sec. 17, T.2S., R.5W., northeast of Holland. It is possible that some of these mines changed ownership through time.

The Buffaloville Coal in geologic section 6 is directly overlain by a 3-foot-thick dense, cherty limestone, which is probably the same limestone that overlies the Lewisport coal. About 14 feet above the limestone is another coal, 0 to 4 feet thick, that is also overlain by a fossiliferous limestone. Channel samples of both coals were taken. The upper coal is palynologically correlated to the Delwood Coal of Illinois (Peppers, unpublished data), and the overlying limestone might be equivalent to the Mitchellsville Limestone of Illinois. Hutchison (1964) mapped the coal as an unnamed coal in the Staunton Formation.

As at the type area of the Buffaloville Coal, the spore assemblage of maceration 2204 is dominated by ***Laevigatosporites globosus*** (46.5 percent) (Fig. 6) . ***Lycospora granulata*** makes up 15 percent, and ***Punctatosporites minutus*** accounts for 9 percent of the spore assemblage. ***Laevigatosporites ovalis*** and ***L. desmoinesensis*** (17 percent) is more abundant and ***Florinites mediapudens*** (5.5 percent) is less abundant at the Whitrock mine than at the type area.

A coal in the abandoned Maple Grove Strip Mine in Fountain County is correlated with the Buffaloville and Lewisport coals (Fig. 2). It is up to 30 inches thick but pinches out toward the north end of the pit. It is 25 feet above the Perth Limestone and 20 feet below the coal containing coal balls that has been correlated with the Murphysboro Coal Bed of Illinois (Peppers, 1982). In maceration 2418 A (Table 2) ***Laevigatosporites globosus*** and ***Lycospora granulata*** are almost equally represented with 27 percent and 26 percent, respectively. ***Punctatosporites minutus*** (14 percent),

Punctatisporites minutus (8.5 percent), and *Laevigatosporites ovalis* (8 percent) are also abundant.

Illinois

Lewisport Coal Bed

The Lewisport coal is here correlated with the O'Nan Coal Bed in southern Illinois, mostly in the subsurface. Rotary drill cuttings of a coal seam (maceration 1892 B) at a depth of 1,305 to 1,306 feet in a well in sec. 18, T.4S., R.14W., White County contains a spore assemblage that is very similar to that in the Lewisport coal in western Kentucky. It is about 21 feet below the Delwood Coal and 44 feet above the Rock Island Coal (unpublished data). *Lycospora granulata* is most abundant at 40.5 percent (Table 2c, Fig. 7) and is followed in abundance by *Punctatosporites minutus* (18.5 percent), *Laevigatosporites globosus* (14.5 percent), *Florinites mediapudens* (8 percent), and *Granasporites medius* (5.5 percent).

A core cut in sec. 1, T.8S., R.7E., Saline County (site No. 27, Table 1) contains a 27-inch-thick coal (macerations 1123 H_1-H_3) that can be palynologically correlated with the Lewisport coal. It is about 53 feet below the Delwood Coal; however, since the well was drilled to only a few feet below the Lewisport coal, the occurrence of any lower coal seams is not known. I divided the coal for palynological analysis into 3 benches, each about 9 inches thick. *Lycospora* is the most abundant genus with 58 percent of the spore assemblage in the lower bench (maceration 1123 H_3, Table 2c) and 26.5 percent in the upper bench (maceration 1123 H_1). In the middle bench *Lycospora* accounts for 18 percent, but *Florinites mediapudens* at 26 percent is unusually abundant for the

Lewisport coal. ***Laevigatosporites globosus***, which is a major component of the spore population in the Lewisport coal in western Kentucky, reaches its maximum abundance of 8 percent in the middle bench. Other important taxa in the middle bench are ***Laevigatosporites ovalis*** (9 percent), ***Pilosisporites aculeolatus*** (7 percent), and ***Granasporites medius*** (5 percent). ***Punctatosporites minutus*** (17 percent), ***Florinites mediapudens*** (12 percent), and ***Triquitrites bransonii*** (7.5 percent), which is unusually abundant, are important constituents in the upper bench. In the lower bench ***Florinites mediapudens***, ***Granasporites medius,*** and ***Laevigatosporites ovalis*** each represent 6 to 7 percent of the spore assemblage.

A coal equivalent to the Lewisport coal crops out in sec. 35, T.10S., R.5E., Saline County a few feet above the Murray Bluff Sandstone Member and less than a mile from the type section of the sandstone. Nelson and Lumm (1990) mapped the coal as an unnamed coal in the lower part of the Spoon Formation. ***Laevigatosporites ovalis*** and ***L. desmoinesensis*** at 29.5 percent (Table 2) in maceration 2951 is most abundant and is followed in abundance by ***Laevigatosporites globosus*** (18.5 percent), ***Lycospora granulata*** (9 percent), and ***Punctatisporites minutus*** (6 percent).

A well drilled in sec. 1, T.6S., R.2E., Franklin County, is important in understanding the stratigraphic position of the Lewisport coal in southern Illinois. The Lewisport coal (maceration 1894 F, Table 2c) occurs between 1130 and 1133 feet and is overlain by a limestone at 1125 to 1128 feet, which should correlate with the limestone that overlies the Lewisport coal in western Kentucky. The Murphysboro Coal Bed lies at 1070 to 1075 feet and a coal bed equivalent to the Oldtown and Rock Island Coals at 1178 feet.

Over two-thirds of the Lewisport spore assemblage is made up of ***Lycospora granulata*** (41 percent), ***L. pusilla*** (16 percent), and ***Laevigatosporites globosus*** (14.5 percent).

A diamond-drill core from sec. 16, T.6S., R.1E., Franklin County, contains a coal correlative to the Lewisport coal at a depth of 986.25 to 987.25 feet. A coal correlated with the Rock Island Coal was found at 1,078 feet, and the base of the Murphysboro Coal occurs at 954.5 feet. No limestone bed was encountered above any of these coals. Most of the spores in maceration 548 F (Fig. 6) are rather well distributed between ***Laevigatosporites globosus*** (17.5 percent), ***Punctatosporites minutus*** (17 percent), ***Granasporites medius*** (15 percent), ***Florinites mediapudens*** (13.5 percent), and ***Lycospora granulata*** (13 percent).

A coal between 2 massive sandstones in sec. 18, T.9S., R.2W., Jackson County and west of the subcrop of the Murphysboro Coal (Jacobson, 1983) is correlated to the Lewisport coal. In maceration 1781, ***Lycospora*** is almost equally divided between ***L. pellucida*** and ***L. granulata*** with about 19 percent each (Table 2c). The next most abundant species is ***Florinites mediapudens*** at 15 percent. ***Laevigatosporites*** is well represented by ***L. ovalis*** and ***L. globosus*** with 10 and 9 percent, respectively.

A coal at a depth of 1614 to 1618 feet in a rotary drilled well in sec. 35, T.7N., R.9E., Jasper County, Illinois, is tentatively correlated to the Lewisport coal (maceration 2352 D). It is about 40 feet above the Willis Coal and 125 feet below the Wise Ridge Coal Member. ***Lycospora granulata*** (28.5 percent), ***Laevigatosporites globosus*** (17.5 percent), and ***Punctatisporites minutus*** (15 percent) are the three most abundant species. Taxa that are less well represented are ***Punctatosporites minutus*** (8.5

percent), *Lycospora micropapillata* (8 percent), and *Granasporites medius* (7 percent).

DISCUSSION

Palynological assemblages in the Lewisport coal and equivalent coals are diverse, and a total of 46 genera and 124 species were recorded. Stratigraphic ranges of spore taxa (Peppers, 1984) are important in distinguishing the Lewisport coal from older and younger coals (Fig. 8). *Dictyotriletes bireticulatus, Endosporites zonalis, Simozonotriletes intortus, Vestispora magna, Lophotriletes gibbosus,* and *Quasillinites diversiformis* occur in the Rock Island Coal and its equivalents, but their ranges do not extend as high as the Lewisport coal. Although most are rare, *Lophotriletes copiosus, Anapiculatisporites grundensis, Mooreisporites inusitatus, Vestispora wanlessii,* and *Murospora kosankei* first appear just above the Rock Island (No. 1) Coal and extend above the Delwood Coal. The range of *Thymospora pseudothiessenii* begins at the Rock Island (No. 1) Coal, but only a few specimens have been found in that coal. Although sparse, it is commonly observed in the Lewisport coal. *Peppersites ellipticus* and *Laevigatosporites* cf. *vulgaris*, which is thicker than typical specimens of the species, are frequently present and distinctive. Considerable variation in relative abundance of species occurs in the Lewisport coal from place to place. The spore assemblages are commonly dominated by either *Lycospora granulata* or *Laevigatosporites globosus*, but they may be almost equally represented. Other taxa that are commonly abundant are *Punctatosporites minutus, Florinites mediapudens, Laevigatosporites ovalis, Granasporites medius,* and

Lycospora pellucida; in fact, some of these may dominate at some localities. *Calamospora breviradiata, Endosporites globiformis, Punctatisporites minutus,* and *Pilosisporites aculeolatus* are secondary in importance.

