Chapter 3 - Paleontology

Introduction

Paleontological investigations of Carboniferous strata in the Cumberland Basin contribute to an improved understanding of the sedimentological and stratigraphic development of the basin in three principal ways: (1) they provide age relationships and aid stratigraphic correlation; (2) they assist in paleoenvironmental interpretation; and (3) they provide insights into paleoclimatology.

The paleontology undertaken as part of this study can be divided into five basic components: (1) ichnology, the study of trace fossils; (2) invertebrate paleontology and paleobotany in carbonates; (3) invertebrate paleontology and paleobotany (megaflora) in clastic sedimentary rocks; (4) palynology, the study of spores and pollen; and (5) vertebrate paleontology.

Ichnology

Diplichnites

The occurrence of *Diplichnites* has been summarized in an earlier, preliminary paper (Ryan, 1986a). This trace fossil occurs in the Cumberland Basin at the following localities: (1) along the shore, 500 m north of Reef Point near Cape John, Pictou County, Nova Scotia; (2) Smith Point, along the Northumberland Strait shore, 2.1 km west of Smith Point, Cumberland County, Nova Scotia; (3) Pugwash, along Pugwash Harbour shore, 1.1 km north of Highway 6 bridge, Cumberland County, Nova Scotia; and (4) Coal Mine Point near Joggins, Cumberland County, Nova Scotia (Fig. 3-1).

Briggs *et al.* (1984) describe in detail the morphology of *Diplichnites cuithesis* from the Tynemouth Creek Formation of southern New Brunswick and compare it with the trails previously described from Joggins, Nova Scotia (Ferguson, 1966). In addition, they attribute these trails to the myriapod *Arthropleura*. The first trails linked to *Arthropleura* were those reported from Joggins, Nova Scotia, by Ferguson (1966, 1975). The trails at Joggins are from Cumberland Group strata of Westphalian A age. A Namurian specimen from Arran, Scotland (Briggs *et al.*, 1979), and a Stephanian specimen from Montceau-Les-Mines, France (Rolfe *et al.*, 1982), may also be trails produced by fossil myriapods.

The trails occur at three stratigraphic horizons in the Cumberland Basin. The older, smaller trace fossils at Smith Point and Pugwash (Fig. 3-1) occur within Cumberland Group strata of Westphalian C age, and at Joggins in Westphalian B Cumberland Group strata. The larger, younger trails are found in Pictou Group strata of Stephanian age at Cape John, Pictou County, Nova Scotia.

Cape John Locality

Three trails are found at this locality (Fig. 3-2). Two of the trails, A and B (Fig. 3-2), cross each other with a third trail occurring near the top of the exposed outcrop. All three of the trails exhibit similar average widths and, therefore, are attributed to trails made by a single *Arthropleura* (Fig. 3-3). The two longer trails, A and B, are 2.75 m and 2.5 m in length, respectively. Trail C is approximately 1.5 m in length. The width of the trails varies from 46.30 cm to 50.25 cm with an average of 47 cm width in the straight sections. All three of the trails exhibit variable degrees of turning with trail C having the most acute (shortest) turning radius. Briggs *et al.* (1984) presented a detailed discussion of the turning mechanics of *Arthropleura*.

The trails are simple with two parallel rows of tracks (each up to 13 cm wide). The tracks are elongate and approximately perpendicular to the trail axis. Twenty-eight track depressions can be counted per metre on each side of the trail, although coincident footfalls probably occur. The depth of the tracks varies (up to 1.3 cm), in part due to differential outcrop weathering.

Smith Point Locality

Twenty-five well preserved trails, as well as several poorly preserved trails, are found on two separate bedding surfaces at this locality. The lower surface has nineteen well preserved trails (Fig. 3-4) and the upper surface has six (Fig. 3-5).

Each of the trails on the lower bedding surface have the same average width of 37 cm. The width varies from 35.2 cm to 40.0 cm, with the average 37 cm occurring in the straight sections of the trails (Fig. 3-4). Trails on the upper bedding surface are slightly smaller with an average width of 32 cm. The two surfaces are separated by 1.3 m of cross-stratified, medium-grained arkosic sandstone.

