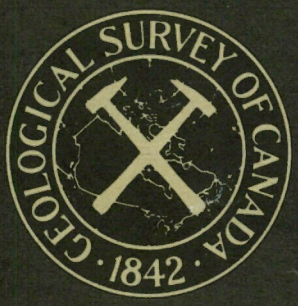

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DEPARTMENT OF MINES
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PAPER 63-3

PALYNOLOGY AND STRATIGRAPHY OF SOME UPPER PENNSYLVANIAN AND PERMIAN ROCKS OF THE MARITIME PROVINCES

(Report and 4 figures)

M. S. Barss, P. A. Hacquebard, and R. D. Howie

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Introduction

The purpose of this investigation was to establish an age relationship between the red beds on Prince Edward Island and beds in New Brunswick and Nova Scotia. The age relationship of these beds has long been a controversial subject because of the small number of vertebrate fossils and megafloral specimens discovered in them.

In the Maritime Provinces the Upper Pennsylvanian rocks are entirely of non-marine origin and are represented in the Sydney Coalfield of Nova Scotia by the Morien Group. The Morien Group represents all or part of the type Pictou Group of the Cumberland Basin in Nova Scotia, and has been correlated with various other coal areas in the Maritime Provinces (Bell, 1938; Hacquebard and Barss, 1958; Hacquebard, Barss, and Donaldson, 1960)[1]. (See Fig. 1.)

In New Brunswick, Pictou rocks occupy a roughly triangular area of cratonic cover on Palaeozoic folded zones (Neale et al., 1961). This area represents a broad shelf, with nearly horizontal beds, which slopes gently northeasterly toward Prince Edward Island, and comprises several lithological units (Gussow, 1953; Muller, 1951). The oldest known Pictou rocks occur to the west in the Minto Coalfield, and the youngest along the northeastern shore of the province (Gussow, 1953). (See Fig. 1.)

Megafloral collections from the Pictou rocks in New Brunswick are rare, with the exception of the Minto and Beersville coal areas. The megaflora and miospores from such rocks in these coal areas have permitted a correlation with parts of the Morien Group (Bell, 1938; Muller, 1951; Hacquebard and Barss, 1958). A few fossil plants collected near Sackville and on Richibucto River also indicate correlation with the Morien Group (Gussow, 1953).

On Prince Edward Island the surface rocks are predominantly red and generally have very low dips. They consist of a series of non-resistant claystones, siltstones, sandstones, calcareous sand-shale breccias, and minor conglomerates. Drill samples and many surface exposures indicate abundant crossbedding, rapid facies changes, and the occurrence of many foreset beds with festoon bedding. This lack of continuity and good marker horizons in

[1] Names and/or dates in parentheses are those of publications listed in the References.