The Rock Island Coal is older than the Lewisport coal, and the Delwood Coal is the major coal that is younger than the Lewisport. The Hermon Coal, which is intermediate in age between the Rock Island and Lewisport coals, and the Bancroft coal, which is intermediate in age between the Lewisport and Delwood Coals, are local in extent. Figure 7 illustrates the relative abundance of the most common spores in the Rock Island, Lewisport and Delwood Coals (macerations 1892 A-C, Table 1) from a well drilled in White County, Illinois. *Punctatisporites minutus, Punctatosporites minutus, Laevigatosporites ovalis*, and *L. globosus* are typically dominant in the Rock Island Coal, whereas *Lycospora* is usually less than 10 percent of the spore assemblage. By contrast, the Delwood Coal is greatly dominated by *Lycospora* and fern spores are not common. The spore assemblages in the Lewisport coal are intermediate in composition with those in the Rock Island and Delwood Coals (Figs. 5 and 6).

The Lewisport coal-forming swamp were co-dominated by arborescent lycopods and marattialean tree ferns. Generally, ferns were a little more abundant than lycopods in most of western Kentucky and in Indiana, but lycopods were more abundant in Illinois. The lycopod *Diaphorodendron (Granasporites medius)* was more abundant than *Sigillaria (Crassispora kosankei)*, which was rare. Sphenopsids *(Calamospora*, large

Laevigatosporites) and cordaites *(Florinites mediapudens)* were sporadically major constituents in the coal swamps.

CONCLUSIONS

Palynology of the Lewisport coal and its correlatives from 32 sample sites in the Illinois Basin indicates that the Lewisport peat and peat beds of equivalent age were deposited over a large area during early Desmoinesian time. The center of peat deposition was in the eastern and northeastern part of western Kentucky where the Lewisport and its correlatives, the Western Kentucky No. 4, Mining City, Cates, Mannington, and Lewisport coals, have been mined for many years. According to Shepard (1980), after cessation of Mannington (Dawson Springs) peat deposition, the swamp was inundated by sediment of a prograding, fluvial-dominated lobate delta that was wave-modified and tide-influenced. He thought that the delta may be part of a large eustatically controlled cyclothem of unknown extent.

The Lewisport coal can be correlated to other coal seams by using stratigraphic ranges of key spores. Also, it can be distinguished from immediately younger and older coals because of differences in composition of the entire spore assemblages.

A coal about 25 feet below the Lewisport coal has been mined in the vicinity of Empire, and there was a question concerning which coal was named the Empire. Williams and others (1982) and I conclude that the lower of the two coals as the Empire. In the western part of western Kentucky, the Curlew (Lewisport) coal was designated the No. 4 coal by Owen (1857) and Glenn (1912); however, Kehn and others (1967), changed

it to the No. 5 coal. The name Curlew coal was changed to O'Nan Coal by Kosanke and others (1960) for the coal of equivalent age in Illinois.

The Lewisport coal extends into southern Indiana as the Buffaloville Coal, which has been miscorrelated with the Minshall Coal. A coal bed of approximately the same age as the Lewisport was identified between the Minshall Coal and a coal equivalent to the Murphysboro Coal in a strip mine in Fountain County, Indiana. The Lewisport coal is correlated with the O'Nan Coal Bed in White, Jasper, Saline, Franklin, and Jackson Counties in southern Illinois.

The limestone overlying the Lewisport coal in western Kentucky has been incorrectly identified as the Curlew Limestone, and the limestone above the Buffaloville Coal in Indiana has been incorrectly correlated with the Perth Limestone. Palynological evidence indicates that the Lewisport and Buffaloville Coals are younger than the Minshall Coal, which underlies the Perth Limestone. Spore analysis of the Lewisport coal, a little above the Curlew Limestone near its type section in Union County, supports this conclusion. In western Kentucky the Curlew Limestone overlies the Empire coal. Curlew Limestone is generally not present in southern Illinois, but where it does occur in the subsurface, it is underlain by the Oldtown Coal Bed, which is equivalent to the Rock Island Coal of the northwestern part of the Illinois Basin. The limestone above the Lewisport coal is older than the Mitchellsville Limestone which overlies the Delwood Coal in southern Illinois. A limestone overlying the Lewisport coal has not been identified in southeastern Illinois (Fig. 1).

I recommend that the name Lewisport coal bed be used for that coal and the Mining City, Mannington, Cates, and Western Kentucky No. 4 in Kentucky, the Buffaloville Coal Member in Indiana, and the O'Nan Coal in Illinois. Further, I suggest naming the limestone overlying the Lewisport and equivalent coals the Mannington Limestone Member based on Glenn's (1912, p. 60) use of the name Mannington Limestone for the limestone in the road cut near the Terry Mine at Mannington. That outcrop and other outcrops of the Mannington Limestone should be examined before a formal type section is designated. The name Empire Limestone should be discontinued because the limestone overlying the Empire coal is here correlated with the Curlew Limestone.

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List of illustrations

Fig. 1

STAGE	SERIES	STAGE	FORMATION	ILLINOIS SOUTHWESTERN MEMBERS AND BEDS	ILLINOIS SOUTHEASTERN MEMBERS AND BEDS	WESTERN KENTUCKY FORMATION	WESTERN KENTUCKY MEMBERS AND BEDS	INDIANA FORMATION	INDIANA MEMBERS AND BEDS	NORTHWESTEN MEMBERS AND BEDS
WESTPHALIAN D	PENNSYLVANIAN	DESMOINESIAN		Murphysboro C.						
				Granger Ss.	Granger Ss.					
				Mitchellsville Ls.						
				New Burnside C.						Brush Creek C.
				Delwood C.	Delwood C.					
				"Golden Sandstone"	Curlew Ss.	TRADEWATER	Curlew Ss.			
				Mannington Ls.			Mannington Ls.		Mannington Ls.	
				Dawson Springs C.	O'Nan Dawson Springs C.		Dawson Springs C. *		Dawson Springs C.	Hermon C
							Curlew Ls.		Perth Ls.	Seville Ls.
WESTPHALIAN C	MIDDLE	ATOKAN	TRADEWATER	Oldtown C.	Oldtown C.		Empire C.	BRAZIL STAUNTON	Minshall C.	Rock Island (No. 1) C.
				Murray Bluff Ss.	Murray Bluff Ss.					
							Ice House C.			
					Willis C.		No. 4a C. *		Upper Block C.	Pope Creek C.
							Marker C.		Lower Block C.	Tarter C.
				Tarter C.			Lead Creek Ls.		Lead Creek Ls.	
							Dunbar C.		Mariah Hill C.	
				Cedar Creek Ss.				MANSFIELD	Mansfield Ss.	Manley C.
					Grindstaff Ss.		Fannie Ss.			
				Ozark Ss.			Smith C.		Blue Creek C.	
				Tunnel Hill C.			Bell C.		St. Meinrad C.	

* Includes W. Ky. No. 4, Mining City, Mannington, Cates, and Lewisport coal beds


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Fig. 2

Figure 3

Wanless 1939		McFarlan 1943		Kosanke et al. 1960		Kehn et al. 1967	Gildersleeve 1972	Rice et al. 1979	
W. Kentucky	Illinois	W. Kentucky	Illinois	W. Kentucky	Illinois	W. Kentucky	W. Kentucky	W. Kentucky	Illinois
			Stonefort ls.		Stonefort Ls.			Unnamed ls.	Stonefort Ls.
Lewisport c. No. 5 c.	Wise Ridge c.	Lewisspprt c.	Wise Ridge c.						
	Mt. Rorah c.	No. 5 c.							
					Creal Spg. Ls.				
Curlew ss.	Vergennes ss. ?	Curlew ss.	Curlew ss.	Curlew Ss.	Gronger Ss.				"Curlew" Ls.
No. 4 c. Mining City c.	Curlew c.	No. 4 c. Mining City c.		No. 4 C. Mining City C.	O'Nan C.	No. 5 c. Curlew L.	Mining City c. No. 4a c.		
		Mannington ls.							
Curlew ls. Lead Creek ls.	Seville ls.	Curlew ls. Lead Creek ls.	Seville ls.	Curlew Ls.	Seville Ls.	Curlew Ls.	Curlew Ls. "Marker" c.	Curlew Ls.	Seville Ls.
Cates c.		Cates c.		Cates C.			Cates c.		
Dunbar c. Mannington c. Empire c.	Rock Is. (No.1) c.	Lead Creek c. Mannington c. Empire c.	Rock Is. (No.1) c.	Mannington C.	New Burnside C. Rock Is. (No.1) C.	No. 4 c. Dawson Sps. c.	No. 4 c. Dunbar c.	No. 4 c.	Rock Is. (No.1) C.
Dawson Sps. c. Smith c.		Dawson Sps. c. Smith c.		Empire C.	Bidwell C.				
				Murray Bluff Ss.				Lead Creek L	
Elm Lick c. Ice House c.	Pope Creek c.	No. 3-Ice House c.		Ice House C.	Pope Creek C. Delwood C.			No. 3 (Ice House c.	Willis C.
Finnie ss.		Finnie ss.		Finnie Ss.	Finnie Ss.				
Bell c.	Willis c.	Bell c.	Willis c.	Bell C. Grindstaff Ss	Willis C. Tarter C. Grindstaff Ss.			Bell c.	Reynoldsburg c.

