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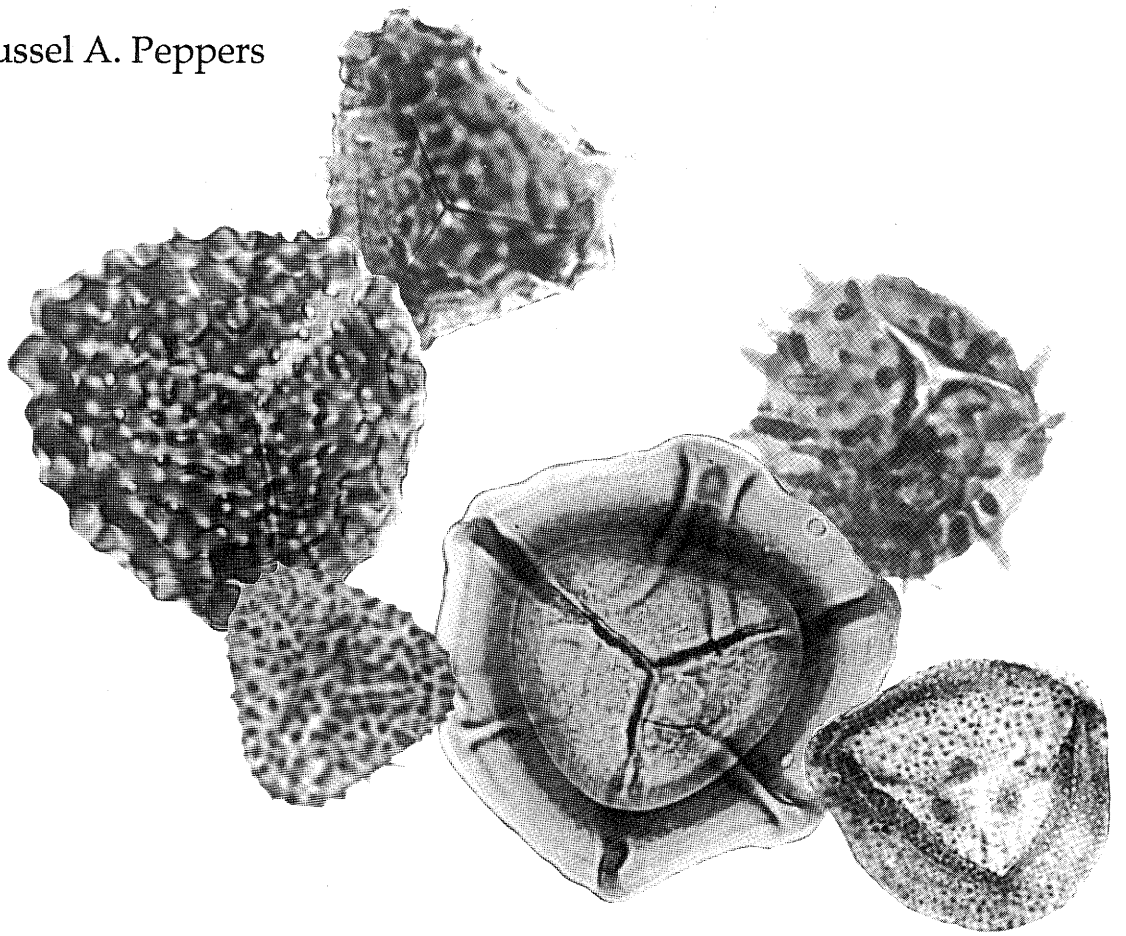
Russel A. Peppers



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Department of Energy and Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

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Morris W. Leighton, Chief

Natural Resources Building
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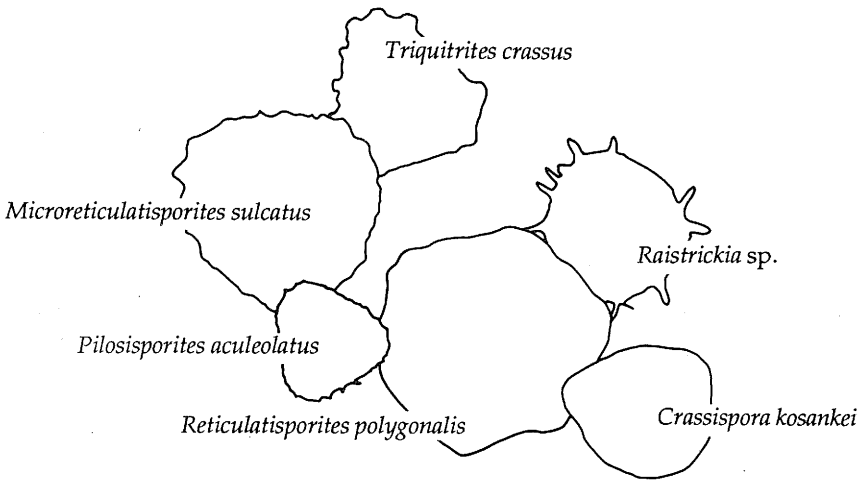
Champaign, Illinois 61820-6964



Cover Identification of spores

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ABSTRACT

The "Boskydell Sandstone" is an early Middle Pennsylvanian unit of reddish gray sandstones or facies in southern Illinois. Distinctive because they contain marine fossils, the sandstones have been frequently noted in stratigraphic studies and were sometimes used as a basis for stratigraphic correlations. Some geologists, however, have suspected that more than one sandstone called "Boskydell" actually exists (Kosanke et al. 1960). Additional interest in the "Boskydell Sandstone" is due to the recent search for evidence of marine incursions in Illinois during the Early and early Middle Pennsylvanian. Recognition of marine facies is important because of renewed interest in cyclic deposition and sequence stratigraphy. Thus, this study was conducted to determine the geologic age of sandstones containing marine fossils, which aid in interpreting the deposition history of lower Pennsylvanian strata in southern Illinois.

Palynology of coal beds adjacent to sandstones with marine facies was used to determine that the "Boskydell Sandstone" near the town Boskydell and elsewhere in Jackson County is part of a sandstone, informally named the "golden sandstone," which occurs in the upper part of the Tradewater Formation and is early Desmoinesian. The fossiliferous facies of the "golden sandstone" may correlate with the Curlew Limestone Member of western Kentucky and the Seville Limestone Member of northwestern Illinois. A fossiliferous marine facies similar to that in the "Boskydell Sandstone" also occurs in the Murray Bluff Sandstone Member in parts of Saline and Pope Counties. This facies is late Atokan age. In Williamson County, an early Atokan sandstone similar to the "Boskydell" lies near the base of the Tradewater Formation. A sandstone bed called the "Boskydell marine zone" in Gallatin County is in the Finnie Sandstone Member below the Willis Coal Bed, and may correlate with the early Atokan sandstone in Williamson County.

The sandstone containing a marine zone near the town of Boskydell in Jackson County could properly be called the "Boskydell Sandstone" because it occurs near where the Boskydell was originally described. Confusion may be avoided, however, by discontinuing the use of the name "Boskydell" and using "fossiliferous marine facies in the golden sandstone" for the youngest sandstone, "fossiliferous marine facies in the Murray Bluff Sandstone" for the intermediate sandstone, and "fossiliferous marine facies in an unnamed sandstone above the Bell Coal Bed" for the oldest fossiliferous sandstone.

INTRODUCTION

Sandstones called the "Boskydell" are brownish to reddish gray, fine to medium grained, and fossiliferous. They occur at several localities in southern Illinois. Because the presence of marine fossil shells in lower Pennsylvanian sandstones is distinctive in outcrops, the sandstones have been used as marker beds in local mapping and stratigraphic studies. The precise age of the "Boskydell Sandstone" has not been determined; in fact, use of the name "Boskydell Sandstone" has been discouraged because fossiliferous sandstone of different ages may have been identified by that name. The marine fossils in the sandstone at most localities are not definitive enough to provide a reliable age determination.

The purpose of this report is to interpret the ages of the sandstones identified as "Boskydell" by using palynology of coal beds closely below or above lower Middle Pennsylvanian sandstones containing marine fossils. Palynology of the coals can be used to confirm ages provided by studies of the marine fossils because some spore species in the coals have shorter chronostratigraphic ranges than most Middle Pennsylvanian marine fossil material. Another consideration is whether the marine facies of the sandstones correlate with previously described limestones elsewhere. The stratigraphic relationships of these sandstones can also be used to help interpret marine incursions and cyclic depositional patterns in lower Middle Pennsylvanian strata in southern Illinois.

The names of stratigraphic units in Kentucky and Indiana are used according to the nomenclature proposed by their geological surveys.

Historical Review

The names "Boskydell marine horizon" and "Boskydell limestone" were introduced by Wanless (1939) to refer to a calcareous marine sandstone near the town of Boskydell in Jackson County, Illinois. In 1956, he identified the type locality as NE, Section 8, T10S, R1W (fig. 1). In a correlation chart compiled by Siever in the same report, the name "Boskydell Sandstone" was used for the marine zone. The name was formally discontinued by Kosanke et al. (1960) because it had been used for a similar kind of sandstone at different stratigraphic positions and because several marine sandstones existed. Although the name "Boskydell Sandstone" was dropped from formal usage, references to the "Boskydell marine zone" are still made.

The unusual occurrences of marine fossils in lower Pennsylvanian sandstones in southern Illinois have been recognized by geologists for some time. Lamar (1925) was the first to mention the occurrence of a sandy limestone containing marine fossils in S 1/2 NE, Section 8, T10S, R1W, Jackson County. He wrote that it was "uncommon and rather remarkable for the Makanda as known in this area" (Carbondale Quadrangle).