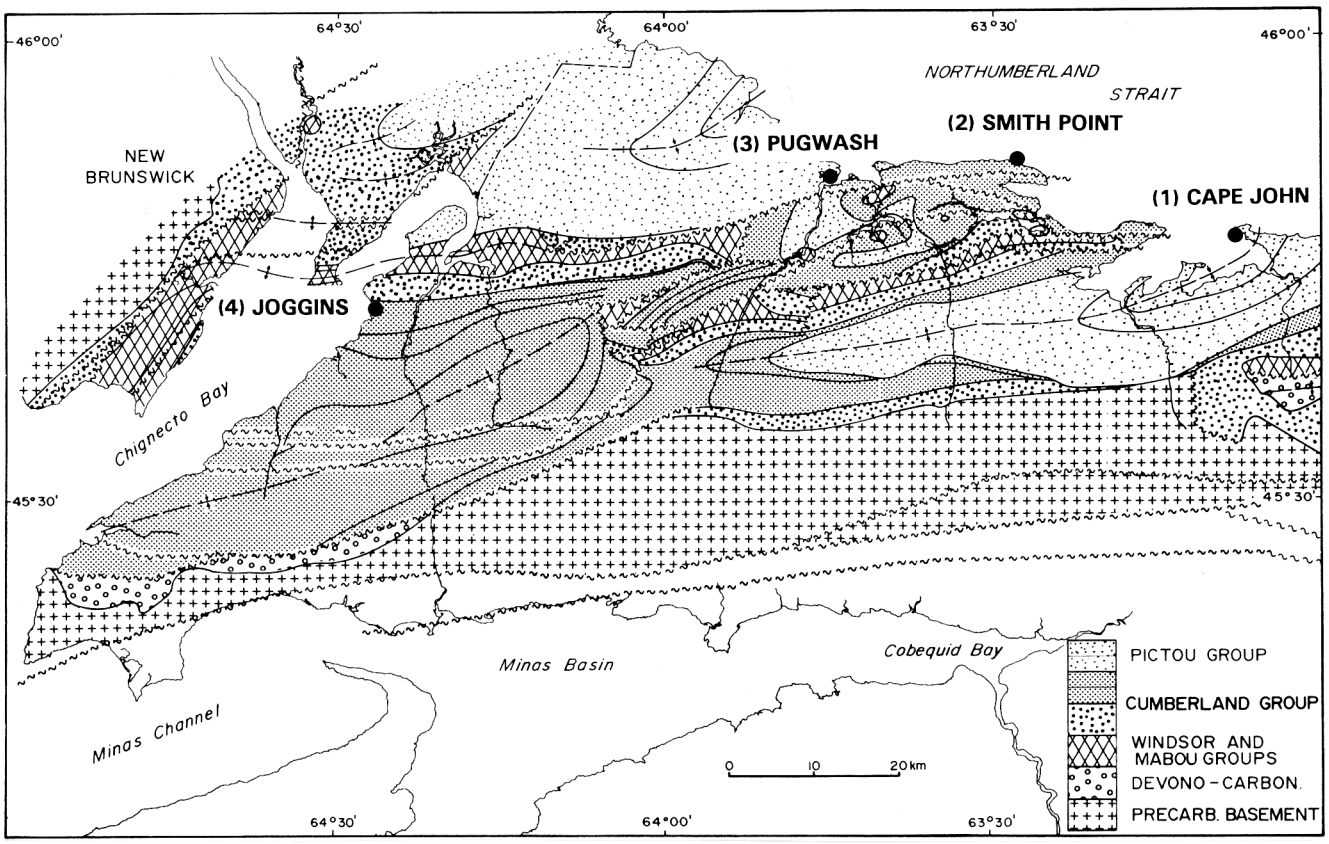

Figure 3-1. Location map of the *Diplichnites* trails in the eastern Cumberland Basin.

The trails are simple and similar to the trails found at Cape John. They consist of two parallel rows of tracks, each up to 11 cm wide. The tracks are almost perpendicular to the trail axis, although they vary more than the Cape John trails. The tracks are closely spaced, 24 per metre per side, and attain a maximum depth of 3 cm; cross-over of trails is common. One of the trails on the upper surface has a preserved turn of nearly 300° (Fig. 3-5).

Pugwash Locality

Twelve poorly preserved trails (undertracks) are found at this locality. They are identical to the trails at Smith Point. The width of the trails varies from 37 to 41 cm. There are 22 to 24 track depressions per metre per side. The depth of the tracks varies from 2 to 3 cm and the width from 8 to 10 cm (Fig. 3-6). Only slight turning is evident at this locality and cross-overs are absent. The coarse-grained nature of the sandstone and the severe coastal weathering have obliterated much of the detailed morphology of the trails.