Peppers and Popp 1979		Williams et al. 1982		Shaver et al. 1986		This Paper	
W. Kentucky	Illinois	W. Kentucky	Illinois	W. Kentucky	Indiana	W. Kentucky	Illinois
	Stonefort Ls. Wise Ridge C. Mt. Rorah C. Creal Spg. Ls. Murphysboro C.		Stonefort Ls.				
Curlew Ss.	Granger Ss. New Bernside C.		"Curlew" Ls.			Curlew Ss.	Granger Ss. New Bernside C. Delwood C.
O'Nan C.	Bidwell C.	Curlew Ls.					
Curlew Ls. No. 4 (Dawson Sps.) Elm Lick C.	Curlew Ls.		Seville Ls.	Curlew Ls.	Perth Ls.	Mannington Ls. Dawson Sps. C	Mannington Ls Dawson Sps. C.
Unnamed Ls.	Seville Ls.						
Empire C.	Rock Is. (No.1) C.	Lewisport c. Mining City c. Mannington c. W. Ky. No. 4 c.	Rock Is. (No.1) C.	Lewisport C.	Minshall C. Buffallowville C.	Empire C.	Rock Is. (No.1) C. Oldtown C.
	Unnamed Ss.	No. "4a" c.					Murray Bluff Ss.
		Lead Creek Ls.					
No. 3 (Ice House) C	Pope Creek C. Willis C.	Dunbar c. Ice House (No3) c.	Willis C			Ice House C. No. "4a" C.	Pope Creek C. Willis C.
No. 4a C.	Tarter C.					Marker C.	Tarter C.
Lead Creek Ls.				Lead Creek Ls.	Lead Creek Ls.	Lead Creek Ls.	
Dunbar C.					Mariah Hill C.	Dunbar C.	
Smith C.						Finnie Ss.	Grindstaff Ss.
Finnie Ss.	Grindstaff Ss.	Finnie Ss.				Smith C.	
No. 1b (Bell) C.	Bell C.	Bell (No. 1b) c.	Reynoldsburg C.			No. 1b (Bell) C.	Bell C. Reynoldsburg C.

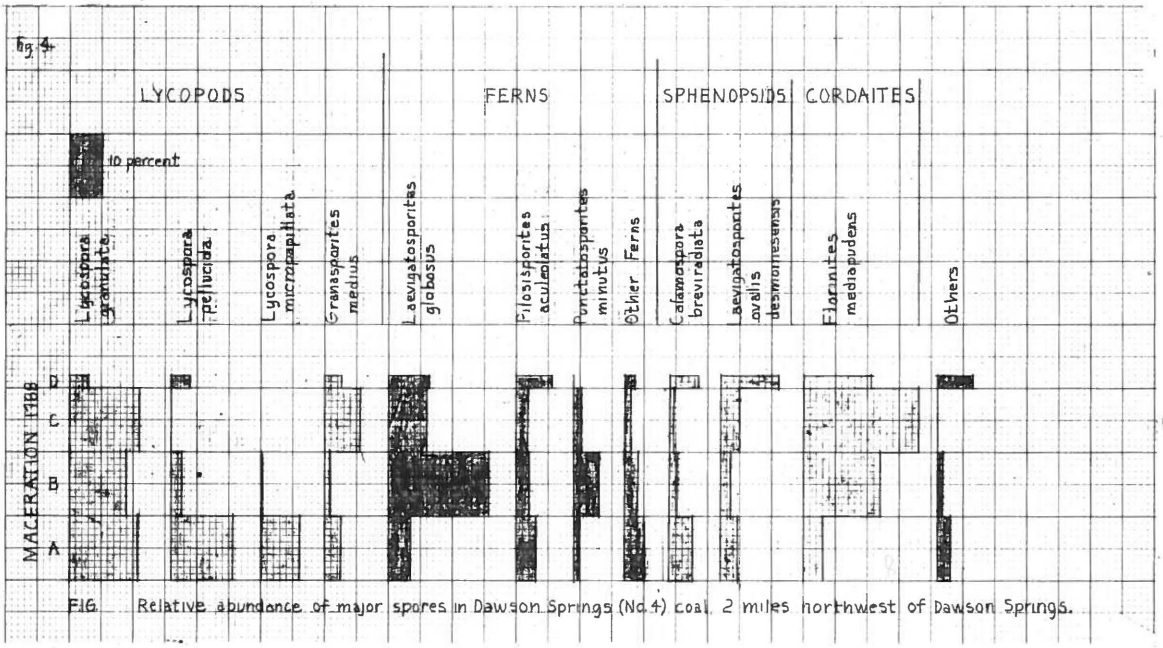


FIG. Relative abundance of major spores in Dawson Springs (No. 4) coal, 2 miles northwest of Dawson Springs.