Use of the name Makanda Sandstone has been discontinued; the lower part is equivalent to the Pounds

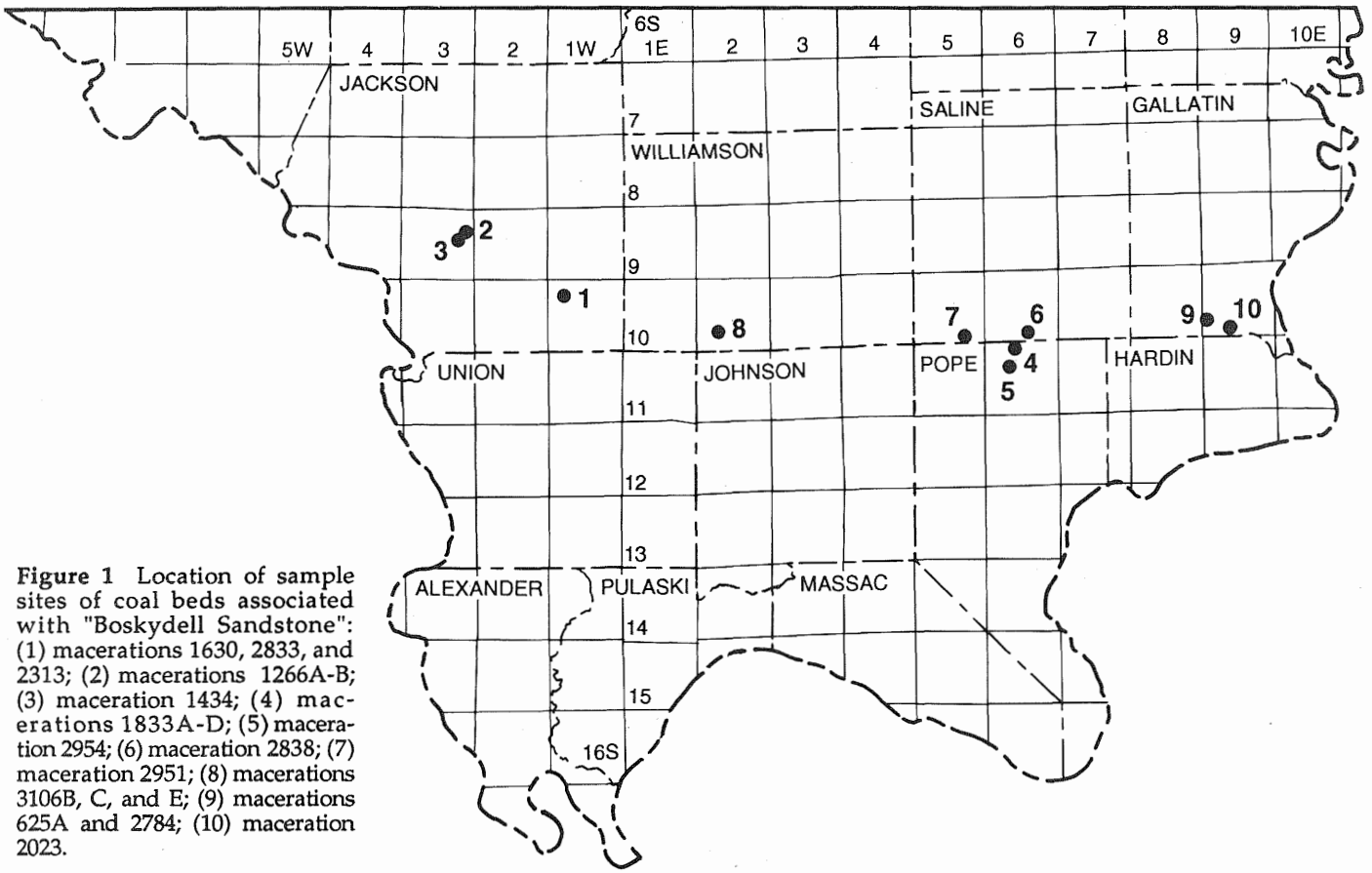


Figure 1 Location of sample sites of coal beds associated with "Boskydell Sandstone": (1) macerations 1630, 2833, and 2313; (2) macerations 1266A-B; (3) maceration 1434; (4) macerations 1833A-D; (5) maceration 2954; (6) maceration 2838; (7) maceration 2951; (8) macerations 3106B, C, and E; (9) macerations 625A and 2784; (10) maceration 2023.

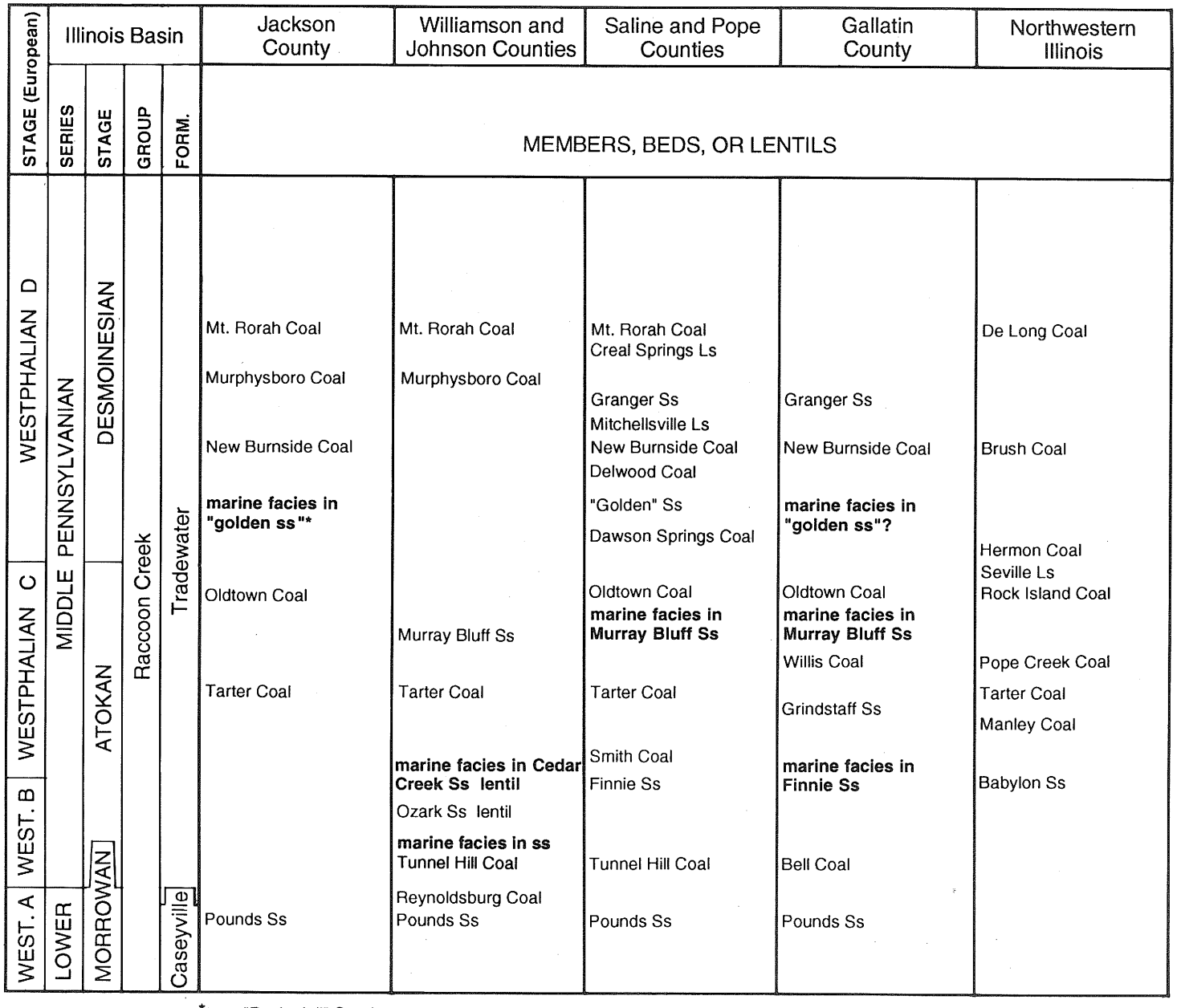
Sandstone Member (Kosanke et al. 1960) in the upper part of the Caseyville Formation (fig. 2). Kosanke et al. (1960) did not mention what the upper part of the Makanda Formation was to be called after use of that name was to be discontinued.

Wanless (unpublished ISGS field notes, 1933) described the "Boskydell Sandstone" as brownish gray with brown spots, fine to medium grained, glauconitic to calcareous, and grading into a very ferruginous, sandy limestone with fossils. The sandstone is crossbedded with evenly truncated foreset beds, and contains beds of calcareous ironstones and some fossils scattered in places. Some of the topset beds display polygonal joints. A few quartz pebbles up to 1/4 inch in diameter occur in the sandstone.

Some fossils appear to be water worn and oxidized so that they are indistinguishable; others are well preserved. Crinoid columnals are most abundant. Other fossils identified by Fuller (unpublished ISGS manuscript, c. 1920) include *Schizostoma, Pharkidonotus, Platyceras, Aviculopecten, Composita, Mesolobus, Spirifer, Punctatospirifer, Orbiculoidea, Dictyoclostus, Marginifera,* and an occasional trilobite. The sandstone also contains shark teeth, fossil wood, and fusain.

