

# Miospore Zonation in the Brookville (No. 4) Coal (Pennsylvanian) of Ohio<sup>1</sup>

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**ABSTRACT.** Samples of the Brookville Coal collected from two localities in northeastern Ohio were analyzed palynologically. *Laevigatosporites globosus*, the most abundant species, accounted for up to 85% by number of the sample populations. Four assemblages, characterized by combinations of the genera *Laevigatosporites*, *Lycospora*, *Florinites*, and *Acanthotriletes*, are recognized. Although the basal zones at the two localities are somewhat different, the middle and upper zones are remarkably similar, providing palynological evidence which suggests that the two exposures are part of the same stratigraphic unit. Paleocological evidence indicates that the Brookville was deposited in a swamp that was forested primarily by tree ferns during most of its existence.

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## INTRODUCTION

The palynology of Pennsylvanian-age coals has been little studied in Ohio; among the few significant investigations are those of Kosanke (1943) on the Pittsburg and Pomeroy Coals and Gray (1967) on the Lower and Middle Kittanning, Lawrence, and Strasburg Coals. In order to expand our information on coal palynology in Ohio, a series of studies on the Allegheny Group was conducted at Kent State University (Huesken 1984, Anderson 1985, Hasenstaub 1985). The purpose of the present report, which is in part derived from the latter study, is to describe and interpret the miospore zonation, miospore succession, and paleoecology of the Brookville Coal.

## STRATIGRAPHIC FRAMEWORK

The Allegheny Group underlies approximately 23,000 km<sup>2</sup> of Ohio at an average thickness of 65 m (Collins 1979) and is comprised of 32 named beds. The lowermost of this group, the Brookville Coal, was first named and described by Rogers (1858) for outcrops in the Brookville, Pennsylvania area. It is not one of the major coal producing beds of Ohio, although it is locally important in Stark, Tuscarawas, and Vinton Counties (DeLong 1957). The total original reserves of the Brookville were estimated by DeLong (1957) to be 446,215,000 short tons.

The Allegheny Group is divided into 13 named cyclothems (Branson 1962). The Brookville cyclothem, the lowest one, is composed of four members: Homewood Sandstone, Brookville Underclay, Brookville Coal, and Putnam Hill Limestone or Shale (Sturgeon et al. 1958). The Homewood Sandstone and Brookville Underclay are generally considered to be part of the Pottsville Group, although Sturgeon et al. (1958) included them in the Allegheny. All of the members vary considerably in thickness, even over relatively short horizontal distances. Also, any of the members, particularly the Brookville Coal, may be locally absent in Ohio.

## METHODS AND MATERIALS

The samples for this study were collected from two outcrops in Stark and Tuscarawas counties, Ohio. The first outcrop, hereafter referred to as the Canton locality, is located along I-77 at the northwest corner of the I-77 and Route 400 interchange on the south side of Canton, Ohio. The Brookville Coal at this locality is exposed near the top of the outcrop; samples were taken from a small ravine backcut

slightly into the slope. The second locality, hereafter referred to as the Bolivar locality, is located on the east side of I-77 North, and is the first outcrop north of the Bolivar, Ohio exit. The Brookville Coal at this locality is found approximately half way up the side of the exposure, which is approximately 0.17 km long. Samples at both localities were taken from horizons corresponding to the top, middle, and base of the coal and at irregularly-spaced intervals within the seam to include all obvious lithologic changes, and from the overlying and underlying shale units.

All samples were processed with standard palynological extraction techniques slightly modified from those of Gray (1965) and Bars and Williams (1973). The resulting residues were mounted in glycerin jelly and sealed with CoverBond. A total of 200 specimens were counted in each sample. Separate categories were not established for unidentifiable or fragmented specimens. However, identifiable fragments were included in the counts, provided that at least half of the specimen was still intact. Only samples from selected horizons, corresponding to the lower, middle, and upper parts of the seam at each locality, were counted. The scanning of slides from other samples indicated that most of these did not contain countable numbers of miospores, and those that did contained no new assemblages.