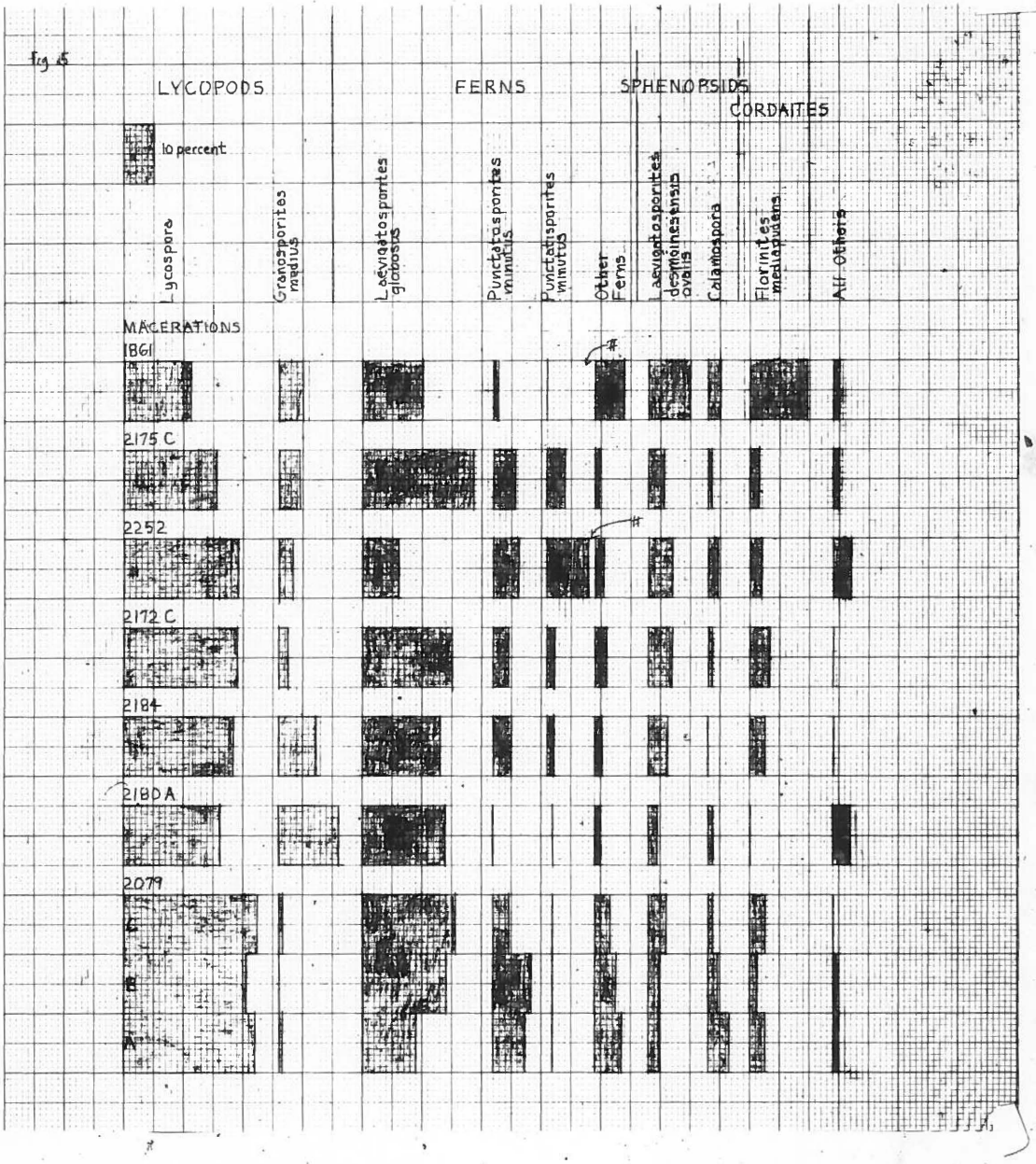
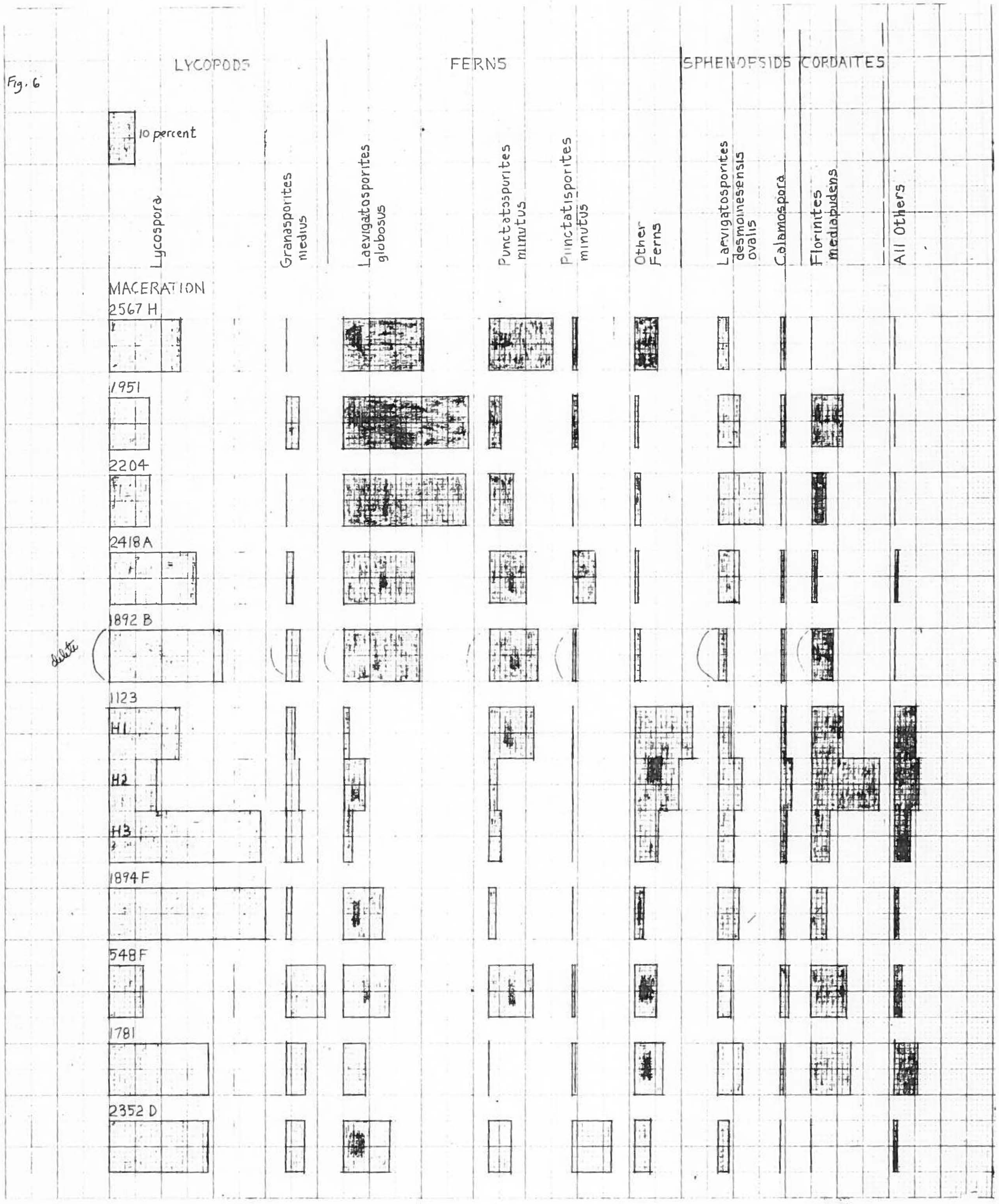


fig 6
LYCOPODS
FERNS
SPHENOPSIDS
CORDAITES
10 percent
Lycospora
Granosporites radius
Laevigatosporites globosus
Punctatosporites minutis
Punctatisporites minutus
Other Ferns
Laevigatosporites desmoinesensis ovalis
Calamospora
Florinites mediapudens
Alf. Others
MACERATIONS
1861
2175 C
2252
2172 C
2184
2180 A
2079
E
B
A

Fig. 6


LYCOPODS
FERNS
SPHENOPSIDS
CORDAITES
10 percent
Lycospora
Granasporites medius
Laevigatosporites globosus
Punctatosporites minutus
Punctatisporites minutus
Other Ferns
Laevigatosporites desmoinesensis ovalis
Calamospora
Florinites mediapudens
All Others
MACERATION
2567 H
1951
2204
2418 A
1892 B
delete
1123
H1
H2
H3
1894 F
548 F
1781
2352 D

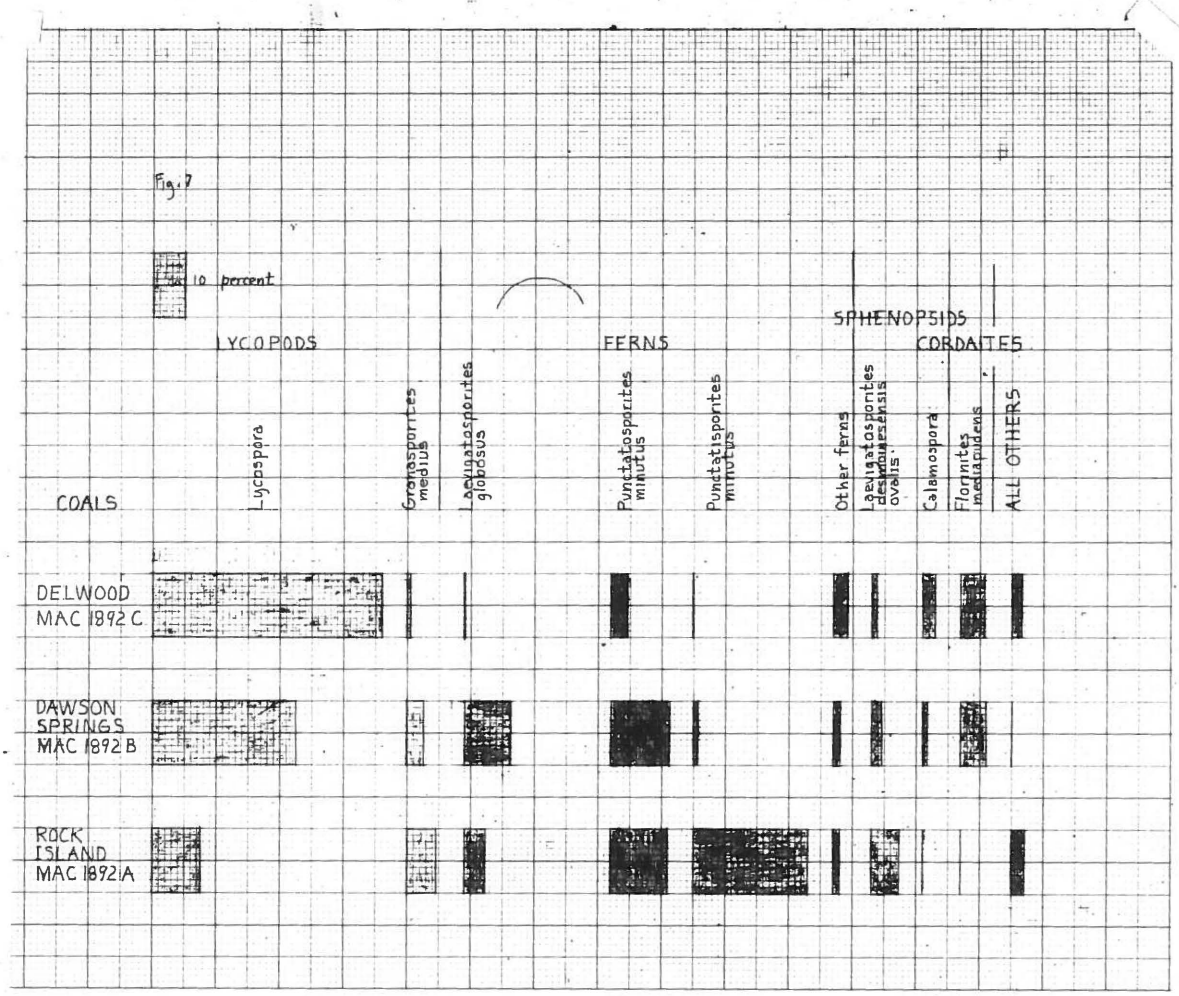
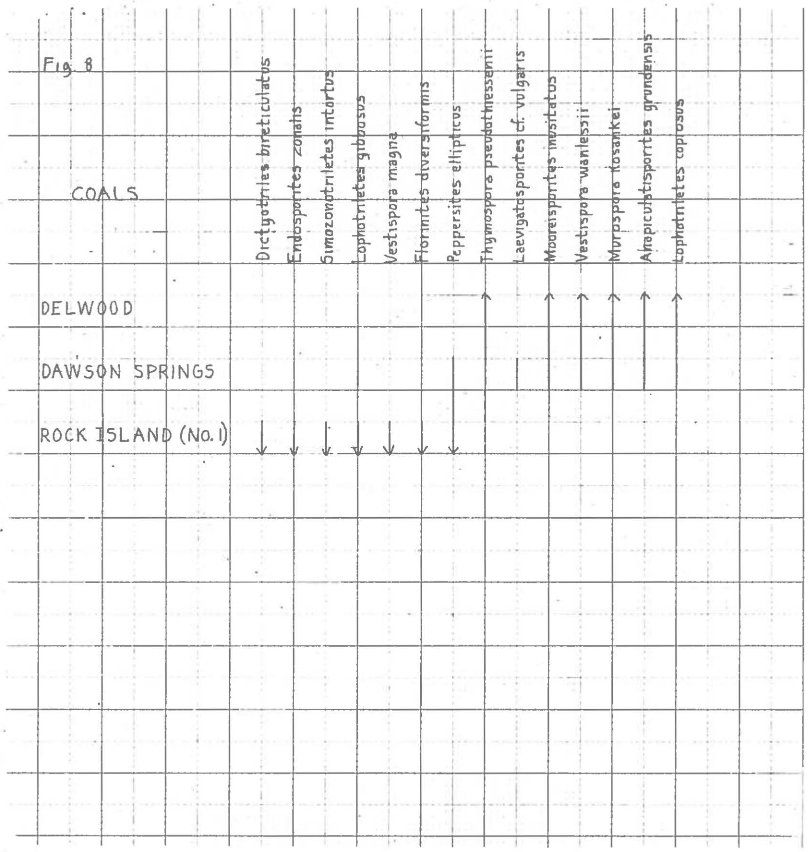