Wanless (1939) and Siever (in Wanless 1956) thought that the "Boskydell marine horizon" or "Boskydell Sandstone" was below the Delwood Sandstone Member (later renamed the Finnie Sandstone Member) and above the Willis Coal Bed. Weller et al. (1942) also supported this correlation.

Although Wanless (1956) designated the type section of the "Boskydell marine zone," he did not describe it. Desborough (1959) described the "Boskydell Sandstone" and thought it might be important for making correlations in the lower part of the Pennsylvanian, which does not contain many marker beds. A 30 foot interval of fissile, gray to dark gray, arenaceous shale interbedded with medium grained, calcareous sandstone lenses separates the "Boskydell Sandstone" from what Desborough called the Pounds Sandstone below it. Desborough placed the "Boskydell" below or in the lower part of the Grindstaff Sandstone Member because the lower part of the "Boskydell" contains quartz pebbles like those in the Caseyville Formation. Because Butts (1925) described the Grindstaff as the sandstone just below the Willis Coal (fig. 2) in southeastern Illinois, the "Boskydell" could not be above the Willis Coal, as interpreted by Wanless (1939, 1956). Kosanke et al. (1960) also thought the "Boskydell" was slightly above the Caseyville Formation because the Willis Coal had been correlated with the Bell Coal Bed below the Finnie Sandstone and slightly above the top of the Caseyville Formation in western Kentucky. The Willis Coal is now known to be equivalent to the Ice House coal bed, which overlies the Finnie Sandstone in western Kentucky (Peppers 1977, Peppers and Popp 1979).



*type "Boskydell" Sandstone

Figure 2 Correlation of stratigraphic units in the Lower and lower Middle Pennsylvanian Series in southern Illinois. Units in northwestern Illinois are also shown for comparison. Sandstones written in bold type contain marine fossils.

Desborough (1959) remarked on the difficulty of identifying the Grindstaff Sandstone in Jackson County because of its apparently wide variation in composition. According to Siever (1957), the Grindstaff in parts of southern Illinois is a clean quartz sandstone almost indistinguishable from the underlying Caseyville sandstones; whereas in other places, it contains abundant clay, feldspar, and mica (as described by Butts), which are atypical of the Grindstaff. Hopkins and Simon (1975) and Fraunfelter (1979) also considered the "Boskydell" as part of the Grindstaff Sandstone in the lower part of the Abbott Formation (now Tradewater Formation).

According to Wanless (1939), the fauna in the "Boskydell marine horizon" indicates that the zone is the same age as the interval between the Lower Mercer Limestone and Sharon Ore in Ohio and a correlative of the Boggs Limestone in the Appalachian region. Douglass (1979) correlated, on the basis of fusulinid studies, the Boggs Limestone with the Seville Limestone Member of Illinois. From a study of the "Boskydell" fauna in Section 8, T10S, R1W, Jackson County, Fuller (unpublished ISGS manuscript, c. 1920) concluded that the fauna is late Morrowan age. Weller (1940) and Weller et al. (1942) concluded that the marine bed contains the oldest post-Morrowan invertebrate fauna known in Illinois.

PALYNOLOGY OF COAL BEDS

Jackson County

Lenses of coal occur intermittently in the top or bottom of the sandstone containing the "Boskydell marine zone" in its type area at the middle of south line SW NE, Section 8, T10S, R1W. A lens about 2 inches thick at the top of the sandstone was sampled. This coal (maceration 1630, appendix A) contains a spore assemblage of numerous taxa that indicates the coal is from the lower part of the upper half of the Tradewater Formation and most closely correlates with the New Burnside Coal Bed (fig. 2).

The assemblage is mainly composed of fern spores: *Laevigatosporites globosus* (30.5%), *Punctatisporites minutus* (16.5%), *Punctatosporites minutus* (13.5%), and other fern spores (6%). This large percentage of fern spores is typical of the New Burnside Coal; however, spore percentages may not be conclusive in identifying thin, discontinuous coals. Some of the most stratigraphically significant spores in maceration 1630 are *Lophotriletes ibrahimii*, which extends from just above the Seville Limestone to the Mt. Rorah Coal Member in the Illinois Basin; *Punctatisporites* cf. *edgarensis*, which extends from the Manley Coal Bed to the Murphysboro Coal Member in northwestern Illinois; *Verrucosisporites* cf. *verrucosus*, which extends from the Caseyville up to the Murphysboro Coal; and *Punctatisporites glaber*, which in Illinois extends from the Mississippian up to the Murphysboro Coal. Also present in maceration 1630 are *Peppersites ellipticus*, which extends from the Caseyville Formation up to the New Burnside Coal in Illinois, and *Wilsonites circularis*, which extends from the base of the Tradewater Formation to the New Burnside Coal. In Iowa, these species extend as high as the Laddsville coal complex, which ranges from a single coal bed to a series of five closely spaced beds that cannot be individually correlated from place to place (Ravn 1986). According to Ravn, the Laddsville complex is equivalent in age to the interval between the Dawson Springs Coal Bed and the Murphysboro Coal in Illinois. *Ahrensisporites angulatus*, which previously had been recorded only in the Mt. Rorah and Murphysboro Coals, was also observed in maceration 1630.

At the same location (SW NE, Section 8, T10S, R1W), a lens of coal 3 feet below the "Boskydell marine zone" was sampled. This coal (maceration 2833, appendix A) is most equivalent to the Rock Island (No. 1) Coal Member near the top of the Atokan in northwestern Illinois (fig. 2). The dominance of *Punctatisporites minutus* (57.5%) and relative scarcity of *Lycospora* (3.5%) in maceration 2833 are typical of the Rock Island Coal. Other fern spores make up 18% of the spore assemblage. *Florinites mediapudens* (15.5%) is unusually abundant for a coal of this age.

Also present is *Zosterosporites triangularis*, which was reported (Peppers 1984) as occurring only in the Pope Creek and Tarter Coal Members just below the Rock Island Coal; however, I have since found rare specimens in the Rock Island Coal (unpublished ISGS data, 1987). Kosanke (1973, 1988) gave its range in northeastern Kentucky as from the roof strata of the Princess No. 5 coal to the seat rock of the Princess No. 5B coal, and in West Virginia from the Coalburg coal to the Upper No. 5 Block coal, which is approximately equivalent to the Rock Island Coal in Illinois. Ravn (1986) recorded the species in Iowa from the Caseyville Formation to the Laddsville coal complex, which is slightly younger than the Rock Island Coal. Thus, the sandstone containing marine fossils near the town of Boskydell is the "golden sandstone," an informal name (Nelson and Lumm 1990a) for a sandstone between the Oldtown Coal Bed (equivalent to the Rock Island Coal) and the Delwood Coal Bed above it.

A coal 32 inches thick occurs 4 to 5 feet below the "Boskydell marine zone" at SW NE SE, Section 8, T10S, R1W, Jackson County, about 1/4 mile south of the type section. Fuller (unpublished ISGS manuscript, c. 1920) and Wanless (1939) identified it as the Willis Coal. The 4 to 5 foot interval between the coal and the "Boskydell marine zone" is a sandy shale that contains plant fragments and coaly streaks. The geologic map of Illinois (Willman et al. 1967) indicates that the rocks at this site are near the base of the Abbott Formation, now called the Tradewater Formation. When the map was prepared, the Willis Coal was thought to correlate with the Bell Coal near the base of the Tradewater Formation (fig. 2) in

western Kentucky (Kosanke et al. 1960). This coal, called the Willis Coal, is actually equivalent to the Tarter Coal slightly below the middle of the Tradewater Formation.

The spore assemblage in the coal below the "Boskydell marine zone" (maceration 2313, appendix A) is greatly dominated by *Lycospora* (87%). The presence of *Dictyotriletes bireticulatus*, which extends from the Mississippian to the Rock Island Coal, and *Densosporites annulatus*, which extends from the Mississippian to the Tarter Coal, indicates that the coal is no younger than the Tarter Coal, located at about the middle of the Tradewater Formation. *Triquitrites sculptilis* and *Laevigatosporites globosus* are rare below the Smith coal bed of western Kentucky. Although not abundant, these two spores are well represented in the sample; therefore, the coal must be younger than the Smith coal bed of western Kentucky. It cannot be the Willis Coal, however, because the Willis contains abundant fern or seed fern spores, such as *Laevigatosporites globosus, Torispora, Punctatosporites minutus,* and *Punctatisporites minutus,* and the lycopod spore, *Radiizonates.*

Rare specimens of *Radiizonates*, however, were observed in the coal below the "Boskydell marine zone." This fact, combined with the abundance of *Lycospora*, indicates that the coal is probably equivalent to the Tarter Coal, the next coal below the Willis Coal. This report documents for the first time that a coal in southern Illinois is found to be equivalent to the Tarter Coal in northwestern Illinois, although the Willis Coal in southeastern Illinois had earlier been erroneously correlated with the Tarter Coal (Peppers 1977). Another Tarter Coal equivalent in T11S, R6E, Pope County, was recently identified by use of spores during geologic mapping of several quadrangles in southern Illinois (Peppers, unpublished ISGS data, 1990). The sandstone with marine facies above the Tarter Coal just south of the Boskydell type area is probably the "golden sandstone."