## RESULTS AND DISCUSSION

Six taxa accounted for slightly over 90% by number of the total miospore population of the Brookville Coal (Fig. 1). These are, in descending order of total abundance: *Laevigatosporites globosus* Schemel, *Lycospora pusilla* (Ibrahim) Schopf, Wilson and Bentall, *Laevigatosporites minutus* Schopf, Wilson and Bentall, *Florinites* (2 species), *Triquitrites bransonii* Wilson and Hoffmeister, and *Acanthotriletes* (2 species). No other species accounted for more than 2.5% of the population in any sample.

By far the most abundant miospore species encountered in this study was *Laevigatosporites globosus*, which comprised from 18 to 85% of the miospore population and was present in every sample. The presence of such large numbers of this single species may have affected the frequencies of occurrence of other less common miospores. However, the presence of assemblages dominated by *L. globosus* appears to be a characteristic feature of the Brookville Coal, although, as discussed later, this species is also common in certain other coal seams.

Vertical changes in the relative abundance and occurrence of various miospore taxa are evident at both localities. These changes can best be expressed by describing the miospore assemblages, named for the taxon or taxa that are dominant or reach a maximum occurrence within them, and by noting which part of the seam, or zone, they occupy. A total of four distinct assemblages are recognized in this study and are named the *Lycospora pusilla-Laevigatosporites globosus* assemblage, the *Laevigatosporites-Acanthotriletes* assemblage, the *Laevi-*

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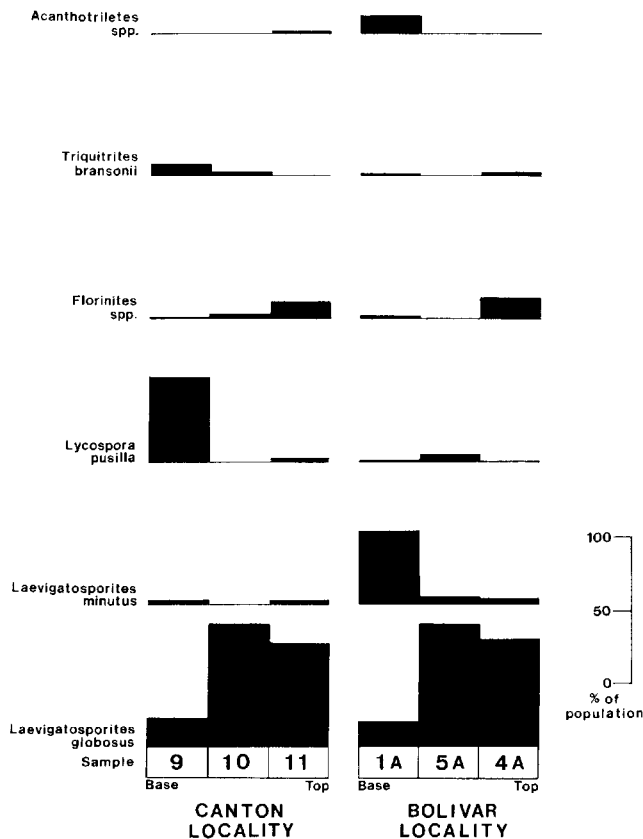


FIGURE 1. Relative abundance of the six most common miospore taxa found in the Brookville Coal of Ohio.

*gatosporites globosus* assemblage, and the *Laevigatosporites globosus-Florinites* assemblage.

The *Lycospora pusilla-Laevigatosporites globosus* assemblage occurs in the lowermost portion of the seam at the Canton locality. This group of miospores is characterized by the dominance of *Lycospora pusilla*, which comprises 58.5% of the population. This represents the peak occurrence of the genus *Lycospora*, which does not account for more than 5.5% of the population in any other sample. *Lycospora* commonly occurs in other Pennsylvanian-age coals; assemblages characterized by this genus have been previously reported from the bases of other coal seams in Great Britain (Smith 1957) and North America (Fredericksen 1961, Habib 1966, Gray 1967, Huesken 1984, and others). *Laevigatosporites globosus*, the other characteristic species, accounts for 20% of the population. *Triquitrites bransonii* reaches its maximum abundance of 8.5% in this assemblage, although it is present in all other counted samples at levels up to 2.5%.