Joggins Locality

The trails at Joggins have been described in detail by Ferguson (1966, 1975) and are almost identical to the trails from the Smith Point Locality. A large sandstone slab containing trails up to 23 cm wide was recovered by Ferguson and is on display at Mount Allison University in Sackville, New Brunswick,

Environmental Setting (*Arthropleura*)

The trails are preserved in pebbly arkosic sandstone overlain by veneers of mudstone, preserved on some of the trail surfaces. In the coarser sandstone there is poor preservation of the trails, with only the undertracks being preserved.

Sandstone beds at all of the localities were probably deposited during flood stages as mid-channel prograding dune bars which were subsequently subaerially exposed during a dry period. At Smith Point, a few of the trails occur over the edge of the bedding surfaces and cut across

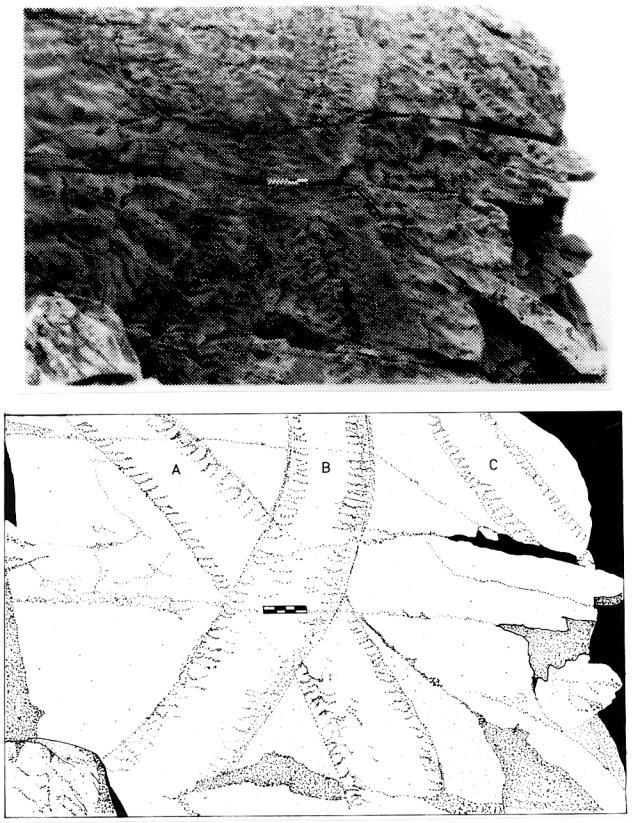

Figure 3-2. (a) Photograph of the trails at Cape John, scale = 25 cm. (b) line drawing of the Cape John trails, scale = 25 cm.

bedding lamination. This suggests that the edges of the foresets were exposed along the lee side of the bars. The *Arthropleura* passed over the beds, perhaps searching for plant material stranded on the emerging bars (cf. Briggs *et al.*, 1984).

The Trailmaker

The size, regularity in the spacing of the tracks, and depositional setting of the fossil localities suggest that the trails were made by *Arthropleura* (Briggs *et al.*, 1979). The body length is approximately 3.75 times the width, based on the reconstruction of Briggs *et al.* (1984). This suggests that the *Arthropleura* responsible for the trails at Cape John were at least 1.7 m in length (Fig. 3-3).

Other Trace Fossils

Many of the fine-grained beds of the basin are highly bioturbated. Burrows vary in size from a few mm to 1 cm in diameter. Detailed descriptions of two of the better preserved ichnogenera are included below. Dawson (1894) described 13 tetrapod traces from the Joggins section. The traces seem to correlate with the fossil

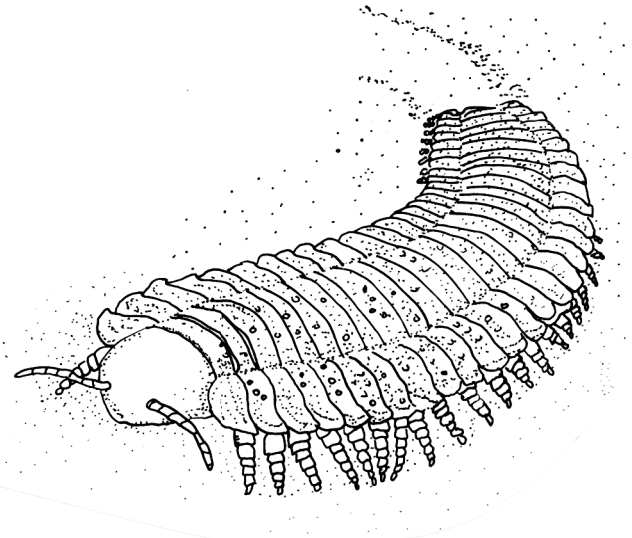

Figure 3-3. Reconstruction of *Arthropleura* (after Briggs *et al.*, 1984; Ryan, 1986).

vertebrates found in the section. Since these fossils were not seen by the authors they are not included here.