A coal bed 4 feet thick at SE NW, Section 12, T9S, R3W, Jackson County (fig. 1, site 2) lies about 80 feet above a 30 foot interval of fossiliferous "Boskydell Sandstone." Palynological analysis of this coal indicates that it is the Murphysboro Coal. The coal swamp flora consisted predominately of tree ferns, with lycopods and cordaites playing a minor role. In the bottom half of the coal (maceration 1266A, appendix A), the spore assemblage is mostly composed of *Punctatisporites minutus* (41%), *Laevigatosporites globosus* (27.0%), and *Triquitrites* (7.0%). Other miscellaneous fern spores account for about 4% of the assemblage. *Florinites mediapudens* (9%) represents cordaites, and *Granasporites medius* (6%) represents lycopods. *Lycospora*, the dominant genus in most Lower and Middle Pennsylvanian coals, amounts to less than 1%. In the upper half of the coal (maceration 1266B, appendix A), *Laevigatosporites globosus* (42%) is the most abundant species, and *Punctatosporites minutus* (15.5%) is second in abundance. Other fern spores include *Triquitrites* (8.5%), *Lophotriletes* (4.5%), and *Punctatisporites minutus* (1.5%). *Granasporites medius* (9.5%) is still the principal lycopod spore; *Lycospora granulata* represents 2% of the spore population. *Florinites,* at 2%, is less abundant in the upper half than in the lower half of this Murphysboro coal, but the sphenopsid spores—*Calamospora* (2.5%) and *Laevigatosporites desmoinesensis* (5%)—are more abundant in the upper half than in the lower half of the coal.

The rare occurrence of *Thymospora pseudothiessenii* in maceration 1266A indicates that the coal at site 2 is early Desmoinesian age and in the upper half of the Tradewater Formation above the Rock Island Coal. The presence of *Mooreisporites inusitatus, Triquitrites pulvinatus,* and *Murospora kosankei* in maceration 1266B, also indicates that the coal is younger than the Rock Island Coal. The stratigraphic range of *Lophotriletes mosaicus* is from the Hermon Coal Bed in northwestern Illinois, just above the Rock Island Coal, to the Mt. Rorah Coal in the middle of the upper half of the Tradewater Formation (fig. 2). *Lophotriletes copiosus* first appears just above the Hermon Coal. Also present in the coal of macerations 1266A and B are *Laevigatosporites striatus,* which extends from below the Rock Island Coal to the Wise Ridge Coal Member, and *Punctatisporites glaber,* which extends to the Murphysboro Coal. *Densosporites,* which very rarely occurs in the Murphysboro Coal, was not observed in either bench of the coal.

Generally, *Lycospora* and *Florinites* are better represented in the Murphysboro Coal than in the coal of macerations 1266A and B (appendix A). The coal at site 2, however, is very near the Oraville sandstone channel, which represents a stream that was contemporaneous with peat deposition. The sample may be from part of the coal swamp that was adjacent to a levee where ferns were abundant. A similar setting prevailed along the penacontemparaneous Galatia channel in the Springfield Coal Member in the Carbondale Formation in the southeastern part of the Illinois Basin (Eggert et al. 1983). In that locale, coal samples collected close to the Galatia channel have an unusually high abundance of the fern spores *Laevigatosporites globosus* and *Punctatosporites minutus* and an abnormally low percentage of *Lycospora.*

Jacobson (1983) investigated the geology and coal resources of the Murphysboro Coal in Perry and Jackson Counties. The outcrop from which the coal of macerations 1266A and B was taken is about 1 mile southeast of the subcrop line of the Murphysboro Coal (Jacobson 1983). The outcrop, however, is near the top of a hill and is probably an outlier. The Murphysboro Coal is 2.5 to 5.5 feet thick in the region; no other coal near the middle of the Tradewater Formation in Jackson County is known to be that thick.

A coal 2 to 4 inches thick was sampled from just below the "Boskydell marine zone" in E 1/2 SE SE, Section 14, T9S, R3W (fig. 1, site 3), Jackson County, less than 2 miles southwest of the sample site of the Murphysboro Coal discussed above. The spore assemblage (maceration 1434, appendix A) has a large diversity of species, and the coal most closely correlates with the Rock Island

and Oldtown Coals (fig. 2). Lycopod spores consisting of *Granasporites medius* (9%) and *Lycospora* (6%) are not well represented. The fern spores *Punctatosporites minutus* and *Punctatisporites minutus* account for 27% and 9% of the assemblage, respectively. *Florinites mediapudens* and *Laevigatasporites ovalis* each make up 13.5% of the spore population. Biostratigraphically useful spores include *Endosporites zonalis* and *Quasillinites diversiformis*, which extend from the Caseyville Formation to just below the Dawson Springs Coal in Illinois. Also found were *Peppersites ellipticus*, which disappears above the New Burnside Coal, and *Zosterosporites triangularis*, which has been found in the Tarter, Pope Creek, and Rock Island Coals of Illinois and in the Laddsville coal complex of Iowa (Ravn 1986).

Verrucosisporites cf. *V. verrucosus* and *Renisporites confossus* were also found in maceration 1434. In Illinois, *V. verrucossus* extends to the Hermon Coal overlying the Rock Island Coal, and *R. confossus* extends to the Pope Creek Coal, underlying the Rock Island Coal. In Iowa, *R. confossus* extends to the Cliffland Coal, which is slightly younger than or equivalent to the Rock Island. *Vestispora clara*, also present, first appears in the Pope Creek Coal and disappears below the Murphysboro Coal. One specimen each of *Densosporites glandulosus* and *Laevigatosporites contactus* was also found. *D. glandulosus* occurs sporadically up to the Rock Island Coal; *L. contactus* was reported by Ravn (1986), who first described it as being no younger than the Morrowan; therefore, the specimen was probably redeposited.

The "Boskydell marine zone" in Sections 12 and 14, T9S, R3W, is the "golden sandstone," since it is between the Murphysboro and Oldtown Coals. In Jackson County, the "Boskydell marine zone" also occurs in Section 8, T8S, R3W; Section 31, T9S, R1W; Section 26, T9S, R2W; Sections 12 and 14, T9S, R3W; Sections 5, 7, and 9, T10S, R1W; and Sections 3 and 4, T10S, R2W (unpublished ISGS field notes, c.1920-1930), but no coal beds have been found near these sites; therefore, the ages of the sandstones have not been palynologically determined.

Pope County

Henbest and Weller (unpublished ISGS field notes, 1926) described the "Boskydell Sandstone" in SW SE NE, Section 4, T11S, R6E, Pope County, as massive, calcareous, ferruginous, and containing shale pebbles and marine fossils. They wrote, "A coal occurring stratigraphically above this (fossiliferous sandstone) has been mined 200 yards down the hollow." The coal has a shale parting and is about 10 feet below another massive sandstone. This locality (fig. 1, site 4) was referred to as station 248 by Henbest and Weller and also as Weller's Pope County fossil collection No. 1. Thompson et al. (1959), however, in their study of fusulinids and ostracodes, placed station 248 in NE, Section 4, T11S, R6W, rather than in R6E. They described the outcrop in the section as, "highly fossiliferous limestone in thick sandstone exposed in a sharp north-south valley and 200 yards upstream, south, from farm crossing of stream, exposed on stream bed and banks, a few hundred feet stratigraphically above old coal mine working." Thus, Thompson et al. (1959) incorrectly described the coal as stratigraphically below the fossiliferous sandstone rather than above it. Also, the two units would not be stratigraphically separated by as much as a few hundred feet.

Dunbar and Henbest (1942) described the marine fauna in what they called the "Boskydell Sandstone" at station 248 in SW NE NE, Section 4, T11S, R6E. The SW NE NE is no doubt an error. The geologic map of the Eddyville Quadrangle shows that the Murray Bluff Sandstone is in SW SE NE and at a higher elevation than the coal, but because the rocks dip northward, the sandstone is stratigraphically below the coal. The SW NE NE location is downstream from the coal mine.

Many of the shells in the marine zone are reworked and poorly preserved, but Dunbar and Henbest (1942) identified *Fusulinella iowensis* var. *stouti*(?). The same variety was also recorded in the Seville Limestone by them and confirmed by Thompson and Riggs (1959). Thompson and Riggs concluded that the age of the fusulinid fauna is intermediate between that of fusulinid fauna in the Dunbar Limestone (now called Lead Creek Limestone Member) and the type Curlew Limestone in western Kentucky. They considered the "Boskydell Sandstone" to be stratigraphically below the Rock Island Coal.

Palynology of this coal (4 feet thick) above the "Boskydell marine zone" at station 248 indicates that it is the Delwood Coal (equivalent to the Bidwell Coal Bed). The coal was sampled in four benches represented in macerations 1833A-D. Maceration 1833A of the bottom bench yielded a poorly preserved spore assemblage and is, therefore, not listed in the appendix. Maceration 1833B (appendix A) is from a clay band between the bottom and middle benches. The most abundant spores in the clay band are *Lycospora pusilla* (24%), *L. granulata* (14%), *Laevigatosporites ovalis* (20%), and *L. globosus* (15.5%). The alga *Botryococcus* also is present. *Lycospora granulata* (60.5%) accounts for most of the spore population in the middle bench (maceration 1833C, appendix A) and is followed in abundance by *Laevigatosporites ovalis* (10%), *Laevigatosporites desmoinesensis* (9.5%), and *Lycospora pusilla* (6%). *Lycospora granulata* diminishes in abundance in the upper bench (maceration 1833D), but it is still the most common species at 25.5%. *Lycospora pusilla* (13.5%) and *L. pellucida* (7.5%) add to the total of *Lycospora*. Three species of *Laevigatosporites*—*L. globosus* (10.5%), *L. ovalis* (7.5%), and *L. desmoinesensis* (5%)—make up most of the remaining spore assemblage.