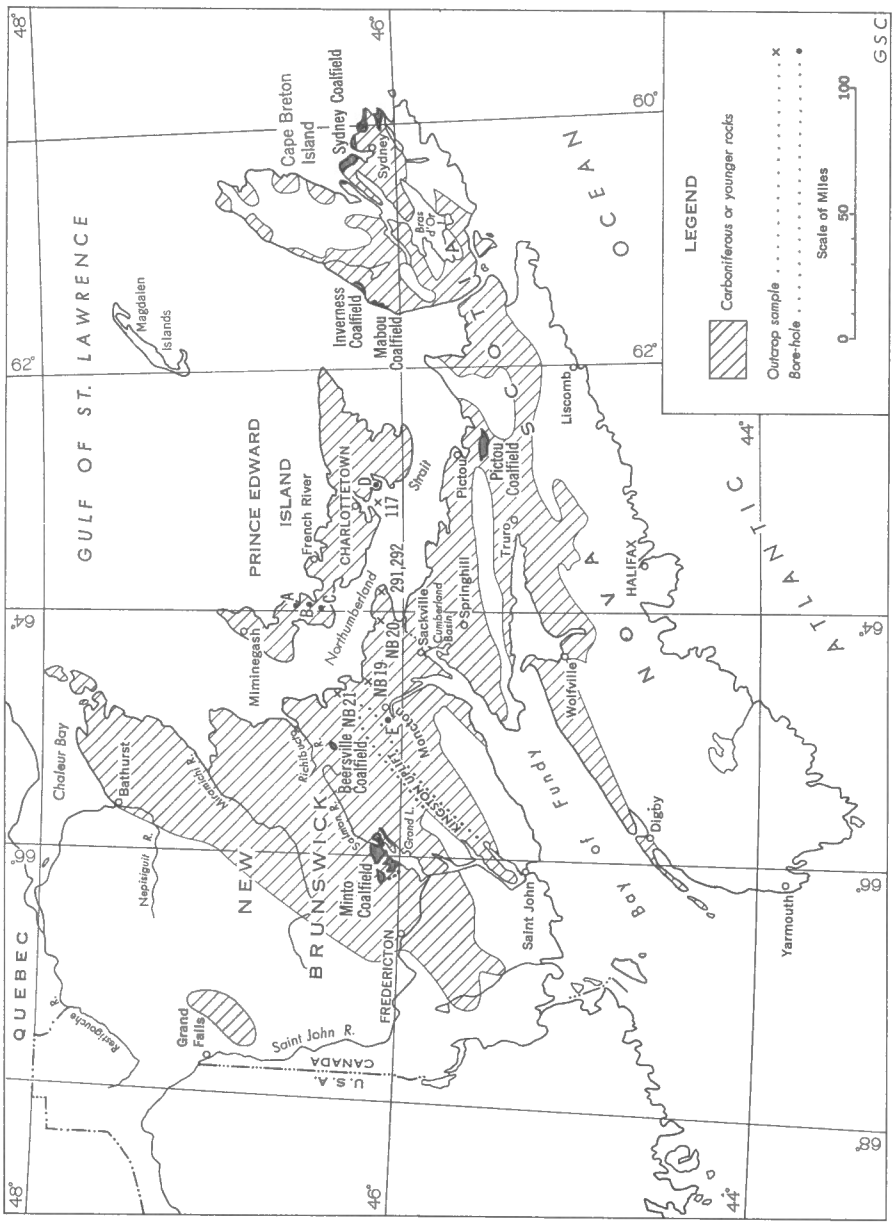


Figure 1. Geological sketch-map of the Maritime Provinces showing coal areas containing rocks correlated with the Morien Group, and locations of outcrop samples and bore-holes