Palaeophycus tubularis

Ichnogenus PALAEOPHYCUS

Type ichnospecies - Palaeophycus tubularis

Diagnosis: Branched or unbranched, straight to slightly curved to slightly undulose, smooth or ornamented, lined, cylindrical, mostly horizontal burrows of variable diameter; infillings are typically the same lithology as the host (Wiley, 1986).

Discussion: Specimens found are very similar in morphology to those described by Wiley (1986) from Horton Group strata in New Brunswick. The preservation is poor; however, a few specimens do exhibit some fine transverse ornamentation. The diameter of the burrows varies from 2-8 mm. This ichnogenus is found throughout the Pictou Group of the study area, most commonly occurring in fine-grained sandstone and siltstone. The sandstone and siltstone are either planar laminated or ripple drifted and are interpreted to occur at the top of channel sequence and/or levees.

Cruziana problematica

Ichnogenus CRUZIANA

Diagnosis: Straight or curved, outer self-crossing *Cruziana* up to 5 mm wide, possessing faint, unevenly

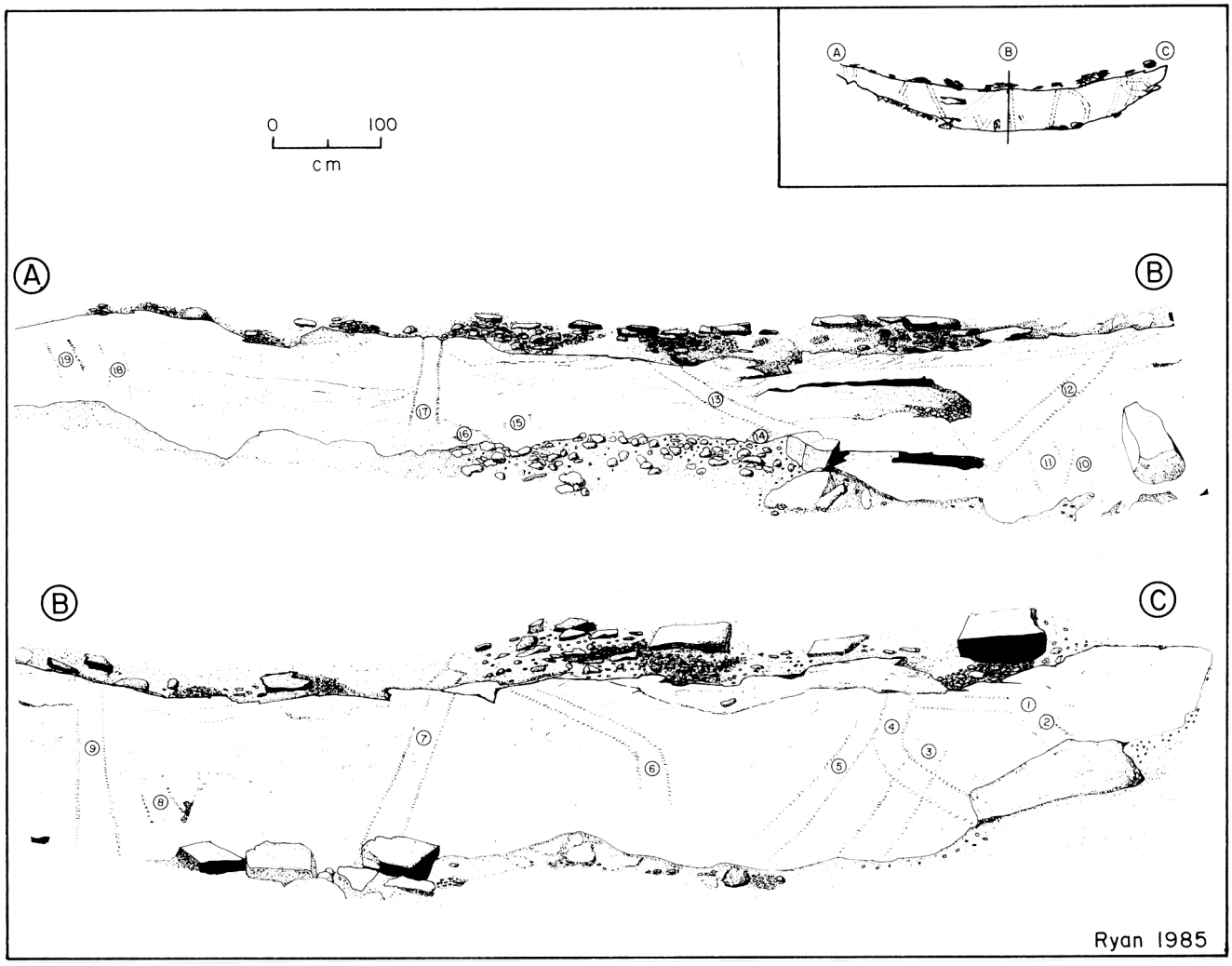

Figure 3-4. *Arthropleura* trails, lower surface, Smith Point, Cumberland County.

spaced transverse striations which may reach the margins in specimens of low relief or end in high relief specimens before reaching the margin.

Discussion: Curved specimens dominant in the strata of the study area. Curves range from 2-5° to 80°. The average width of the traces is 5 mm. Transverse striations are visible on well preserved specimens. This ichnospecies occurs most commonly in fine-grained silty sandstone interpreted as having been deposited in overbank or levee environments within the Tatamagouche and Cape John formations. This fossil has been previously described in Carboniferous strata of the Maritimes Basin by Wiley (1986) in her description of the trace fossils found in the Horton Group of New Brunswick.