Fig. 7
10 percent
LYCOPODS
FERNS
SPHENOPSIDS
CORDAITES
COALS
Lycospora
Cristasporites medius
Laevigatosporites globosus
Punctatosporites minutus
Punctatisporites minutus
Other ferns
Laevigatosporites desmoinesensis ovalis
Calamospora
Florinites mediapudens
ALL OTHERS
DELWOOD MAC 1892 C
DAWSON SPRINGS MAC 1892 B
ROCK ISLAND MAC 1892 A

Fig 8


COALS
Dictyotriletes bireticulatus
Endosporites zonalis
Simozonotriletes intortus
Lophotriletes gibbosus
Vestispora magna
Florinites diversiformis
Peppersites ellipticus
Thymospora pseudothiessenii
Laevigatosporites cf. vulgaris
Mooreisporites inusitatus
Vestispora wanlessii
Murospora kosankei
Anapiculatisporites grundensis
Lophotriletes copiosus
DELWOOD
DAWSON SPRINGS
ROCK ISLAND (No. 1)

List of Illustrations

Figure 7. Distribution of major spore taxa in the Lewisport coal bed, the overlying Delwood Coal, and the underlying Rock Island Coal in a core drilled in White County, Illinois (Site No. 26).

Figure 8. Stratigraphic ranges of selected spores in the Rock Island (No. 1) Coal Member, and Lewisport and Delwood Coal Beds.

Table Captions

Table 1 Location of sample sites of the Lewisport coal bed and equivalent coals.

Table 2a-c Spore analysis of samples of the Lewisport coal bed and equivalent coal in the Illinois Basin. Locations of sample sites are given in Table 1. Numbers are percentages; "x" designates species is present but not abundant enough to be in the count.

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Table 1. Location, maceration numbers, and thickness or depth of Lewisport coal bed and equivalent coals.

Kentucky			
Site No.	**Maceration No.**	**Thickness or Depth**	**Location**
1.	1788 A B C D	lower 15 in 15 in 15 in top 4 in	22,000 ft N. line, 9,350 ft W. line, Dawson Springs Quad., 1 mi NW Dawson Springs, Hopkins Co.
2.	1268 X	?	Chemical Coke Co. 307,750 ft N. 1,461,600 ft E., St. Charles Quad., Hopkins Co.
3.	1268 Y	?	Chemical Coke Co., Hole 4, 312,000 ft N., 1,457,300 ft E., St. Charles Quad., Hopkins Co.
4.	1861	345- 349 ft	Chemical Coke Co., DDH 11, 313,200 ft N., 1,456,700 ft E., St. Charles Quad., Hopkins Co.
5.	2175 C	14 in	Whittington pit, 3,000 ft N. line, 1,600 ft E. line, Carter Grid 21-H-24, Dawson Springs SE Quad., .5 mi NW of Empire, Christian Co.
6.	2176	23 in	2,900 ft N. line, 2,500 ft E. line, Carter Grid 21-H-24, Dawson Springs SE Quad., .5 mi WNW of Empire, Christian Co.
7.	1146 A B	upper 12 in lower 12 in	Ligon Mine, 500 ft E. line, 2,800 ft S. line, Carter Grid 19-H-24, Dawson Springs SE Quad., near Christian-Hopkins Co. line, 2 mi NW of Empire, Christian Co.
8.	2178	?	Bell or Walker Mine, 4,600 ft N. line, 3,700 ft E. line, Carter Grid 22-H-24, Dawson Springs SE Quad., 2 mi W. of Empire, Christian Co.
9.	1880	?	White Brothers Mine, 3,900 ft S. line, 2,100 ft W. line, Carter Grid 23-H-24, Dawson Springs SE Quad., 2.5 mi W. of Empire, Christian Co.
10.	2186	48 in	Black Gold Mine, 300 ft N. line, 1,500 ft E. line, Carter Grid 16-H-24, Dawson Springs SE Quad., 4 mi NW of Empire, Christian Co.
11.	2252	48 in	2,350 ft S. line, 900 ft E. line, Carter Grid 15-H-26, Crofton Quad. .5 mi SW of Red Hill, Christian Co.
12.	54 1799	lower 10 in upper 20 in	1,100 ft S. line, 1,300 ft E. line, Carter Grid 2-I-33, South Hill Quad., .75 mi NE of Mining City in elbow of Green River, Butler Co.
13.	2172 C	42 in	Jessup Bros. Mine, 200 ft S. line, 1,900 ft E. line, Carter Grid 8-I-33, South Hill Quad., 1.1 mi SW of Mining City, Butler Co.
14.	2182	15 in	600 ft S. line, 3,500 ft W. line, Carter Grid 21-J-34, Flener Quad., Butler Co.
15.	2183	22 in	2,100 ft N. line, 1,400 ft W. Line, Carter Grid 7-I-34, Morgantown Quad., Mile Post 29.5, Green R. Parkway, Butler Co.
16.	2184	36-39 in	2,800 ft N. line, 1,800 ft E. line, Carter Grid 7-I-34, Morgantown Quad., Mile Post 29, Green R. Parkway, Butler Co.
17.	2180 A	9 in	1,700 ft N. line, 1,800 ft W. line, Carter Grid 21-L-32, Horton Quad., along Green R. Parkway, Ohio Co.