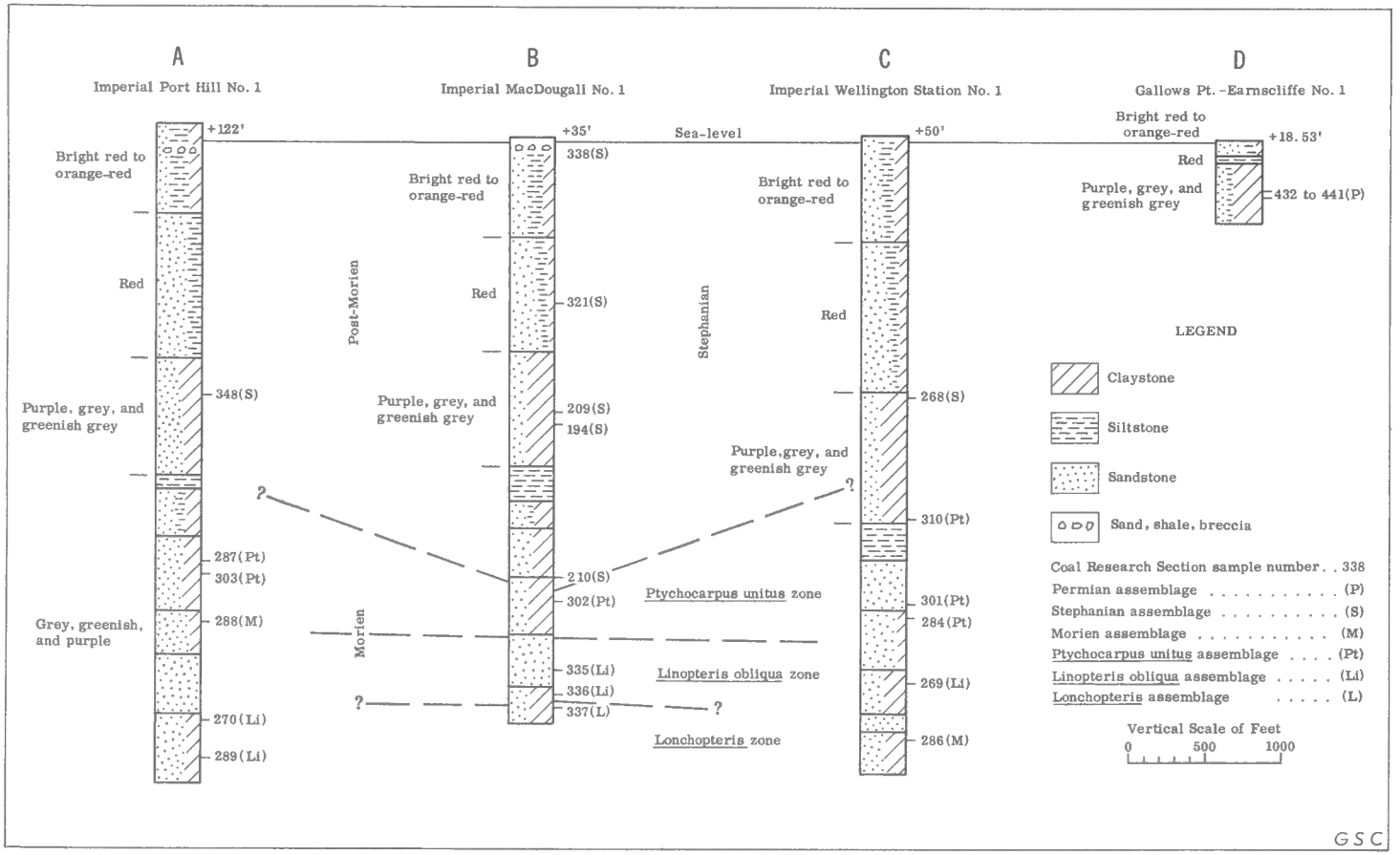


Figure 2. General stratigraphy of bore-holes with age relationship and position of samples examined, Prince Edward Island (See Figure 1)

the red-bed sequence makes stratigraphic and structural interpretation difficult. These rocks have been described by Dawson (1842), Dawson and Harrington (1871), Milligan (1949), Prest (1962), and others.

Because of the scarcity of fossils, the age of these red beds has long been in doubt. Since the first published report (Dawson, 1842) they have been assigned to the Carboniferous, Permian, and Triassic Systems. A Carboniferous (Stephanian) age has been indicated for the western part of Prince Edward Island (Darrah, 1937) on the basis of a megafloral collection made by Bain (1881) in the Miminegash area. Earlier, Leidy (1854; 1855) had postulated a Triassic or Permian age for the red beds on the basis of a vertebrate fossil, Bathygnathus borealis Leidy, discovered near French River, Queens county. The Geological Survey of Canada has shown the entire island as Permo-Carboniferous on its geological map (910A) of the Maritime Provinces, because of the uncertain age relationship. In recent years, geologists have occasionally encountered fragments of bones at various places on Prince Edward Island; in all, twenty vertebrate specimens have been collected since 1854. Of these, twelve are useful for age assignments, and favour a Permian age for the rocks in the northern and central parts of the island (Langston, 1963).

Samples Studied

The present palynological investigation is based on a generic spore study of forty samples of shale, sandstone, and coal, obtained from the well cuttings of three Imperial Oil Limited bore-holes (A, B, and C, on Figs. 1 and 2) in western Prince Edward Island, and from surface exposures in New Brunswick, east of Beersville (NB 19-21, 291, and 292, on Fig. 1). Recent drilling for the Geological Survey of Canada at Gallows Point (D, on Figs. 1 and 2), in the eastern part of Prince Edward Island, to establish a stratigraphic relationship with the beds of Governor Island (117, on Fig. 1), provided additional samples of grey shale and sandstone within the red-bed sequence (432-441, on Fig. 2). Drilling by the Canadian National Railways in their Moncton Hump Yard #1 bore-hole (E, on Fig. 1), also provided samples for the study.

The palynological information obtained from these samples has been integrated with that obtained from samples of the Upper Pennsylvanian rocks of New Brunswick and Nova Scotia previously examined by the Coal Research Section of the Geological Survey of Canada (Hacquebard and Barss, 1958; Hacquebard, Barss, and Donaldson, 1960).

For purposes of this paper, the rock units penetrated by four recent drill-holes (A, B, C, and D, on Fig. 1) on Prince Edward Island have been separated on the basis of colour and general lithology (see Fig. 2), using "Munsell Soil Colour Charts" (1954 edition), and a "Wentworth Sand Gauge Scale" (1922 edition). The bright red to orange-red unit (Fig. 2) corresponds to values 6 and 5 (excluding 10R 5/1) on chart 10R of Munsell; the red unit to values 5 and 4 on chart 10R (excluding 10R 4/1, and 5/1); and the purple and purplish red (brown) are 10R 5/1, 4/1, 3/1 to 3/6, 2/1, and 2/2. The colour comparisons were made using dry samples.