Conclusions

Many other trace fossils that warrant additional research can be found within the Cumberland Basin. A through investigation into the trace fossils of the Upper Carboniferous strata may provide data useful in reconstructing the environments of deposition in the basin. A complete investigation of the ichnology in the area was beyond the scope of this study.

Invertebrate Paleontology of Carbonates

Windsor Group

Bell (1929) established two zones and five faunal subzones

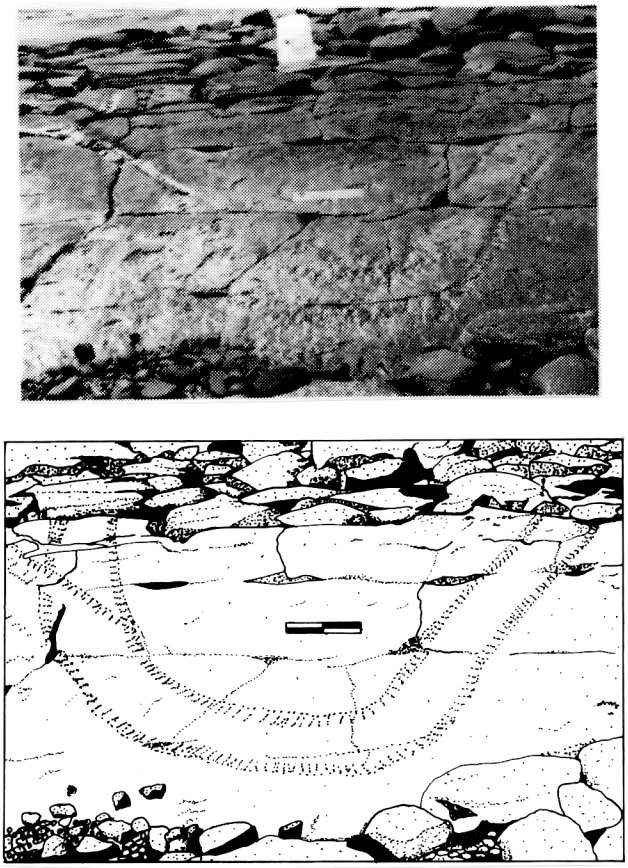

Figure 3-5. (a) Turning *Arthropleura* trail, upper trail surface, Smith Point, scale = 21 cm. (b) Line drawing of the same trail.

in the marine strata of the Lower Carboniferous Windsor Group in the Maritimes Basin. The subzones were designated A through E. The A and B subzones constitute the lower zone of the Windsor Group and the C, D and E subzones constitute the upper zone of the Windsor Group. Regionally the Lower Windsor Group is typically dominated by thin carbonates interbedded with thick evaporite sequences whereas the Upper Windsor Group comprises thin carbonates and evaporites interbedded with thick siltstone and sandstone sequences. Bell (1944, 1958) documented the stratigraphy and paleontology of Windsor Group strata in the Cumberland Basin. He concluded that rocks herein assigned to the Lime-kiln Brook Formation had fauna typical of the B subzone of the Windsor Group. Some of the uppermost strata of the Lime-kiln Brook Formation exposed at Lower Maccan and at Lime-kiln Brook Quarry may extend up into the earliest C subzone of the Windsor Group.