The coal at site 4 contains an abundance of *Lycospora*, a characteristic very typical of the Delwood Coal. *Camptotriletes confertus*, found in maceration 1833C, and *Vestispora wanlessii*, found in macerations 1833C and D, have short stratigraphic ranges. *C. confertus* extends from the Dawson Springs Coal to the New Burnside Coal in Illi-

nois. In Iowa, however, Ravn (1986) recorded this species in only the Blackoak Coal, which is slightly older than the Dawson Springs Coal. The range of *V. wanlessii* is from the Hermon Coal (one questionable specimen) to the New Burnside Coal, but it is most typical of the Delwood and New Burnside Coals. The presence of a distinct clay band in the coal, which is a characteristic of the Delwood Coal, is an additional clue to the identification of the coal.

Nelson and Lumm (1990a) mentioned the occurrence of fossiliferous, calcareous sandstone at the base of the Murray Bluff Sandstone in the Eddyville Quadrangle. A coal mined about 1.5 miles south of the "Boskydell" outcrops (site 5) is stratigraphically below the sandstone. Palynological analysis was conducted on three samples of this coal (macerations 2952-2954) from three closely spaced outcrops. Only maceration 2954 (appendix A), which contained the best preserved spores, is discussed in this report.

Maceration 2954 (NW NW NE, Section 16, T11S, R6E, site 5) is greatly dominated by *Lycospora* (54%), followed by *Laevigatosporites globosus* (15%) and *L. ovalis* (8%). *Densosporites annulatus* and *Radiizonates difformis*, diagnostic for identifying the Tarter Coal, are present but not common.

In Pope County, the "Boskydell" marine facies occurs in the Murray Bluff Sandstone between the Delwood and Tarter Coals.

Saline County

Wanless (unpublished ISGS field notes, 1933) reported the presence of *Derbyia, Fenestrellina, Ambocoelia, Mesolobus,* and trilobites in a calcareous sandstone at SW NW SE, Section 34, T10S, R6E, Saline County. He suggested that the sandstone may be equivalent to the "Boskydell Sandstone." The type area of the Delwood Coal is also in Section 34. A core drilled in the Eddyville Quadrangle (SE NE SE, Section 33), about 1/2 mile west of the "Boskydell" site, shows the coal is about 17 feet above the sandstone mapped as the Murray Bluff Sandstone by Nelson and Lumm (1990a). In the past (Kosanke et al. 1960, Hopkins and Simon 1975), the Delwood Coal was thought to underlie the Murray Bluff Sandstone and belong to the lower part of the Tradewater Formation rather than to the upper part. Although the coal is topographically below the Murray Bluff, the dip of the rocks indicates it is stratigraphically above the sandstone.

A sample of the Delwood Coal (maceration 2838, appendix B) was obtained from SW NW, Section 34 (fig. 1, site 6). Its spore assemblage is similar to those in macerations 1833A–D of the Delwood Coal about 1 mile southwest in Pope County. *Lycospora* at 78% is followed in abundance by *Laevigatosporites* at 8.5% of the spore assemblage in maceration 2838.

Henbest (1926) and Wanless (unpublished ISGS field notes, 1933) noted a zone of marine fossils and ironstone pebbles in loose blocks of sandstone along the bottom of Buzzard Roost Hollow at NE, Section 35, T10S, R5E, Saline County. The zone was thought to resemble the "Boskydell marine zone." A conglomerate containing marine fossils at the base of the Murray Bluff Sandstone also occurs at the top of the hill called Murray Bluff in NE NE, Section 35, T10S, R5E, Saline County. Henbest and Wanless thought the Willis Coal should be below the fossiliferous sandstone, but no coal was found.

A fault along Murray Bluff places the Murray Bluff Sandstone above the "golden sandstone," which is actually younger than the Murray Bluff Sandstone. The "golden sandstone" is not above the Delwood Coal, however, as shown in parts of the Stonefort and Eddyville Quadrangles (Nelson and Lumm (1990a, b), but it is older. Nelson and Lumm (1990a) found a coal at the base of Buzzard Roost Hollow and stratigraphically between the Murray Bluff Sandstone and "golden sandstone." Palynology of the coal (maceration 2951, appendix B; fig. 2) indicates that it is most closely equivalent to the Dawson Springs Coal, which is slightly younger than the Rock Island Coal.

Lycospora accounts for only 11% of the spore assemblage in the Dawson Springs Coal in contrast to the large percentage (78%) found in the Delwood Coal. The most abundant genus is *Laevigatosporites*: *L. globosus* (18.5%), *L. ovalis* (15%), *L. desmoinesensis* (14.5%), and *L. vulgaris* (3.5%). *Thymospora*, which first appears at the beginning of the Desmoinesian, is very rare in this sample.

Williamson County

Core G-1, drilled at SW SW, Section 28, T10S, R2E, Williamson County (fig. 2, site 8) during geologic mapping of the Goreville Quadrangle (Jacobson 1992), contains an interval of calcareous sandstone similar to the "Boskydell marine zone" in Jackson County. This marine zone, 3.5 feet thick, is a fine grained, argillaceous, medium olive gray sandstone with coal, clay, and shale fragments. Also present are crinoid and brachiopod fragments. Three unnamed coal beds lie above the marine zone: one bed is 15 feet above (maceration 3106C, appendix B); another, which failed to yield identifiable spores, is 40 feet above (maceration 3106D, appendix B); and the uppermost bed is 47 feet above (maceration 3106E). A coal (maceration 3106B, appendix B) also lies 10 feet below the marine zone.

The spore assemblage in the uppermost coal (maceration 3106E) is poorly preserved, so relative percentages of spore taxa could not be determined. The assemblage, however, is most similar to that in the Tarter Coal. In the Illinois Basin, *Radiizonates difformis* has been found only in the Willis and Tarter Coals; however, the species is rare in the Tarter Coal. Rare specimens of *R. difformis* were found in maceration 3106E. It also contains *Densosporites annulatus*, which extends from the Mississippian to the Tarter Coal, and an abundance of *Lycospora granulata*, which is also characteristic of the Tarter Coal. Maceration 3106E correlates with maceration 2313 (appendix A) of the Tarter Coal (discussed earlier), which crops out slightly below a marine, calcareous

sandstone near the type section of the "Boskydell Sandstone" in Jackson County.

The unnamed coal (maceration 3106C) 15 feet above the marine zone contains an abundance of *Lycospora* (84.5%) and lacks *Triquitrites sculptilis, Laevigatosporites globosus, Vestispora fenestrata,* and *Torispora,* indicating that it is stratigraphically between the Tunnel Hill Coal Bed (equivalent to the Bell Coal in western Kentucky) and the Smith Coal Bed.

The coal below the fossiliferous sandstone (maceration 3106B) in core G-1 correlates with the Tunnel Hill Coal Bed. Maceration 3106B is greatly dominated by *Lycospora* (95%) and contains only 2% fern spores. Only one specimen of *Endosporites globiformis,* which first appears in the Tunnel Hill Coal and extends through the rest of the Pennsylvanian, was observed. The presence of *Radiizonates striatus* and *Waltzispora prisca* also indicates that the coal is no younger that the Tunnel Hill Coal. *R. striatus* has been previously reported to extend from the Mississippian to almost as high as the Tunnel Hill Coal. The stratigraphic range of *Waltzispora prisca* is from the Mississippian to the Bell and Tunnel Hill Coals (Peppers 1974). The marine facies in core G-1 is, therefore, at the base of the Ozark sandstone lentil slightly above the Tunnel Hill Coal (fig. 2).

A marine zone possibly equivalent to the "Boskydell marine zone" was noted in the southeast part of the Creal Springs Quadrangle in Sections 27, 28, 31–33, T11S, R4E, and Sections 5, 6, T12S, R4E, Johnson County (Trask and Jacobson 1990). The early Atokan marine zone is in argillaceous limestone and black shale and contains abundant marine fossils. It lies below the Cedar Creek sandstone lentil and above the Ozark sandstone lentil. This zone is not typical of the "Boskydell" because the fossiliferous facies is not in a sandstone. The overlying Cedar Creek sandstone lentil, however, grades into interbedded sandstone and shale that contain marine fossils similar to those in the "Boskydell marine zone." These sandstone lentils are equivalent to part of the thicker Finnie Sandstone along the Ohio River in western Kentucky. The Finnie Sandstone lies between the Ice House (equivalent to Willis Coal in Illinois) and Bell coal beds. No coal beds in the southeast part of the Creal Springs Quadrangle were studied.

Fraunfelter et al. (1973) noted the presence of crinoid columnals, brachiopods, gastropods, and horn corals in a sandstone exposed in the spillway of Little Grassy Lake (Section 18, T10S, R1E, Williamson County). Devera (1989) thought an ichnofossil assemblage at the Little Grassy Lake spillway belonged to the middle of the lower half of the Tradewater Formation, which is Atokan age and stratigraphically close to the "Boskydell marine zone" in Jackson County mentioned by Lamar (1925). The "Boskydell marine zone" noted by Lamar is, however, early Desmoinesian age. The age of the sandstone at the Little Grassy Spillway is still in doubt. Because no coal beds are present at the spillway, palynological evidence concerning the age of the ichnofossils is not available.