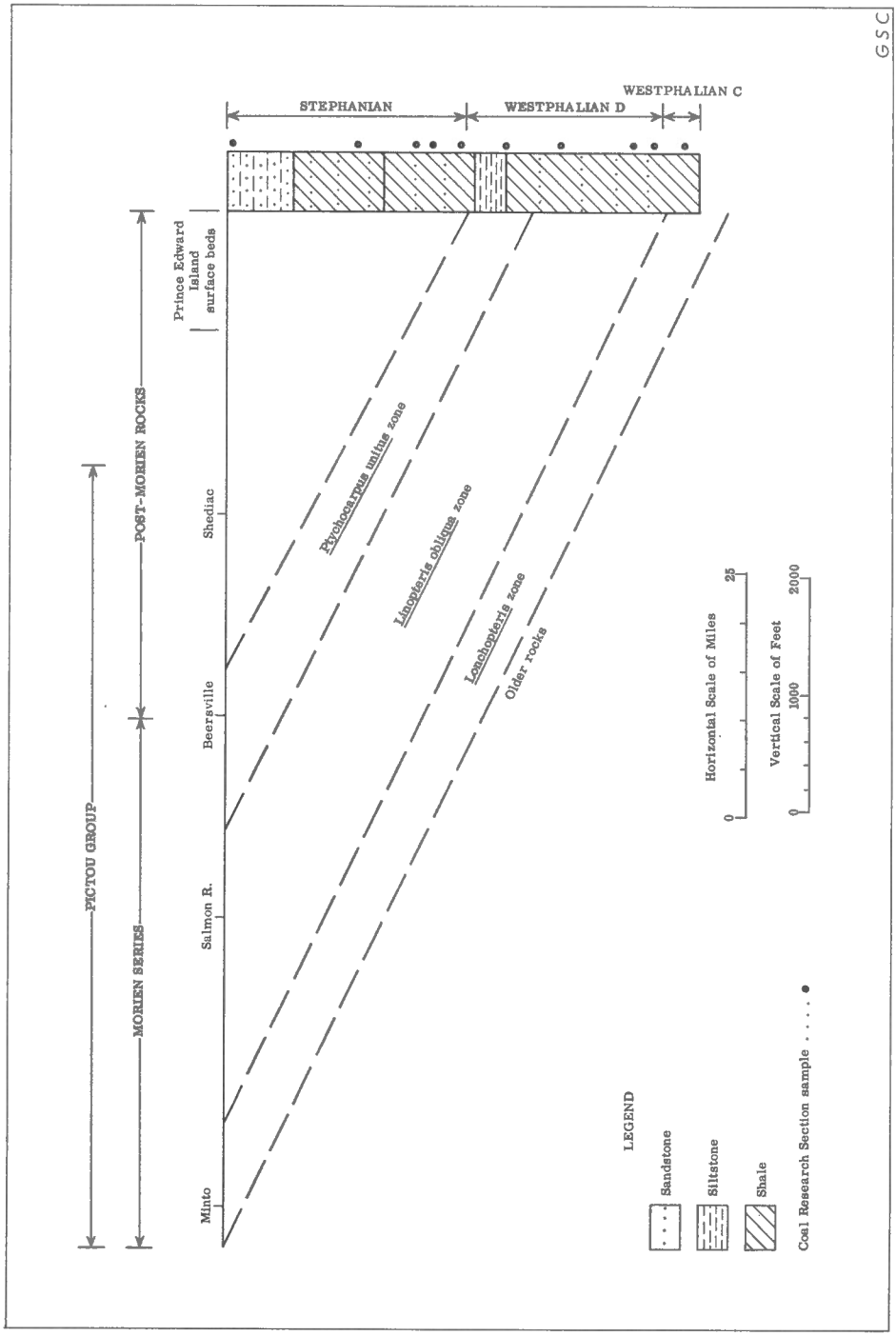


Figure 3. Generalized section through the Pennsylvanian rocks of eastern New Brunswick and western Prince Edward Island

Results of Spore Investigation

In the Sydney Coalfield the Morien Group has been subdivided into three floral zones by Bell (1938). These zones, in ascending order, are: the Lonchopteris zone, the Linopteris obliqua zone, and the Ptychocarpus unitus zone. The age of the lowest two zones was considered Westphalian C, the upper zone Westphalian D. Recent palynological evidence supports these megafloral subdivisions, but indicates a lowering of the boundary between the Westphalian C and D in the Morien Group (Hacquebard, Barss, and Donaldson, 1960). (See Fig. 4.)