In the eastern Cumberland Basin the Windsor Group strata exposed at surface are restricted to areas within, or adjacent to, evaporite-cored diapiric anticlines and domes.

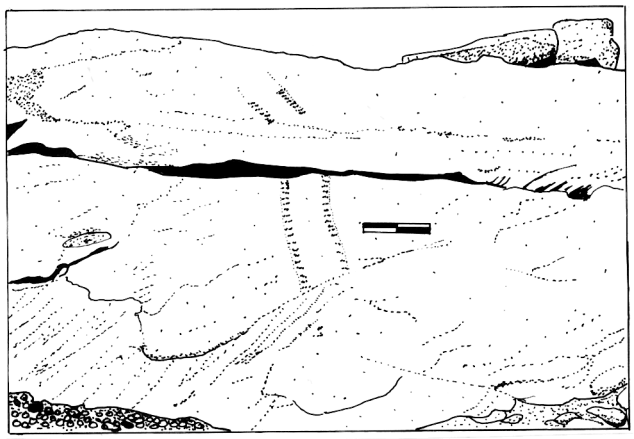

Figure 3-6. *Arthropleura* trails from Pugwash, scale = 21 cm.

No Upper Windsor strata have been documented within the Cumberland Basin. All of the fossiliferous carbonates studied to date were assigned to the B subzone based on the biota present.

Six Windsor Group localities (Lime-kiln Brook Formation) were examined in detail as part of this study: (1) Dewar Hill Quarry near Pugwash, (2) Canfield Creek, (3) Roslin, (4) Hansford, (5) Lime-kiln Brook, and (6) Lower Maccan (Fig. 2-3). Fossil identification and age determinations are based on Moore and Ryan (1976). Summaries of the results are presented in Table 3-1.

Upper Carboniferous Carbonates

There are numerous Upper Carboniferous to Early Permian limestone and dolomitic limestone exposures in the study area. Paleontological investigations were carried out on 13 of these localities (Fig. 3-7) as well as on numerous drillholes that cored these limestone units.

The limestone is fossiliferous, containing mostly algae and ostracods. The laterally continuous nature of the lithofacies and the close association with fluvial strata suggest that the limestone was deposited in a lacustrine environment. Paleontology indicates that most of the limestone deposition took place in fresh to brackish water conditions. The presence of a Codacean alga and possible *Lingula*(?) as well as a Starparollus type gastropods indicate that there is a possible marine influence to sedimentation in some of the limestone beds. The biota identified in the course of this study, and from compilations of Bell (1944), Copeland (1957) and Carroll *et al.* (1972), and their localities are presented in Table 3-2.

Table 3.1 Paleontology of Windsor Group carbonates.

FOSSIL	LOCATION					
	LOWER MACCAN	LIME-KILN BK.	HANSFORD	ROSLIN	CANFIELD CREEK	DEWAR HILL
Aviculopecten sp.			X		X	X
Batostomella sp.			X	X		
Beecheria sp.	X	X	X	X	X	X
Composita windsorensis		X		X		
Crinoid detritus	X	X	X	X	X	X
Diodoceras avonensis	X				X	X
Leptodesma sp.	X	X	X		X	
Ovatia sp.	X	X	X	X		X
Ovatia lyelli		X	X		X	X
Paleocrisidia sp.		X				
Paraconularia sp.	X		X			X
Streblopteria sp.	X	X				X

Calcareous Algae

Two species of calcareous algae have been previously described from Upper Carboniferous strata in the Maritimes Basin, *Paleochara acadica* (Bell, 1922) and *Garwoodia* sp. (identification by Mamet for Masson, 1986).

Paleochara acadica (Fig. 3-8)

This is the genotype for the calcareous algae *Paleochara* of the phylum Charophycophyta (Charophyta). Bell (1922) describes the alga in detail from specimens collected at the St. Rose coal mine, Inverness County, Nova Scotia. Charapyta are common today in fresh water ponds, lakes, and in brackish water lagoons.

Bell's (1922) description is: "Oogonium subglobular to pear-shaped with hemi-spherical base and conical apex. Length somewhat exceeding the greater diameter. Investing cells six in number, commencing around a smooth, circular, basal area and making one complete spiral turn to the raised conical end. Six or seven spiral ridges visible on a side view. Length 0.55 mm; diameter 0.53 mm; diameter of the smooth basal area 0.075 mm."