Kentucky			
Site No.	**Maceration No.**	**Thickness or Depth**	**Location**
18.	2257 B C	lower 24 in upper 28 in	1,257 ft W. line, 1,100 ft S. line, Carter Grid 2-Q-32, Tell City Quad., 3 mi SE of Lewisport, Hancock Co. Lewisport Coal
19.	2079 A B C	lower 9 in middle 9 in upper 9 in	5,700 ft S. line, 350 ft E. line, Maceo Quad., 1.5 mi ESE of Knottsville, Daviess Co. Lewisport coal
20.	2203	36 in	O'Bryan Mine, 4,000 ft S. line, 3,500 ft E. line, Maceo Quad., 1 mi SE Knottsville, Daviess Co. Lewisport coal
21.	1958 C D	lower 1.25 in upper 1.25 in	23,000 ft N. line, 11,900 ft W. line, Dekoven Quad., Union Co.
22.	2567 H	341.8 - 342.3 ft	Kentucky Geol. Survey DDH Gil 15, 1,950 ft S. line, 2,100 ft W. line, Carter Grid 5-M-18, Dekoven Quad., Union Co.
Indiana			
Site No.	**Maceration No.**	**Thickness or Depth**	**Location**
23.	1951	42 in	Ctr. sec. 9, T.5S., R.5W., .5 mi SW of Buffaloville, Spencer Co.
24.	2204	36 in	Whitrock or Frick Strip Mine, C S½, sec. 19, T.3S., R.5W., DuBois Co.
25.	2418 A	30 in	Maple Grove Strip Mine, SW NW SW, sec. 25, T.18N., R.9W., Fountain Co.
Illinois			
Site No.	**Maceration No.**	**Thickness or Depth**	**Location**
26.	1892 B	1305 - 1306 ft	E. Hon No. 1, Lewis Company, SW SW NW, sec. 18, T.4S., R.14W., New Harmony Quad., White Co.
27.	1123 H_1 H_2 H_3	951 ft, 0 in- 951 ft, 9 in 951 ft, 9 in- 952 ft, 5.5 in 952 ft, 5.5 in- 953 ft, 3 in	Hole 178, Bransford Company, SW cen. NW, sec. 1 , T.8S., R.7E., Eldorado Quad., Saline Co.
28.	2951	3 in	1,700 ft S of NE/c, sec. 35, T.10S., R.5E., Eddyville Quad., Saline Co.
29.	1894 F	1130 - 1133 ft	Old Ben Hole 7A, Markham Company, sec. 1, T.6S., R.2E., Franklin Co.
30.	548 F	986 ft, 3 in- 987 ft, 3.5 in	Hole 19A, Old Ben Coal Corp, 30 ft N, 140 ft W, SE cor., NW NE, sec. 16, T.6S., R.1E., Sesser Quad., Franklin Co.
31.	1781	32 in	Cen. NE SE, sec. 18, T.9S., R.2W., Pomona Quad., Jackson Co.
32.	2352 D	1614 - 1618 ft	C. K. Ross Hole No. 1, Big Chief Company, SW NW NW, sec. 35, T.7N., R.9E., Greenup Quad., Jasper Co.

mapped as Lewisport - close to Gil-1

mapped as Lewisport, 1 mile NE of Lanham Mine just east of Lanham Mine

3/4 mile south of type Buffaloville

Table 2a. Spore analysis of selected samples of the Lewisport coal bed and equivalent coal beds in the Illinois Basin. Locations of sample sites are given in Table 1. Numbers are percentages; "X" designates species is present but not in the count.

Spore taxa	1788A	B	C	D	1268X	1268Y	1861	2175C	2176	1146A	1146B	2178	1880	2186
Deltoidospora levis								X			X			
D. priddyi					X	X		0.5	X					
D. sphaerotriangula												X		X
D. spp.					0.5						0.3			
Punctatisporites flavus								X	X					X
P. glaber											X			
P. minutus	0.3	0.3	0.3		0.5	X	0.5	6.0	8.0	X	4.7	7.5		
P. obesus								X					X	X
Calamospora breviradiata	6.7	2.3	1.0	9.0	7.0	7.0	4.0	1.0	3.5	2.7	1.7	0.5	3.0	2.5
C. hartungiana	0.3				X			X	X			X		X
C. mutabilis				X				X	X		X		X	0.5
C. straminea	X				X			X						
C. spp.										0.3				
Granulatisporites adnatoides									X					
G. granularis						0.5		X			0.3			X
G. pallidus	0.3				X	0.5		X	X					
G. verrucosus	1.0				X	X								
G. spp.						X								

Spore taxa	1788A	B	C	D	1268X	1268Y	1861	2175C	2176	1146A	1146B	2178	1880	2186
Cyclogranisporites aureus		0.3		X			0.5							
C. leopoldi							X							
C. microgranus												X	X	
C. minutus									X			X		0.5
C. orbicularis					X	0.5								
C. spp.		0.3												
Verrucosisporites donarii						0.5								
V. microtuberosus			X			X		X	X	X	X	X		X
V. racemus				X										
V. sifati		X											X	
V. verrucosus		X												
V. cf. verrucosus													X	
V. spp.							1.0						X	
Lophotriletes commissuralis						0.5								
L. copiosus			0.3	X				X		X				
L. granoornatus		X												
L. microsaetosus								X	X					2.5
L. mosaicus			0.3										X	
L. rarispinosus	1.7	0.3			0.5		1.0	X						

Spore taxa	1788A	B	C	D	1268X	1268Y	1861	2175C	2176	1146A	1146B	2178	1880	2186
Anapiculatisporites grundensis	1.3					X	1.0	X	X			X		1.0
A. spinosus	0.3	0.3		5.0	0.5	X		0.5	3.0	2.3	1.7	2.0	3.5	1.0
Pustulatisporites crenatus			0.3					X						
Apiculatasporites setulosus					X	X	X	X			X	X	X	
A. spinososaetosus								X				X		
A. variusetosus		X	X					X			X	X		0.5
Pilosisporites aculeolatus	5.7	4.0	3.7	11.0	1.0	2.5	5.0	X	X	1.0	1.3	1.0		
Raistrickia abdita				X					X					
R. aculeolata					X			X						
R. breviminens		X		X	X			0.5	X		X	X	X	X
R. crocea		0.3					X		X		0.3	X		X
R. frequentispinosus							X							
R. lowellensis								X						
Spackmanites habibii			X	X					X	X				
Maculatasporites punctatus					X		X			X		X		
C. sp.								X						
Microreticulatisporites nobilis								X				X		
M. sulcatus	0.7	0.3			X	X	0.5	X	X					X
Camptotriletes confertus					X			X		X		X		

Spore taxa	1788A	B	C	D	1268X	1268Y	1861	2175C	2176	1146A	1146B	2178	1880	2186
C. triangularis				1.0					X					
Triquitrites additus	0.3				X			X	X					X
T. bransonii	0.7	0.3	0.7		1.5	X	0.5	X	0.5			0.5	1.0	1.5
T. exiguus					X	X		X						
T. pulvinatus	0.3	X	X		X	0.5	X	X	X				X	
T. sculptilis				2.0					X	X				
T. spp.		1.0												
Mooreisporites inusitatus				X			X		X				X	X
Reinschospora magnifica			X							X				
R. triangularis				X				X	X	X	X	X	X	
Knoxisporites stephaneformis													X	
Reticulatisporites densoreticulatus										X				
R. polygonalis					X			X	X	X				
R. reticulatus		X	X	X	X	X		X	X	X	X	X	X	
R. reticulocingulum										X				
Reticulitriletes clatriformis									X					
R. falsus				X										
Crassispora kosankei	X	X	X	2.0		X	0.5		0.5			X	2.0	X
Granasporites medius	4.3	1.3	11.3	5.0	7.0	3.5	7.5	7.0	4.0	17.3	12.7	16.5	10.0	6.5
Murospora kosankei												X		

Spore taxa	1788A	B	C	D	1268X	1268Y	1861	2175C	2176	1146A	1146B	2178	1880	2186
Densosporites sphaerotriangularis			X	X			X		X	6.7			X	
D. triangularis								X					X	
Lycospora granulata	21.3	18.0	21.7	5.5	28.5	30.0	11.0	25.0	19.5	11.3	26.3	14.5	17.5	21.0
L. micropapillata	12.0	0.3				3.5	1.0				X			2.5
L. pellucida	19.7	3.7	X	2.5	11.0	19.0	10.0	4.5	1.0		1.7	2.0		4.5
L. pusilla					3.0									
L. rotunda			1.0	X			0.5	2.0		0.3	1.0	X	X	1.0
L. subjuga									0.5					
Paleospora fragila				0.5	X					X			X	
Cirratriradites annulatus		X					X	X	X		X		X	X
C. annuliformis			X											
C. maculatus	X					X	X							
C. sp.												X		
Endosporites globiformis		0.3	X	1.0	X	1.5		X	X	0.3	X	X	0.5	2.0
Alatisporites hexalatus				X		X			X		X	X		
A. hoffmeisterii		X	X	X		X		X		X		X		
A. pustulatus				X										
A. trialatus		X		X	X	X	X	X		X	X	X	X	X