The *Laevigatosporites-Acanthotriletes* assemblage occurs in the lowermost portion of the seam at the Bolivar locality. Two species of *Laevigatosporites*, *L. minutus* and *L. globosus*, characterize this group. *Laevigatosporites minutus* reaches its maximum abundance of 49%, whereas, conversely, *L. globosus* reaches its minimum abundance of 18%. *Acanthotriletes* (cf. *A. echinatus* (Knox) Potonie and Kremp), which comprises 11.5% of the population, is also characteristic of this assemblage. Another species of *Acanthotriletes*, designated *A. sp. 1* in this report, is also present. This species accounts for only 1% of the population, and does not appear in the counts from any other sample.

The *Laevigatosporites globosus* assemblage occurs in the middle portion of the seam at both the Canton locality and the Bolivar locality. This group of miospores is characterized by the strong dominance of *L. globosus* which accounts for 85% of the population. No other species accounts for more than 4.5%, possibly due to the masking effect of *L. globosus*. An abundance of this miospore has been reported in stratigraphically equivalent horizons in coals from the Illinois Basin by Peppers (1970, 1984) and from Great Britain by Smith and Butterworth (1967). In both of these studies, however, *L. globosus* was usually reported as subdominant to other species. Assemblages strongly dominated by this species were also reported from the Brookville Coal of eastern Pennsylvania (Fredericksen 1961).

The *Laevigatosporites globosus-Florinites* assemblage occurs in the upper portion of the seam at both the Canton and Bolivar localities. This group of miospores is similar to the previous assemblage, although the abundance of *L. globosus* decreases slightly from 85% to an average of 73.2% of the population. An important difference from the *L. globosus* assemblage is an increase in *Florinites* miospores, with two species, *F. mediapudens* (Loose) Potonie and Kremp and *Florinites* (cf. *F. pumicosus* (Ibrahim) Schopf, Wilson and Bentall), comprising a total of 11 to 14% of the population.

A comparison of the assemblages observed at the two localities reveals that, although the lowermost zones are considerably different, the middle and upper zones are remarkably similar. Both localities have a *Laevigatosporites globosus* assemblage in their middle zones and an *L. globosus-Florinites* assemblage in their upper zones. This palynological evidence suggests that the two exposures are part of the same stratigraphic unit.

Although the reasons for the miospore changes or succession through the profile are complicated by our limited knowledge of the ecological requirements and, in certain cases, the exact affinities of the plants that produced the miospores, enough information exists to provide a basic understanding of the paleoecology of the Brookville. For example, the cordaites, represented in this study by *Florinites*, are believed to indicate physiologically drier conditions (Phillips and Peppers 1984, Phillips et al. 1985). The gradual increase of *Florinites* in the upper zones suggests a trend toward drier conditions within the coal swamp.

It is also clear that the Brookville Coal developed in a swamp that was largely forested during most of its existence. In addition to *Florinites*, the three other most abundant miospore taxa have affinities with arborescent plants. Miospores assignable to *Laevigatosporites globosus* and *L. minutus* have been isolated from fruitifications belonging to several species of the marattalian tree fern genus *Scolecopteris* (Millay 1979); miospores of *Lycospora* have been isolated from arborescent lycopods (Phillips et al. 1974). In contrast, the miospores of both *Triquitrites bransonii* and *Acanthotriletes* were most likely produced by small ferns (Ravn 1979). The greater abundance of these small fern-related miospores in the lowermost zones at both localities suggests that a greater extent of open marsh conditions existed early in the history of the swamp.

Thus, a somewhat generalized paleoecological interpretation of the miospore succession in the Brookville

Coal, based in part on inferences drawn from other studies of Carboniferous coals, can be summarized by the following series of stages. First, the coal swamp is forested, with either an arborescent lycopod (*Lycospora pusilla*) or a tree fern (*Laevigatosporites minutus*) dominating; in both cases a different tree fern (*L. globosus*) is a subdominant. A local environmental factor, such as depth of the water table, could account for the difference in the dominant species (Phillips and DiMichele 1981). The relative abundance of small ferns (*Acanthotriletes*) or probable small ferns (*Triquitrites bransonii*) indicates a certain amount of open marsh conditions (Ravn 1979). Second, tree ferns (*L. globosus*) become strongly dominant at the expense of other arborescent species, and the extent of open marsh habitat is reduced. Third, a slight reduction in the abundance of tree ferns and a concomitant increase in the abundance of cordaites (*Florinites*) suggest a gradual shift toward better-drained conditions favoring the growth of arborescent gymnospermous plants.

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