Remarks: Charaphyta algae are common in almost all of the limestone in the strata of the eastern Cumberland

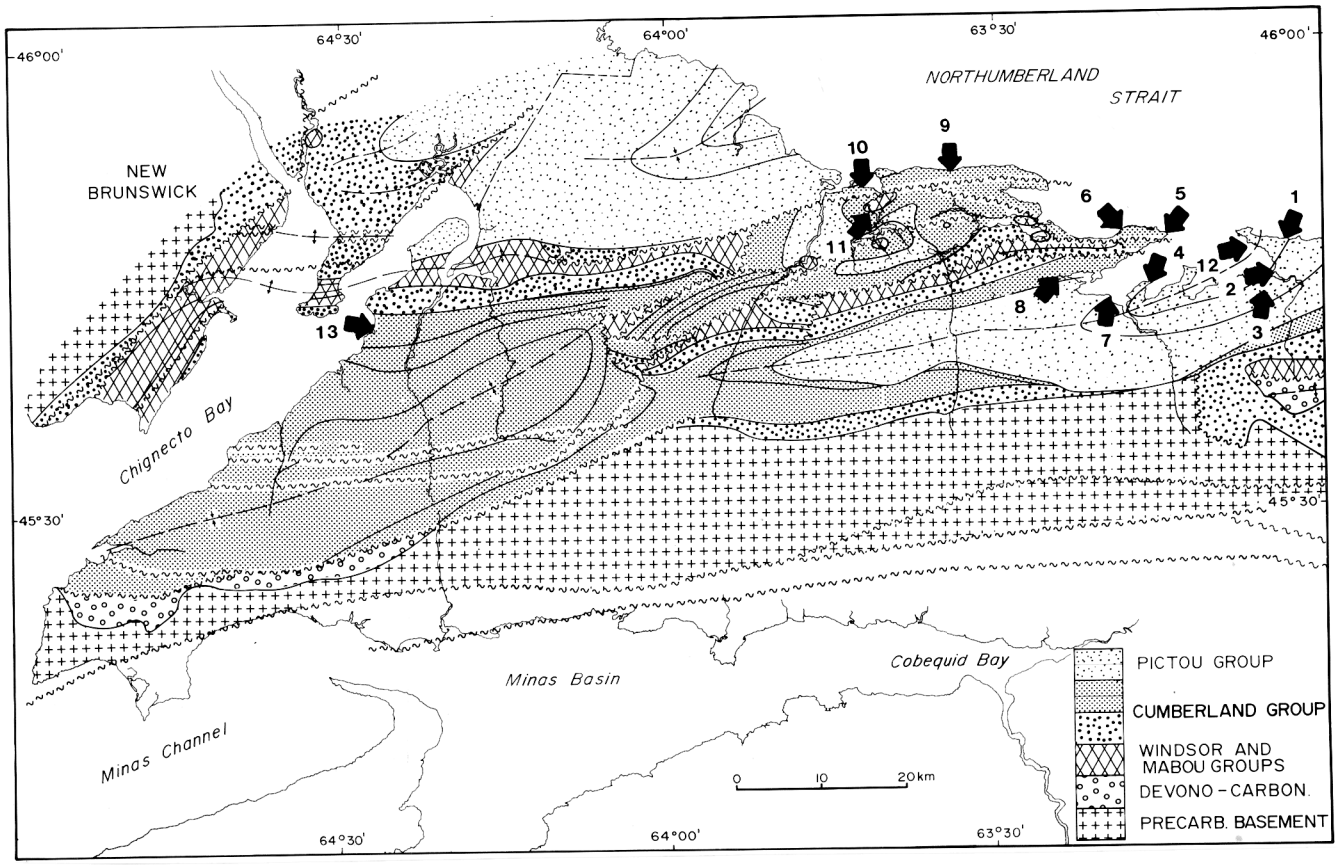

Figure 3-7. Location map for paleontological study locations in the Cumberland Basin, Upper Carboniferous carbonates: (1) Melville Cove, (2) Murphy Point, (3) Louisville, (4) Chambers Point, (5) Malagash Point, (6) Treen Bluff, (7) Blockhouse Point, (8) Dewar River, (9) Lower Gulf Shore, (10) Pugwash, (11) South Shore Pugwash Bay, (12) Salisbury Point.

Basin. Although these fossils vary slightly in size and in the number of spiral ridges (4 to 6), they are believed to belong to the genus *Parachara*.

Garwoodia (Fig. 3-9)

Description: Molds of algal threads occurring as nodules and with a radial arrangement. The tubes are practically straight and of equal thickness in section. Common branching occurs.