Spore taxa	1788A	B	C	D	1268X	1268Y	1861	2175C	2176	1146A	1146B	2178	1880	2186
Laevigatosporites desmoinesensis	1.0		3.3	2.5	2.0	X	2.0	0.5	0.5	0.3	1.7	1.0	3.5	X
L. globosus	6.7	31.3	11.7	12.5	15.0	9.0	19.5	36.5	36.5	40.7	29.3	37.5	41.0	25.0
L. medius	X							0.5	X			X	1.0	
L. ovalis	5.7	3.0	6.0	18.0	9.5	2.5	12.0	5.0	7.0	9.0	6.0	8.5	7.5	3.0
L. striatus						X		X	X		X	X	X	
L. vulgaris	X			1.5		X	0.5	0.5	X	0.7	X	0.5	X	
L. cf. vulgaris				X		X		X	X	X		X	X	
Punctatosporites minutus	1.3	8.0	2.3		3.5	6.0	1.5	7.5	11.5	3.3	2.0	3.5	3.0	14.5
Spinosporites exiguus						0.5								
Thymospora pseudothiessenii				X		0.5		X	X	0.3		X		
Torispora securis			X		X	X	X		X			0.5		
Vestispora fenestrata	1.0		0.3		0.5	1.0	1.5	X	0.5		0.7	0.5	X	0.5
V. foveata									0.5					
V. laevigata			X					X	X	X		X		
Florinites mediapudens	5.7	24.0	35.7	21.0	7.0	9.5	18.5	2.5	2.0	3.3	8.3	3.5	6.5	8.0
F. millotti	1.3							X	1.0					X
F. similis					X	X	X	X			X	X		

Spore taxa	1788A	B	C	D	1268X	1268Y	1861	2175C	2176	1146A	1146B	2178	1880	2186
Wilsonites circularis								X						
W. delicatus							X	X						X
W. vesicatus	0.3	X			1.5	1.0		X				X		1.5
Vesicaspora wilsonii							X		X					
Quasillinites diversiformis								X					X	
Peppersites ellipticus					X	X	X				X			
Trihyphaecites triangulatus										X				
Botryococcus								X						

Table 2b. Spore analysis of selected samples of the Lewisport coal bed and equivalent coal beds in the Illinois Basin. Locations of sample sites are given in table 1. Numbers are percentages; "X" designates species is present but not in the count.

Spore taxa	2352	1799	54	2172C	2182	2183	2184	2180 A	2357 B	2357C	2079A	2079B	2079C
Deltoidospora levis					X								
D. priddyi			X	0.5		0.5		X					
D. sphaerotriangula	X												
D. spp.						0.5							0.5
Punctatisporites flavus								X					
P. glaber	X			X		0.5	X						X
P. minutus	13.5	2.3	1.5	2.5		2.5	2.5		3.0	4.0	0.5		
Calamospora breviradiata	2.5	0.7	6.5	1.5	0.5	1.5	0.5	1.5	8.0	0.5	7.0	3.5	1.5
C. hartungiana	1.0	X	0.5			X		X	0.5		X		
C. mutabilis							X		X				
C. straminea	X										X		X
Granulatisporites adnatoides							X						X
G. granularis			1.0		0.5	0.5		0.5	1.0	1.0	0.5	1.5	1.0
G. pallidus		0.3											
G. verrucosus									0.5	0.5		0.5	
G. spp.		0.3					1.0		0.5	0.5			
Cyclogranisporites aureus	X				X			X			0.5		X

Spore taxa	2252	1799	54	2172C	2182	2183	2184	2180 A	2257 B	2257C	2079A	2079B	2079C
C. microgranus	X	X			X	X		0.5		X		X	
C. minutus	X						X	X					
C. spp.						0.5							
Verrucosisporites microtuberosus	X			X		X		X	X			X	X
V. sifati		X		0.5		X					X		
Kewaneesporites patulus				X				X					
Lophotriletes commissuralis	X			1.0							X	0.5	
L. copiosus	X			X				X					
L. gibbosus	X				X								
L. microsaetosus	1.0			0.5		1.0	X	X	1.5		2.0		
L. mosaicus					X								
L. pseudaculeatus								X					
L. rarispinosus													X
Anapiculatisporites grundensis	X	X				0.5							X
A. spinosus	1.0		0.5		X	X	0.5	0.5	0.5	X			
Apiculatasporites setulosus	X			X									X
A. spinososaetosus	X								X				
A. variusetosus	0.5	X		X		X						X	X

Spore taxa	2252	1799	54	2172C	2182	2183	2184	2180 A	2257 B	2257C	2079A	2079B	2079C
A. spp.								0.5					
Pilosisporites aculeolatus	0.5	0.3	2.0		0.5				1.0		1.5	1.0	2.0
Raistrickia abdita	X				X								
R. aculeolata	X	0.3											X
R. breviminens	X			X				X	X				X
R. crocea		X				X			X				
R. lowellensis					X								
R. subcrinita							X						
Spackmanites habibii					X			X					
Maculatasporites punctatus	X												
Convolutispora florida	X												
Microreticulatisporites nobilis	0.5	X				0.5	X				X		X
M. sulcatus	X	X		X	X		0.5			X			
Camptotriletes confertus	X											X	
Triquitrites additus	X	X		X	X	X	X		2.5		X	X	
T. bransonii	0.5	X	1.5	1.5	0.5	X	1.0	0.5	3.0	X	4.0	2.5	0.5
T. exiguus	X		0.5			X	X				0.5	0.5	X
T. protensus	X												
T. pulvinatus	X		X			X					X		X
T. sculptilis										X			0.5

Spore taxa	2252	1799	54	2172C	2182	2183	2184	2180 A	2257 B	2257C	2079A	2079B	2079C
Mooreisporites inusitatus					X								
Reinschospora triangularis				X			X	X					
Knoxisporites stephaneformis	X	X					X	X					
Reticulatisporites mediareticulatus								X					
R. polygonalis	X	X											
R. reticulatus				X		X							X
R. reticulocingulum							X						
Reticulitriletes falsus	X												
Crassispora kosankei	0.5			X	4.0	0.5	1.5	1.0	3.5				X
Granasporites medius	4.5	6.3	9.0	3.0		1.0	12.5	20.0	1.5	0.5	1.0	0.5	1.0
Densosporites sphaerotriangularis		X							X	X			
D. triangularis		X											
Lycospora granulata	28.0	44.0	46.0	37.5	62.5	45.0	35.5	23.0	14.5	12.0	41.5	39.5	44.5
L. micropapillata	2.0			1.0		0.5		2.0	1.0		2.0		
L. pellucida	4.0	1.3	1.0		4.0		1.0	5.5	1.5	0.5		1.0	1.0
L. pusilla	2.5					1.0		1.5					
L. rotunda	2.0							0.5				0.5	
L. subjuga	X				X							0.5	

Spore taxa	2252	1799	54	2172C	2182	2183	2184	2180 A	2257 B	2257C	2079A	2079B	2079C
Cirratriradites annulatus	X					X	X				0.5	0.5	X
C. annuliformis					X								X
C. maculatus				X	X		X			X			X
C. sp.												X	
Endosporites globiformis	X	X	1.5	X	1.0			9.0	17.0	X	1.0	0.5	
E. plicatus	X												
Alatisporites hexalatus		X											
A. hoffmeisterii	X	X				X	X			X			X
A. trialatus						X	X			X			X
Laevigatosporites desmoinesensis	X	X	0.5	1.0	0.5	X	X	X	X	X	X	X	2.0
L. globosus	12.0	15.3	5.5	30.5	16.0	32.0	26.0	27.5	14.5	56.5	17.5	28.0	31.5
L. medius	X	0.3		X				1.0		X			X
L. ovalis	8.0	14.0	12.0	7.0	0.5	4.0	6.5	3.0	12.0	8.5	3.5	3.5	4.0
L. striatus	X	X	X										
L. vulgaris	X	0.7				0.5		X	0.5			X	X
L. cf. vulgaris					X		X	X		X			X
Punctatosporites minutus	9.0	7.0	0.5	5.0	8.0	5.5	6.0	0.5	1.5	2.0	11.0	12.5	5.5
Spinosporites exiguus								1.5					

Spore taxa	2252	1799	54	2172C	2182	2183	2184	2180 A	2257 B	2257C	2079A	2079B	2079C
Thymospora pseudothiessenii		X		X			X	X	X			X	X
Torispora securis									X				
Vestispora fenestrata	0.5	X			X	X	X	0.5	1.5	X			
V. foveata				0.5									
V. laevigata		X		X				X		X		X	X
V. pseudoreticulata								X					
V. wanlessii							X						
Florinites mediapudens	4.0	6.7	10.0	6.5	1.5	1.5	5.0		8.0	13.0	5.0	2.5	5.0
F. millotti	1.0	X						X			X		
F. similis	X	X						X	X		0.5		
Wilsonites circularis								X	0.5				X
W. delicatus	0.5			X				0.5	X				
W. vesicatus	0.5	X	X			X	X	0.5	4.0	0.5			
Peppersites ellipticus	X	X	X	X			X				X	X	
Trihyphaecites triangulatus								X					
Botryococcus		X						X					

Table 2c. Spore analysis of selected samples of the Lewisport coal bed and equivalent coal beds in the Illinois Basin. Locations of sample sites are given in table 1. Numbers are percentages; "X" designates species is present but not in the count.