Gallatin County

Baxter and Desborough (1965) noted the presence of quartz pebbles and poorly preserved crinoid columnals, solitary corals, and brachiopods in a medium to thin bedded sandstone interbedded with carbonaceous shale in Gallatin County. This sandstone, thought by Desborough (1959) to correlate with the "Boskydell marine zone" in southwestern Illinois, was noted by Baxter and Desborough (1965) in SE SW, Section 25; SW SW, Section 27; SW SW Section 28; and W1/2 SW, Section 29, all in T10S, R8E. Baxter and Desborough (1965) stated that this fossil zone, which is just below the base of the Grindstaff Sandstone, extends in outcrops for at least 5 miles. Butts (1925) designated the Grindstaff as the sandstone above the Caseyville Formation and immediately below the Willis Coal. Kosanke et al. (1960) thought that the Willis Coal correlated with the Bell coal in western Kentucky and the Tarter Coal in northwestern Illinois (fig. 2). Peppers (1977) proposed that the Willis Coal correlates with the Ice House coal in western Kentucky and the Pope Creek Coal in Illinois. The Pope Creek Coal is considerably younger than the Bell Coal. In western Kentucky, the Ice House overlies the Finnie Sandstone; therefore, the Grindstaff is equivalent to the upper part of the Finnie Sandstone and not below the Finnie, as shown by Nelson and Lumm (1986a, b, c).

The Willis Coal was mined immediately above the Grindstaff Sandstone at the Schneider Mine (NW SE, Section 30, T10S, R9E), less than 1 mile from the coal's type locality (fig. 1, site 9). Palynology of the coal shows that it is much younger than the Bell Coal and stratigraphically between the Oldtown and Tarter Coals. Hence, the "Boskydell Sandstone" in Gallatin County is just below the Grindstaff Sandstone and equivalent to the upper part of the Finnie Sandstone of western Kentucky (fig. 2). The spore assemblage in the Willis Coal from the Schneider Mine is dominated by fern spores. In the lower half of the coal (maceration 625A, appendix B), *Laevigatosporites globosus* makes up 25% of the spore assemblage; other fern spores make up 14.5%. *L. ovalis* (19.5%) is the second most abundant species. *Lycospora* accounts for only 6.5%, but other lycopod spores, *Densosporites* (19%) and *Radiizonates* (7%), are well represented. In the upper half of the coal (maceration 625B, appendix B), *Lycospora* and *Radiizonates* increase to 23% and 18%, respectively, and *Laevigatosporites globosus* and *L. ovalis* decrease to 18.5% and 16.5%, respectively.

Baxter and Desborough (1965) mentioned the presence of marine fossils in other sandstones above the Abbott Formation (now called the lower part of the Tradewater) in Gallatin County. A sandstone mapped as the Murray Bluff Sandstone by Baxter and Desborough (1965) is underlain by a coal they identified as the Delwood Coal. Geologists at the time thought the Delwood Coal was beneath the Murray Bluff Sandstone. The coal at NE SW NE, Section 30, T10S, R9E (fig. 1, site 9), palynologically correlates, however, with the Oldtown Coal. Thus, the overlying sandstone is not the Murray

Bluff but a correlative of the "golden sandstone" in Jackson County. The spore assemblage in the Oldtown Coal (maceration 2784, appendix B) largely consists of fern spores: *Punctatisporites minutus* (34%), *Laevigatosporites globosus* (20%), *Latosporites minutus* (12%), *Punctatosporites minutus* (3%), and others (4.5%). Only 14.5% of the assemblage is *Lycospora*.

Baxter et al. (1963) identified another coal as the Willis Coal in NW, Section 33, T10S, R9E, Gallatin County (fig. 1, site 10), which also palynologically correlates with the Oldtown Coal. Maceration 2023 of this coal contains mostly fern spores: *Laevigatosporites globosus* (26.5%), *Punctatisporites minutus* (17.5%), *Latosporites minutus* (10.5%), *Punctatosporites minutus* (3.5%), and others (2.5%). *Lycospora* amounts to 24.5%.

CONCLUSIONS

The "Boskydell Sandstone" is no longer recognized as a formal name for the reddish brown to gray, fine to medium grained, crossbedded sandstones in the lower Middle Pennsylvanian in southern Illinois. The sandstones contain some ironstones and quartz pebbles, but their distinctive feature is the occurrence of marine fossils including crinoid columnals, brachiopods, pelecypods, cephalopods, bryozoa, and trilobites. Uncertainty in determining the stratigraphic relations of similar occurrences has led to miscorrelation of some sandstones because of their discontinuity and lack of diagnostic fossils or distinctive characteristics. Palynology of coal beds above and below the marine sandstone was used to determine the age of some sandstones designated as "Boskydell Sandstone."

The fossiliferous marine facies in the "Boskydell Sandstone" near the town of Boskydell in Jackson County contains a thin coal at its base and top. The basal coal was correlated with the Oldtown and Rock Island Coals and the upper coal was correlated with the New Burnside Coal. This sandstone is therefore a correlative of the informally named "golden sandstone" (Nelson and Lumm 1990a, b) just above the middle of the Tradewater Formation. The marine facies also occurs about 1/4 mile south of the type section of the "Boskydell" where it is underlain by the Tarter Coal. This marine facies is, however, probably the same age as the facies near Boskydell. About 12 miles west of Boskydell in Jackson County, another thin coal bed at the base of a fossiliferous sandstone, was correlated with the Rock Island Coal. A coal 4 feet thick that palynologically correlates with the Murphysboro, occurs about 80 feet above the marine sandstone in the same area.

In southern Saline and northern Pope Counties, the Murray Bluff Sandstone contains a fossiliferous marine facies. The Dawson Springs Coal overlies this fossiliferous marine facies in the region of Murray Bluff, about 3 miles southwest of the town of Delwood. The Tarter Coal crops out below the marine sandstone south of Delwood.

A core drilled in southwestern Williamson County contains fossiliferous marine zones in a sandstone near the base of the Tradewater Formation. The latter sandstone has been called the "Boskydell Sandstone," but it is much older than the sandstone near the town of Boskydell. The age of the sandstone containing shell fossils and ichnofossil assemblages at Little Grassy Creek in southwestern Williamson County and referred to as the "Boskydell Sandstone" (Devera 1989) was not determined because no coal beds are present above or below it. A fossiliferous limestone and shale near the base of the Tradewater Formation in the Creal Springs Quadrangle, thought to be equivalent to the "Boskydell" (Trask and Jacobson 1990), is not typical of the "Boskydell Sandstone" near the town of Boskydell. The overlying Cedar Creek sandstone lentil contains marine fossils, but its age is middle Atokan; thus, it is older than the type "Boskydell Sandstone."

In Gallatin County in southeastern Illinois, a fossiliferous marine facies in the Grindstaff Sandstone, which was once considered a correlative of the "Boskydell," is overlain by the Willis Coal. This fossiliferous sandstone correlates with the upper part of the Finnie Sandstone of western Kentucky. Younger, fossiliferous sandstones reported in Gallatin County by Baxter and Desborough (1965) probably correlate with the Murray Bluff Sandstone, which overlies the Willis Coal and the "golden sandstone," which overlies the Oldtown Coal.

Palynology of adjacent coal beds has shown that the sandstones referred to as "Boskydell Sandstone" or "Boskydell marine zone" occur stratigraphically from the lowermost part of the Tradewater Formation to the "golden sandstone" in the middle of the formation. The sandstones range in age from earliest Atokan (Westphalian B) to the boundary between the Atokan and Desmoinesian (early Westphalian D). The zone of marine fossils in the "golden sandstone" probably represents the Curlew Limestone in western Kentucky, but the older sandstones with marine facies are not known to have any named limestone counterparts elsewhere in the Illinois Basin. The "golden sandstone" may be equivalent to the sandstone (formerly called Curlew Sandstone) that overlies the Dawson Springs and underlies the Delwood Coal. To avoid adding to the difficulty of correlating sandstones, the use of "Boskydell Sandstone" should be discontinued and replaced by "fossiliferous marine facies" followed by the name of the sandstone. If the name of the sandstone is not known, it should be referred to by its relative position in the Tradewater Formation; for example, "marine sandstone beds in the middle of the Tradewater Formation."

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APPENDIX A

PERCENTAGE OF SPORE TAXA IN COAL MACERATIONS FROM SITES 1 TO 5

Spore taxa	Macerations									
	1630	2833	2313	1266A	1266B	1434	1833B	1833C	1833D	2954
	New Burnside Coal	Rock Island Coal	Tarter Coal	Murphysboro Coal		Rock Island Coal	Delwood Coal			Tarter Coal
Deltoidospora levis (Kos.) Ravn					+					
D. priddyi (Berry) McGregor	0.5					2.0				
D. pseudolevis (Peppers) Ravn	+					+				
D. sphaerotriangula (Lo.) Ravn				+						
D. subadnatoides (Bhardwaj) Ravn		+		0.5		1.5				
Punctatisporites edgarensis Peppers			+							
P. cf. *edgarensis* Peppers	+									
P. flavus (Kos.) Pot. and Kr.	+		+			+				
P. glaber (Naumova) Playford		1.0	+	+		5.0				
P. minutus (Kos.) Peppers	16.5	57.5	0.5	1.0	1.5	9.0	0.5			
P. cf. *nudus* Artüz						+				
P. obesus (Lo.) Pot. and Kr.			+				+			
Calamospora breviradiata Kos.			+	+	2.5			0.5	3.5	1.2
C. hartungiana Schopf	+	+				+				
C. liquida Kos.	+					+				
C. straminea Wil. and Kos.	+	+							+	0.4
C. spp.				0.5						
Granulatisporites adnatoides (Pot. and Kr.) Sm. and But.	+		+							+
G. adnatus Kos.	+				+					
G. granulatus Ibr.		0.5								
G. granularis Kos.	+					+				0.8
G. minutus Pot. and Kr.	1.5	+		1.0	0.5	1.0				
G. pallidus Kos.		0.5	+		0.5		0.5			
G. verrucosus (Wil. and Coe) S. W. and B.						1.5				
G. spp.	0.5						0.5	0.5		
Cyclogranisporites aureus (Lo.) Pot. and Kr.		+								
C. cf. *aureus*			+							
C. leopoldi (Kr.) Pot. and Kr.			0.5							
C. microgranus Bhardwaj			+							
C. minutus Bhardwaj		2.5				0.5				
C. sp.								+		
Verrucosisporites microtuberosus (Lo.) Sm. and But.	+				+	0.5				
V. sifati (Ibr.) Sm. and But.	0.5					+				
V. verrucocus (Ibr.) Ibr.									+	
V. cf. *verrucosus* (Ibr.) Ibr.	0.5	+				+				
Lophotriletes commissuralis (Kos.) Pot. and Kr.	+	+								
L. copiosus Peppers					+					
L. gibbosus (Ibr.) Pot. and Kr.										+
L. granoornatus Artüz	+									
L. ibrahimii (Peppers) Pi-Radondy and Doub.	+									
L. microsaetosus (Lo.) Pot. and Kr.	1.0	1.0			4.0	0.5				0.8