As was shown by Hacquebard, Barss, and Donaldson (1960), the three megafloral subdivisions of the Morien Group can be identified in other areas because they contain characteristic spore associations. It was therefore possible to recognize these three subdivisions in the surface rocks of New Brunswick, and in the subsurface rocks of western Prince Edward Island (Figs. 2 and 3).

The Minto Formation, which contains the Minto coal seam, has been correlated with the Lonchopteris zone (Hacquebard, Barss, and Donaldson, 1960). (See Fig. 3.) Similarly the coal occurring along Salmon River and its tributaries, and the coal measures at Beersville contain generic spore assemblages typical of the Linopteris obliqua and Ptychocarpus unitus zones respectively. The spore assemblage encountered in the samples east of Beersville (NB 19-21, 291, and 292, on Fig. 1), however, indicates that these rocks lie in a distinct miospore zone and are Stephanian in age. These rocks, which have been assigned to the Pictou Group by Gussow (1953) are therefore younger than Pictou Group rocks elsewhere in the Maritimes to which Westphalian C and D ages were given by Bell (1938; 1944), and Copeland (1957).

Samples from the three bore-holes in western Prince Edward Island (Fig. 2) have now shown that the three zones of the Morien Group in the Sydney Coalfield that can be recognized in the area west of Beersville in New Brunswick, and the post-Morien (Stephanian) miospore zone east of Beersville, are all present in the subsurface of western Prince Edward Island (Fig. 3). Stephanian-aged rocks also occur on Governor Island (117, on Fig. 1) in eastern Prince Edward Island.

The samples (432-441, on Fig. 2) from the Gallows Point bore-hole (D, on Fig. 1) contain spore assemblages that indicate a Permian age for these rocks.

The various rock units recognized in the bore-holes and from surface exposures on Prince Edward Island are not everywhere contemporaneous, as had formerly been supposed. These units have been differentiated mainly on colour and their correlation on this criterion alone can lead to erroneous stratigraphic interpretation. For example, the sequence of red beds in western Prince Edward Island is clearly of Stephanian age, whereas the apparently same red beds in the Gallows Point area belong to the Permian System.

In helping to interpret the stratigraphy of these Upper Pennsylvanian rocks, the present study shows that a similar

stratigraphic sequence is present at depth on western Prince Edward Island as at the surface in New Brunswick, north of the Kingston Uplift (Fig. 3). Samples obtained from the Canadian National Railways Moncton Hump Yard bore-hole #1 (E, on Fig. 1) correlate with the Lonchopteris zone (Barss, 1962), which indicates that the same stratigraphic sequence also occurs south of the Kingston Uplift. The exact stratigraphic relationship of the Permian rocks in the bore-hole at Gallows Point, to the Stephanian rocks in the western part of Prince Edward Island and on Governor Island, is at present unknown. Accordingly, no information regarding the thickness of the strata, or the possible presence of other miospore assemblages can be given.

Miospore Zones

Of the 63 genera occurring in the samples studied, 18 genera are considered the most diagnostic in subdividing the uppermost Pennsylvanian and Permian rocks in the Maritime Provinces. These are indicated by heavier bars in Figure 4. The three zones of the Morien Group can be readily distinguished by the presence and/or absence of these more significant spore genera, as outlined below:

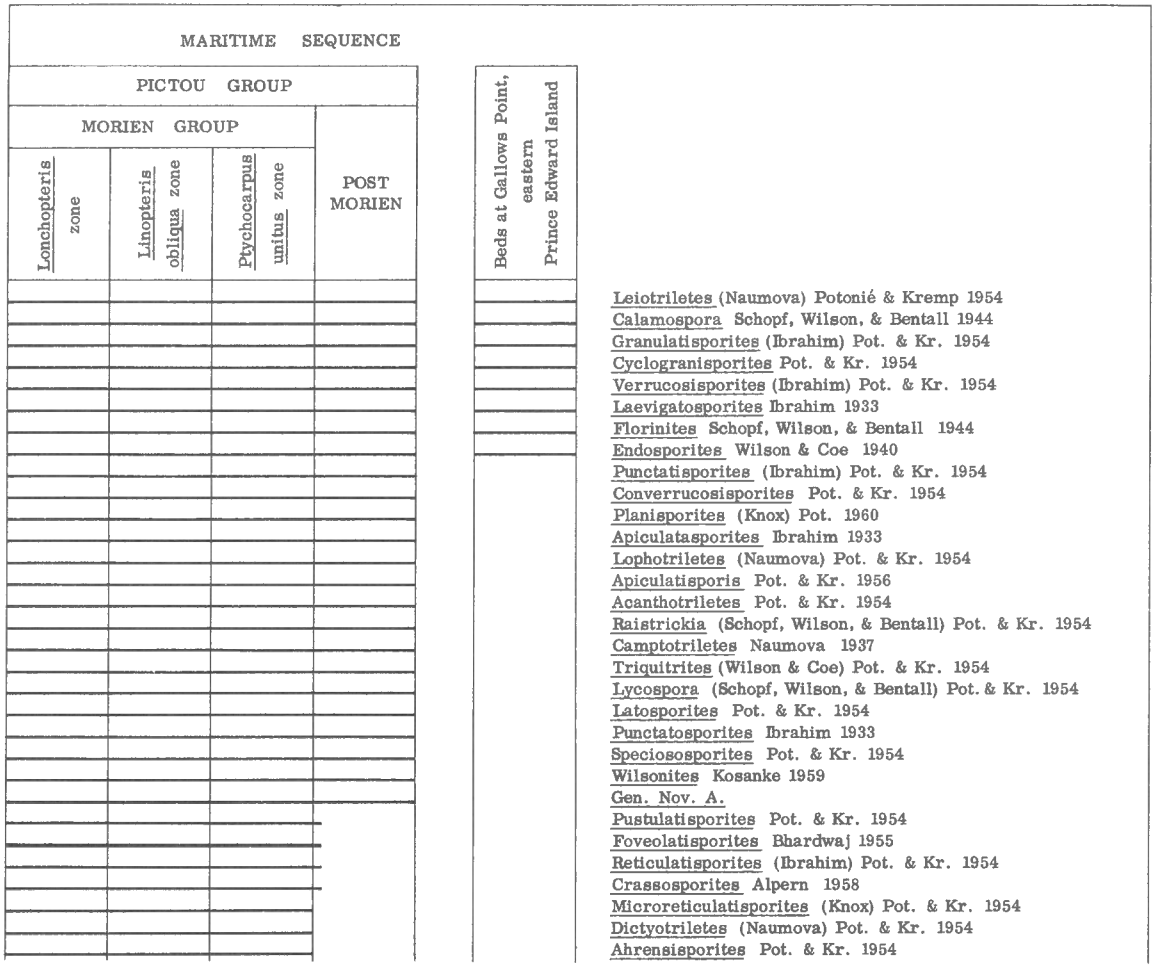
1. The Lonchopteris zone is characterized by miospore assemblages containing Foveolatisporites (which is very diagnostic of rocks of Westphalian C and D ages), Convolutispora, Vestispora, and Novisporites.

2. The Linopteris obliqua zone is distinguished by miospore assemblages containing Foveolatisporites, Torispora, Guthörlisporites, Verrucososporites, in the lower part, with the additional genera Murospora and Alisporites in the upper part.

3. The Ptychocarpus unitus zone is characterized by the miospore genus Schopfites. Like the preceding zone, it can be divided into lower and upper parts, based on the first occurrence of the genera Pericutosporites and Savitrisporites near the middle of this zone.

The post-Morien rocks of eastern New Brunswick and western Prince Edward Island are characterized by the genera Potonieisporites, Pityosporites, and Lunatisporites, none of which were found in the underlying Morien Group. The occurrence of these genera together with the disappearance of Foveolatisporites and 20 other genera indicates that these post-Morien rocks comprise a separate miospore zone, which overlies the Ptychocarpus unitus zone (Westphalian D age) without any apparent break in deposition. The age of this upper zone is considered to be Stephanian. That the post-Morien rocks belong to the Pennsylvanian System is further attested by the presence of such genera as Lycospora and Triquitrites.