Spore taxa	2203	1958C	1958D	2567H	1951	2204	2418A	1892B	1123H1	1123H2	112H3	2951	1894F	548F	1781	2352D
Deltoidospora levis									X	X						
D. priddyi												2.0				
D. sphaerotriangula			0.5			X										
D. subadnatoides												0.5				
D. spp.									0.5					1.0		
Punctatisporites flavus						X										
P. glaber					X	X							X			
P. minutus		0.5		1.5	2.0	0.5	8.5	1.5	0.5	0.3	0.3	6.0	0.5	1.0	0.7	15.0
P. obesus						X			X					X		
Calamospora breviradiata	1.0	4.5	1.5	0.5	1.5	0.5	1.0	1.0	1.5	4.3	1.0	1.0	1.5	3.0	0.7	0.5
C. hartungiana	0.5	2.0	0.5						X		1.0	0.5			0.3	
C. liquida												X				
C. straminea		1.5									X	1.0	X			
C. spp.									1.0			0.5				
Granulatisporites adnatoides				X		X										
G. granularis												0.5				
G. minutus	0.5														0.7	

Spore taxa	2203	1958C	1958D	2567H	1951	2204	2418A	1892B	1123H1	1123H2	112H3	2951	1894F	548F	1781	2352D
G. pallidus									1.0	X		0.5			1.7	
G. verrucosus												1.0				
G. spp.						0.5					X		1.0		0.3	
Cyclogranisporites aureus	X		X	X					0.5		X	X			X	X
C. leopoldi										1.3	1.0					0.5
C. microgranus						1.0						1.0	X			
C. minutus						0.5			3.5			1.0				X
C. staplinii										1.0		X				
Verrucosisporites donarii													X	X		
V. microtuberosus		X		X			X			X		1.0		X		
V. sifati					X	X	X	X	X	X			X		X	
V. verrucosus							X									
V. spp.															0.3	
Kewaneesporites patulus								X		X						
Lophotriletes commissuralis						X										
L. copiosus		X							X					X		X
L. gibbosus						X	X									
L. granoornatus								0.5		0.3	X			X		

Spore taxa	2203	1958C	1958D	2567H	1951	2204	2418A	1892B	1123H1	1123H2	112H3	2951	1894F	548F	1781	2352D
L. ibrahimii									X		X		X			
L. microsaetosus	5.0			1.5												1.0
L. mosaicus		X	0.5						X			0.5	X	X		
L. pseudaculeatus									X							
L. rarispinosus										0.3				1.0	0.7	
L. spp.									X							
Anapiculatisporites grundensis				1.0						0.7				0.5		X
A. spinosus	0.5													2.5		1.0
Pustulatisporites crenatus												X				
P. verrucifer											X	X		X		
Apiculatasporites setulosus												X	X	X		
A. spinososaetosus												0.5				X
A. variusetosus											0.3			X		
A. spp.												0.5				
Planisporites granifer						X										
Pilosisporites aculeolatus				0.5		X			5.5	6.7				2.5	0.3	
Raistrickia abdita						X				X		0.5	X		X	

Spore taxa	2203	1958C	1958D	2567H	1951	2204	2418A	1892B	1123H1	1123H2	112H3	2951	1894F	548F	1781	2352D
R. aculeolata						X				X		X				
R. breviminens		X										X	X		0.3	X
R. crocea					0.5			0.5				X	X			
R. pilosa												X				
R. spp.		0.5			X											
Spackmanites habibii														X		
Maculatasporites punctatus								X					X			
Microreticulatisporites nobilis		1.0	3.5	0.5	X	X	X	0.5	X				X			0.5
M. sulcatus	X			X		X		X	2.0	0.7	1.7				X	X
Camptotriletes triangularis								0.5								
Triquitrites additus	1.0	2.0							2.5	2.0		X	X			
T. bransonii	5.0	2.5	4.5	2.0	X	0.5	X		7.5	3.3	4.0	3.5	2.0	3.5	6.0	2.0
T. exiguus		0.5	1.5		0.5	X		X	X		0.3	X	0.5		X	0.5
T. minutus						X										
T. pulvinatus									X	X				X	0.3	X
T. sculptilis		0.5	0.5		X				X	X	X	2.0	X	X	X	X
T. subspinosus					0.5				X			0.5	X			
T. tribullatus																X
T. spp.											1.0				0.3	

Spore taxa	2203	1958C	1958D	2567H	1951	2204	2418A	1892B	1123H1	1123H2	112H3	2951	1894F	548F	1781	2352D
Mooreisporites inusitatus								X	0.5							
Reinschospora magnifica													X			
R. triangularis					X									X		
Knoxisporites stephanephorus												X		X		
Reticulatisporites densoreticulatus									X					X		
R. reticulatus					X	X							X	0.5		
R. spp.						X										
Crassispora kosankei		X	X		X		0.5	0.5	X	1.0	1.0		X	X	0.7	
Granasporites medius	0.5	2.0	2.5	2.0	5.0	0.5	2.5	5.5	3.0	5.3	6.0	2.0	2.0	15.0	6.0	7.0
Murospora kosankei		0.5														
Densosporites sphaerotriangularis					X		X	X	0.5	2.7					2.3	
D. triangularis							0.5									
D. spp.						X										
Lycospora granulata	28.5	28.5	48.0	23.5	15.0	15.0	26.0	40.5	25.0	10.0	22.0	9.0	41.0	13.0	18.7	28.5
L. micropapillata							2.0	1.5			5.7				0.7	8.0
L. pellucida		2.5	0.5	0.5			4.5		1.5	8.3	30.0		X		19.3	

Spore taxa	2203	1958C	1958D	2567H	1951	2204	2418A	1892B	1123H1	1123H2	112H3	2951	1894F	548F	1781	2352D
L. pusilla	0.5			3.0				3.0				2.0	16.0			1.0
L. rotunda		0.5										1.5	0.5	X	0.3	0.5
L. subjuga					0.5								2.5			
Paleospora fragila					X											
Cirratriradites annulatus		X	X						X	X				X	0.7	
C. annuliformis					X								X			
C. maculatus	X		X	0.5	X	X		X	X	X			X			X
Endosporites globiformis	0.5	5.0	4.5	X	0.5		X	X		1.0	0.7	X	1.5	3.5	2.0	0.5
Alatisporites hexalatus													X			
A. hoffmeisterii					X		0.5	X						X		
A. trialatus		X			X	X	0.5						X	X		
Laevigatosporites desmoinesensis	1.0	2.5	0.5	1.0	1.0	X	0.5	0.5		0.3		14.5	1.5			0.5
L. globosus	16.0	5.0	6.5	30.5	48.5	46.5	27.0	14.5	2.0	8.0	2.7	18.5	14.5	17.5	8.7	17.5
L. medius	0.5	0.5			1.0	2.5	2.0									0.5
L. ovalis	10.5	15.0	15.5	3.0	7.0	17.0	8.0	3.0	4.0	9.0	6.3	15.0	6.5	5.0	10.0	4.5
L. striatus	X	X			X	X										X
L. vulgaris		1.5	1.0		X	X		X	1.0	0.3		3.5	X	X	X	
L. cf. *vulgaris*						X		X		X			X	X		X

Spore taxa	2203	1958C	1958D	2567H	1951	2204	2418A	1892B	1123H1	1123H2	112H3	2951	1894F	548F	1781	2352D
Latosporites minutus												0.5				
Punctatosporites minutus	5.5	1.0	1.0	24.5	4.5	9.0	14.0	18.5	17.0	3.0	4.7	3.0	2.5	17.0	0.3	8.5
Thymospora pseudothiessenii			X		X	X				0.3		X	X	X	X	
Torispora securis		0.5	1.0	3.5					X	0.3		1.5	X	X	0.3	1.5
Vestispora fenestrata			1.0						4.0	0.7	0.3	X	X	X	1.7	0.5
V. laevigata	1.0					X			X	X						X
V. pseudoreticulata												0.5				
V. wanlessii		X	X													
V. spp.		X	X									0.5				
Florinites mediapudens	20.5	13.0	4.5	0.5	12.0	5.5	2.0	8.0	12.0	26.3	7.0	1.5	6.0	13.5	15.3	X
F. millotti		0.5							1.5	2.0	2.0		X			
F. similis		4.5						X	2.0	0.3	0.3	2.0	X	X		
Wilsonites delicatus		X														
W. vesicatus	1.0	1.5	0.5		X	0.5	X				0.7	X	X		0.3	
Vesicaspora wilsonii	0.5									X						
Peppersites ellipticus					X	X				X		X	X	X		
Trihyphaecites triangulatus										X						

Spore taxa	2203	1958C	1958D	2567H	1951	2204	2418A	1892B	1123H1	1123H2	112H3	2951	1894F	548F	1781	2352D
Botryococcus		X														

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