Appendix A *continued*

Spore taxa	Macerations									
	1630 New Burnside Coal	2833 Rock Island Coal	2313 Tarter Coal	1266A Murphysboro Coal	1266B Murphysboro Coal	1434 Rock Island Coal	1833B Delwood Coal	1833C Delwood Coal	1833D Delwood Coal	2954 Tarter Coal
L. mosaicus Pot. and Kr.			+		0.5	+				
L. pseudaculeatus Pot. and Kr.		+			+					
L. rarispinosus Peppers	0.5				+					
Anapiculatisporites grundensis Peppers									0.5	
A. spinosus (Kos.) Pot. and Kr.	+			+	0.5					
Pustulatisporites pustulatus Pot. and Kr.			+							
Apiculatasporites setulosus (Kos.) Ravn		+				+				
A. spinulistratus (Lo.) Ibr.			+							
A. variosetosus (Peppers) Ravn	+									
Pilosisporites aculeolatus (Kos.) Ravn	+	0.5		0.5	3.0	0.5			0.5	
Raistrickia abdita (Lo.) S. W. and B.	+	+								
R. aculeata Kos.			+							
R. aculeolata Wil. and Kos.						+				
R. crinita Kos.					+	+				
R. crocea Kos.	+	1.5	+			+	0.5	+		0.4
R. lowellensis Peppers						+				
R. pilosa Kos.	+					+				
R. subcrinita Peppers			+							
Spackmanites habibii Ravn					0.5	+				
Convolutispora florida Hoff., Stap., and Mall.		+			+					+
C. sp.			+							
Microreticulatisporites nobilis (Wicher) Knox	+		+	+		+	+			+
M. sulcatus (Wil. and Kos.) Sm. and But.	0.5	0.5		+	0.5	+	0.5			
Dictyotriletes bireticulatus (Ibr.) Pot. and Kr.			+							
Camptotriletes confertus (Ravn) Ravn									+	
Ahrensisporites angulatus (Kos.) Pot. and Kr.		+								
Triquitrites additus Wil. and Hoff.			+		3.5	+				0.4
T. bransonii Wil. and Hoff.	2.0	+	2.0	6.5	5.0	2.0	5.0	1.0	4.5	1.2
T. exiguus Wil. and Kos	+	+	+			+				
T. pulvinatus Kos.				0.5			+	+	0.5	
T. sculptilis (Balme) Sm. and But.	1.0	+	4.5			+				+
T. subspinosus Peppers				+						
T. spp.										0.4
Zosterosporites triangularis Kos.		+				+				
Mooreisporites inusitatus (Kos.) Neves					+					
Knoxisporites stephaneformis Love										+
K. triradiatus Hoff., Stap. and Mall.										+
Reticulatisporites muricatus Kos.					+					
R. reticulatus (Ibr.) Ibr.	+					0.5				
R. reticulocingulum (Lo.) Lo.	+									
Crassispora kosankei (Pot. and Kr.) Sm. and But.	+	+	+				1.0		0.5	
Granasporites medius (Dybova and Jachowicz) Ravn et al.	6.0	1.0	0.5	6.0	9.5	9.0		0.5	6.0	1.2
Murospora kosankei Somers			+	+	+					

Appendix A *continued*

Spore taxa	Macerations									
	1630 New Burnside Coal	2833 Rock Island Coal	2313 Tarter Coal	1266A Murphysboro Coal	1266B Murphysboro Coal	1434 Rock Island Coal	1833B Delwood Coal	1833C Delwood Coal	1833D Delwood Coal	2954 Tarter Coal
Densosporites annulatus (Lo.) Sm. and But.			+							1.6
D. glandulosus Kos.						+				
D. sphaerotriangularis Kos.	+	3.0	0.5			+				+
D. triangularis Kos.	+	0.5	+							
Lycospora granulata Kos.	6.5	3.0	80.0		2.0	5.0	14.0	60.5	25.5	54.0
L. micropapillata (Wil. and Coe) S. W. and B	1.0		0.5						1.0	2.0
L. pellucida (Wicher) S. W. and B.	1.5	0.5	1.0			0.5	4.0	4.0	7.5	0.4
L. pusilla (Ibr.) S. W. and B.	3.0		5.0				24.0	6.0	13.5	
L. rotunda Bhardwaj	0.5				+	0.5			0.5	
Cirratriradites annulatus Kos. and Brokaw	+		0.5	0.5	+					
C. annuliformis Kos. and Brokaw			+							
C. maculatus Wil. and Coe	+		+		+					
C. saturni (Ibr.) S. W. and B.	+		+		+	0.5				0.4
Radiizonates difformis (Kos.) Stap. and Jansonius			+							+
Endosporites globiformis (Ibr.) S. W. and B.		+	+	+	0.5		+	3.0	3.5	4.6
E. plicatus Kos.						+				
E. zonalis (Lo.) Knox						+			+	+
Alatisporites hoffmeisterii Morgan					+	+				
A. trialatus Kos.					+					
Laevigatosporites contactus Ravn						+				
L. desmoinesensis (Wil. and Coe) S. W. and B.	1.5	0.5		0.5	2.0	1.0	6.0	9.5	5.0	0.8
L. globosus Schemel	30.5	0.5	2.5	27.0	42.0	+	15.5	2.0	10.5	14.8
L. medius Kos.					0.5	1.0				
L. ovalis Kos.	0.5	+	0.5	3.0	3.0	13.5	20.0	10.0	7.5	7.6
L. striatus Alp.				+	+				+	
L. vulgaris (Ibr.) Ibr.	0.5	+	+	0.5	+	1.5	1.0	+		
Renisporites confossus Winslow						+				
Latosporites minutus Bhardwaj		4.0			0.5					
Punctatosporites minutus (Ibr.) Alp. and Doub.	13.5	3.5	0.5	41.0	15.5	27.0	5.0	1.5	6.0	1.2
Spinosporites exiguus Upshaw and Hedlund		2.0								
Thymospora pseudothiessenii (Kos.) Wil. and Venk.				1.0						
Dictyomonolites swadei Ravn	+		+			1.5				
Torispora securis (Balme) Alp., Doub., and Horst.	+	+	+			0.5	1.0	0.5		0.4
Vestispora clara (Venk. and Bharadwaj) Ravn						+				
V. fenestrata (Kos. and Brokaw) Spode	0.5	0.5		0.5		+	0.5		+	
V. foveata (Kos.) Wil. and Venk.	+		0.5			0.5				
V. laevigata Wil. and Venk.				0.5	+					
V. *pseudoreticulata* Spode										+
V. wanlessii Peppers									+	
V. sp.						+				
Florinites mediapudens (Lo.) Pot. and Kr.	9.5	15.5	0.5	9.0	2.0	13.5	0.5		3.5	3.6
F. millotti But. and Williams					+					+
F. *similis* Kos.					+					
F. visendus (Ibr.) S. W. and B.			+		+					
F. volans (Lo.) Pot. and Kr.	+	+			+					

Appendix A *continued*

Spore taxa	Macerations								
	1630 New Burnside Coal	2833 Rock Island Coal	2313 Tarter Coal	1266A Murphysboro Coal	1266B Murphysboro Coal	1434 Rock Island Coal	1833B Delwood Coal	1833C Delwood Coal	1833D Delwood Coal	2954 Tarter Coal
Wilsonites circularis (Guennel) Peppers and Ravn	+									
W. delicatus (Kos.) Kos.					+					
W. vesicatus (Kos.) Kos.	+		+		+					
Quasillinites diversiformis (Kos.) Ravn and Fitzgerald						+				
Peppersites ellipticus Ravn	+	+				+				
Botryococcus			+				+			

+ Spore present but not observed in count; if species is not present, the column is blank.
Alp. - Alpern; Doub. - Doubinger; Hoff., Stap., and Mall. - Hoffmeister, Staplin, and Malloy; Ibr. - Ibrahim; Kos. - Kosanke; Lo. - Loose; Pot. and Kr. - Potonié and Kremp; S. W. and B. - Schopf, Wilson, and Bentall; Sm. and But. - Smith and Butterworth; Venk. - Venkatachala; Wil. - Wilson