The rocks in the bore-hole (D, on Fig. 1) at Gallows Point (on eastern Prince Edward Island) between 330 to 350 feet, contain the following significant spore genera: Nuskoisporites, Vittatina, Lueckisporites, and Platysaccus, together with the three genera—Potonieisporites, Pityosporites, and Lunatisporites—typical


MARITIME SEQUENCE
PICTOU GROUP
MORIEN GROUP
Lonchopteris zone
Linopteris obliqua zone
Ptychocarpus unitus zone
POST MORIEN
Beds at Gallows Point, eastern Prince Edward Island
Leiotriletes (Naumova) Potonié & Kremp 1954
Calamospora Schopf, Wilson, & Bentall 1944
Granulatisporites (Ibrahim) Pot. & Kr. 1954
Cyclogranisporites Pot. & Kr. 1954
Verrucosisporites (Ibrahim) Pot. & Kr. 1954
Laevigatosporites Ibrahim 1933
Florinites Schopf, Wilson, & Bentall 1944
Endosporites Wilson & Coe 1940
Punctatisporites (Ibrahim) Pot. & Kr. 1954
Converrucosisporites Pot. & Kr. 1954
Planisporites (Knox) Pot. 1960
Apiculatasporites Ibrahim 1933
Lophotriletes (Naumova) Pot. & Kr. 1954
Apiculatisporis Pot. & Kr. 1956
Acanthotriletes Pot. & Kr. 1954
Raistrickia (Schopf, Wilson, & Bentall) Pot. & Kr. 1954
Camptotriletes Naumova 1937
Triquitrites (Wilson & Coe) Pot. & Kr. 1954
Lycospora (Schopf, Wilson, & Bentall) Pot. & Kr. 1954
Latosporites Pot. & Kr. 1954
Punctatosporites Ibrahim 1933
Speciososporites Pot. & Kr. 1954
Wilsonites Kosanke 1959
Gen. Nov. A.
Pustulatisporites Pot. & Kr. 1954
Foveolatisporites Bhardwaj 1955
Reticulatisporites (Ibrahim) Pot. & Kr. 1954
Crassosporites Alpern 1958
Microreticulatisporites (Knox) Pot. & Kr. 1954
Dictyotriletes (Naumova) Pot. & Kr. 1954
Ahrensisporites Pot. & Kr. 1954