APPENDIX B

PERCENTAGE OF SPORE TAXA IN COAL MACERATIONS FROM SITES 6 TO 10

Spore taxa	Macerations								
	2838	2951	3106E*	3106C**	3106B	625B	625A	2784	2023
	Delwood Coal	Dawson Springs Coal	Tarter Coal		Bell Coal	Willis Coal		Old Town Coal	
Deltoidospora levis (Kos.) Ravn									+
D. priddyi (Berry) McGregor		2.0			+	2.0		0.5	1.0
D. subadnatoides (Bhardwaj) Ravn		0.5							
D. spp.						0.5	0.5		
Punctatisporites glaber (Naumova) Playford			+					0.5	+
P. minutus (Kos.) Peppers		6.0			0.5	3.0	1.5	34.0	17.5
P. obesus (Lo.) Pot. and Kr.							+	+	+
Calamospora breviradiata Kos.	1.0	1.0		0.5			3.0		0.5
C. flexilis Kos.						+	1.5		
C. hartungiana Schopf (in S. W. and B.)		0.5	+	0.5	+	0.5	0.5		+
C. liquida Kos		+							
C. mutabilis (Lo.) S. W. and B.							0.5		
C. straminea Wil. and Kos.		1.0				+			
C. spp.		0.5							
Granulatisporites adnatus Kos.									+
G. granularis Kos.		0.5						1.5	+
G. granulatus Ibr.				+					
G. minutus Pot. and Kr.			+	0.5	0.5				0.5
G. pallidus Kos.		0.5							+
G. verrucosus (Wil. and Coe) S. W. and B.		1.0	+						
Cyclogranisporites aureus (Lo.) Pot. and Kr.				0.5				+	
C. cf. *aureus* (Lo.) Pot. and Kr.		+							
C. microgranus Bhardwaj		1.0							
C. minutus Bhardwaj	0.5	1.0							
C. orbicularis (Kos.) Pot. and Kr.	0.5								
C. staplinii (Peppers) Peppers		+							
C. spp.					0.5				
Verrucosisporites microtuberosus (Lo.) Sm. and But.		1.0				+	4.5		
V. sifati (Lo.) Sm. and But.						+	+	+	+
V. verrucosus (Ibr.) Ibr.								+	
V. cf. *verrucosus* (Ibr.) Ibr.								+	+
Lophotriletes commissuralis (Kos.) Pot. and Kr.				0.5					
L. ibrahimii (Peppers) Pi-Radondy and Doub.									+
L. microsaetosus (Lo.) Pot. and Kr.			+					1.0	+
L. mosaicus Pot. and Kr.		0.5							
L. rarispinosus Peppers						0.5			
Anapiculatisporites grundensis Peppers	1.0								
Waltzispora prisca (Kos.) Sullivan					+				
Pustulatisporites crenatus Guennel		+							
Apiculatasporites latigranifer (Lo.) Ravn		+							
A. setulosus (Kos.) Ravn		+							
A. spinososaetosus (Lo.) Ravn		0.5							
A. spp.		0.5				+			

Appendix B *continued*

Spore taxa	Macerations								
	2838 Delwood Coal	2951 Dawson Springs Coal	3106E* Tarter Coal	3106C**	3106B Bell Coal	625B Willis Coal	625A Willis Coal	2784 Old Town Coal	2023 Old Town Coal
Planisporites granifer (Ibr.) Knox									+
Pilosisporites aculeolatus (Kos.) Ravn	+					2.0			
P. spp.						0.5			
Raistrickia abdita (Lo.) S.W. and B.		0.5						+	
R. aculeolata Wil. and Kos.		+							
R. breviminens Peppers		+							
R. crinita Kos.								+	
R. crocea Kos.		+						+	+
R. pilosa Kos.		+							
Spackmanites habibii Ravn				+					
Convolutispora florida Hoff., Stap., and Mall								+	
Microreticulatisporites harrisonii Peppers					0.5				
M. sulcatus (Wil. and Kos.) Sm. and But.	+								
Dictyotriletes bireticulatus (Ibr.) Pot. and Kr.							1.0		+
D. sp.						0.5			
Camptotriletetes sp.									
Ahrensisporites guerickei (Horst) Pot. and Kr.				+					
Tantillus triguetrus Felix and Burbridge						+			
Triquitrites additus Wil. and Hoff.	1.0	+							
T. bransonii Wil. and Hoff.	0.5	3.5						+	+
T. exiguus Wil. and Kos.		+						+	
T. sculptilis (Balme) Sm. and But.	+	2.0	+					0.5	1.0
T. subspinosus Peppers		0.5							
T. spp.									
Reinschospora triangularis Kos.						+			+
Knoxisporites stephaneformis Love		+							
K. triradiatus Hoff., Stap., and Mall.							+		
K. sp.									
Reticulatisporites reticulatus (Ibr.) Ibr.	+					0.5		+	+
R. reticulocingulum (Lo.) Lo.						+	+	+	
Reticulitriletes falsus (Pot. and Kr.) Ravn									+
Savitrisporites nux (But. and Wil.) Sm. and But.				+	+				
Cuneisporites rigidus Ravn						+			
Crassispora kosankei (Pot. and Kr.) Sm. and But.			+	2.5	2.5				0.5
Granasporites medius (Dybova and Jachowicz) Ravn et al.		2.0		2.0			0.5		
Simozonotriletes intortus (Waltz) Pot. and Kr.									+
Densosporites annulatus (Lo.) Sm. and But.			+	5.5	+				
D. irregularis Hacquebard and Barss					+				
D. sphaerotriangularis Kos.	+		+		+	7.0	18.0	+	+
D. triangularis Kos.							1.0		
Lycospora granulata Kos.	73.0	9.0		13.5	77.5	17.0	0.5	12.5	16.5
L. micropapillata (Wil. and Coe) S. W. and B.	1.0		+		1.0	3.5			1.0
L. noctuina But. and Williams					0.5				
L. pellucida (Wicher) S. W. and B.			+	35.0	7.5		6.0	0.5	3.0
L. pusilla (Ibr.) S. W. and B.	2.5	2.0		24.5	8.5	2.5		0.5	3.5
L. rotunda Bhardwaj	1.5	1.5		1.5					
L. subjuga Bhardwaj					+			1.0	0.5

Appendix B *continued*

Spore taxa	Macerations								
	2838 Delwood Coal	2951 Dawson Springs Coal	3106E* Tarter Coal	3106C**	3106B Bell Coal	625B Willis Coal	625A Willis Coal	2784 Old Town Coal	2023 Old Town Coal
Cristatisporites indignabundus (Lo.) Stap. and Jansonius			+		+				
Paleospora fragila Habib							+		
Cirratriradites annulatus Kos. and Brokaw	+								
C. annuliformis Kos. and Brokaw						+			
C. maculatus Wil. and Coe						0.5	0.5	+	
C. saturni (Ibr.) S. W. and B.			+		0.5			+	
C. sp.							+		
Radiizonates difformis (Kos.) Stap. and Jansonius			+			10.0	5.5		
R. rotatus (Kosanke) Stap. and Jansonius						8.0	1.5		
Endosporites globiformis (Ibr.) S. W. and B.	4.5	+	+	7.0	+		+	0.5	
E. plicatus Kos.				+					
E. zonalis (Loose) Kos.						+		+	+
Alatisporites hexalatus Kos.									+
A. hoffmeisterii Morgan						+			
A. pustulatus (Ibr.) Ibr.									+
A. trialatus Kos.	+								+
A. sp.								+	
Laevigatosporites desmoinesensis (Wil. and Coe) S. W. and B.	5.5	14.5		1.0		+	0.5	2.5	5.5
L. globosus Schemel	1.0	18.5				18.5	25.0	20.0	26.5
L. ovalis Kos.	2.0	15.0	+		+	16.5	19.5	8.5	7.5
L. punctatus Kos.			+			3.5	5.0		
L. vulgaris (Ibr.) Ibr.	+	3.5				+	0.5		0.5
Renisporites confossus Winslow							+		
Latosporites minutus Bhardwaj		0.5						12.0	10.5
Punctatosporites minutus (Ibr.) Alp. and Doub.	0.5	3.0	+	0.5			1.0	3.0	3.5
Spinosporites exiguus Upshaw and Hedlund	1.0					1.0	0.5		
Thymospora pseudothiessenii (Kos.) and Venk.	0.5	+							
Torispora securis (Balme) Alp., Doub., and Horst		1.5				1.5	0.5	0.5	+
Vestispora fenestrata (Kos. and Brokaw) Spode	+	+							
V. pseudoreticulata Spode		0.5	+						
V. sp.		0.5		+					
Florinites mediapudens (Lo.) Pot. and Kr.	2.0	1.5	+	3.0		3.5	1.0	0.5	0.5
F. similis Kos.			+	1.0				+	
F. volans (Lo.) Pot. and Kr.	+	2.0						+	+
Wilsonites delicatus (Kos.) Kos.			+	0.5					
W. vesicatus (Kos.) Kos.		+							+
Quasillinites diversiformis (Kos.) Ravn and Fitzgerald			+						
Peppersites ellipticus Ravn		+							

* Spore too poorly obeserved to determine relative abundance

** Unnamed coal between Bell and Smith Coal Beds

\+ Spore present but not observed in count; if species is not present, the column is blank

Alp. - Alpern; Doub. - Doubinger; Hoff., Stap., and Mall. - Huffmeister, Staplin, and Malloy; Ibr. - Ibrahim; Kos. - Kosanke; Lo. - Loose, Pot. and Kr. -Potonié and Kremp; S. W. and B. - Schopf, Wilson, and Bentall; Sm. and But. - Smith and Butterworth; Venk. - Venkatachala; Wil. - Wilson