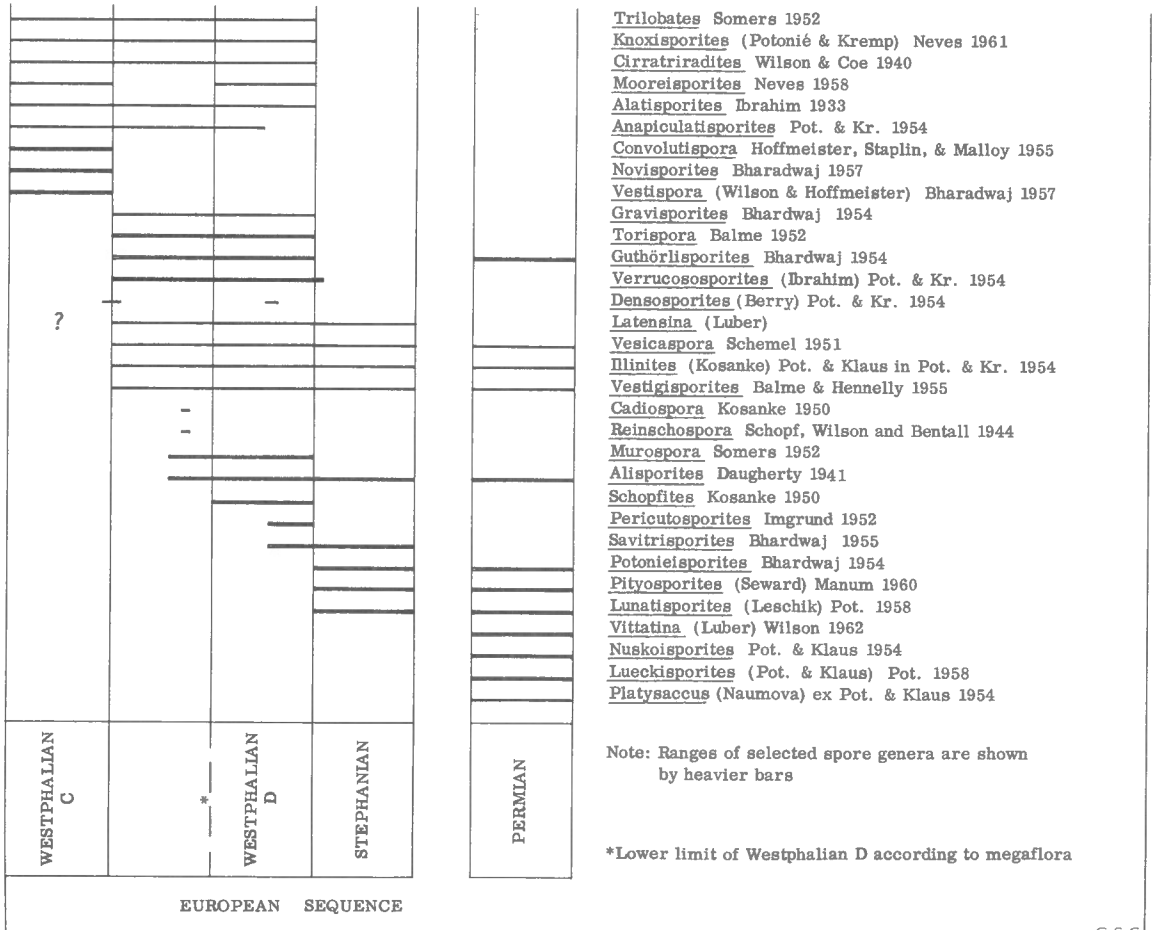


Figure 4. Range chart of spore genera in the uppermost Pennsylvanian and Permian rocks of the Maritime Provinces

of the post-Morien beds. A new and distinct miospore zone is considered to be represented at this level, because apart from the new entries, no less than 17 genera found throughout the Morien Group and the post-Morien zone do not occur in this zone. The spore assemblage of this zone indicates a Permian age for these rocks at Gallows Point. The characteristic genera are all bladder spores, which are typical of Permian strata in other regions, e.g. Oklahoma (Wilson, 1962), and Australia (Balme and Hennelly, 1955; 1956).

Stratigraphic Ranges of Spore Genera

Figure 4 shows the stratigraphic ranges of the 63 genera occurring in the strata examined during this investigation. They are distributed numerically as follows: Lonchopteris zone, 41 genera; Linopteris obliqua zone, 49 genera; Ptychocarpus unitus zone, 51 genera; post-Morien (Stephanian) zone, 32 genera; and Gallows Point (Permian) zone, 20 genera (including 11 bladder types).

The occurrences of several genera shown on Figure 4 are noteworthy because these genera are of somewhat different occurrence elsewhere in North America and in Europe. For example, Lycospora and Triquitrites are present throughout the Upper Pennsylvanian System of the Maritime Provinces but are of erratic occurrence in the Stephanian-aged rocks of Illinois (Kosanke, 1950) and Germany (Bhardwaj and Venkatachala, 1957).

Densosporites was observed in only three of several hundred samples examined—one from beds of Westphalian C age, and two from beds of Westphalian D age. In Europe this genus occurs throughout rocks of Westphalian C age, is known to be present in some rocks of Westphalian D age (Bharadwaj, 1960; Potonié and Kremp, 1956), and has been reported in great numbers from strata of Stephanian age in France (Alpern et al., 1958).

Vestispora, which is restricted to the Lonchopteris zone (Westphalian C age), is known throughout the rocks of the Upper Carboniferous of Great Britain (Butterworth and Millott, 1960). In the Ruhr, it ranges in strata of Westphalian B to D age. In the Saar and in France, it is restricted to rocks of Westphalian D age (Bharadwaj, 1960; Alpern et al., 1958).

Some of the bladder spores, e.g. Guthörlisporites, Illinites, and Alisporites, first appear in the Maritime Provinces in rocks that are older than those in which they first occur in the Ruhr, Great Britain, and the United States (Bharadwaj, 1960).

Summary

The Upper Pennsylvanian rocks in eastern New Brunswick are of non-marine origin and have been assigned to the Pictou Group. In this sequence of rocks, four miospore zones are recognized. The three lowest zones are equivalent in age to that given the type Pictou Group (Westphalian C and D). The uppermost zone is new and is Stephanian in age, and therefore of an age previously not attributed to the Pictou Group. These four miospore

zones are also recognized in the subsurface of western Prince Edward Island. An age relationship is therefore established between the beds of New Brunswick and those of western Prince Edward Island.

Another new miospore zone has been recognized in rocks from a bore-hole in eastern Prince Edward Island. It indicates a Permian age. As the stratigraphic relationship between the rocks of Permian and Stephanian age of the area is at present unknown, there is a possibility that additional miospore zones may be present.

For this report the Morien Group of the Sydney Coalfield has been the type for comparison of the various areas examined. An examination of the spores from the type Pictou Group, in the Cumberland Basin in Nova Scotia, is needed to determine if the four spore zones, as recognized in the Morien Group and post-Morien rocks, are all present.

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