Remarks: The specimen from the study area (Fig. 3-9) is poorly preserved; however, it has the distinctive characteristics of the family Codiaceae. A similar specimen was identified from the Morien Group (Pictou Group equivalent) of the Sydney, Nova Scotia, area by Dr. B. Mamet for Masson (1986). The implication of these occurrences is very important because all known codaceae alga are thought to be marine (Johnson, 1961; Mamet, personal communication); therefore, marine conditions might have been present during the Late Carboniferous in the Maritimes Basin. Recent work at Dalhousie University (Scott *et al.*, personal communication) also suggests a marine influence in the Morien Group, based on arenaceous foraminifera from the strata. Before these recent discoveries, the Upper Carboniferous strata of the Maritimes Basin were thought to be exclusively terrestrial. Hacquebard (1972) utilized the term paralic for the depositional environment of Morien Group coal measures, implying a relationship to marginal marine environments.

Brachiopoda(?)

At locality 12 (Fig. 3-10) several molds were recovered from a calcareous mudstone immediately below a micritic limestone in the Cape John Formation beds. These molds have the overall shape of the brachiopoda *Lingula*; however, positive identification of brachiopods is difficult because of the poor preservation of the specimens (Fig. 3-10). In addition to the *Lingula*-like molds, small low-spired gastropods were also collected from this

Table 3-2. Upper Carboniferous carbonate biota.

	(1) Mellville Cove	(2) Murphy Point	(3) Louisville	(4) Chambers Point	(5) Malagash Point	(6) Treen Bluff	(7) Blockhouse Point	(8) Dewar River	(9) Lower Gulf Shore	(10) Pugwash	(11) Pugwash Bay	(12) Salisbury Point	(13) Joggins
Brachiopoda													
Lingula ?												X	
Gastropoda													
Pupa vetusta	X	X			X								X
Zonites priscus	X												
Straparollus ?				X								X	
Pelecypodia													
Anthracomya Sp.			X		X	X	X		X				X
Naidites carbonarius					X	X			X				
Naidites longus													X
Curvirimula sp.													X
Algae													
Paleochara acadica	X		X		X			X		X			
Garwoodia ?												X	
Ostracods (not identified)	X	X	X	X	X	X	X	X	X	X	X	X	X
Annelida													
Spirorbis carbonarius													X
Vetebrates (fish)													
Baphetes minor													X
Callopristodus pectinatus													X
Ctenacanthus sp.													X
Xenacanthus sp.													X
Rhizodopsis sp.													X
Megalichthys sp.													X

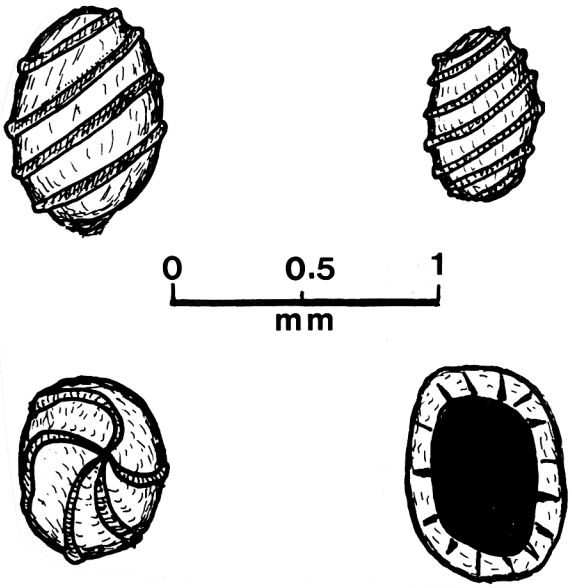

Figure 3-8. Drawing of *Paleochara acadica*, from Malagash Point locality.

locality. The gastropods were *Straparollus*-type but fell apart when the calcareous mudstone dried. Subsequent attempts to find other specimens were unsuccessful. Given that *Garwoodia* and foraminifera of possible marine affinity have been found, it is possible that these molds may be brachiopods and marine gastropods. Additional collection will perhaps document the presence of marine invertebrates in the study area.

Invertebrate Paleontology of Clastic Sedimentary Rocks

In the Cumberland Basin, sandstone exposures contain fragments of stems, roots and trunks of large terrestrial plants. Shale exposures (mudrocks) contain fossil ferns, small land plants, and lacustrine arthropods. A biotic list is given in Table 3-3.

Scott (1984) has attempted to classify sub-environments for the major plant groups within the fluvial setting in Carboniferous rocks of Great Britain. Fossil distribution patterns within the study area are similar to those of Scott's model; however, the paucity of well preserved plant fossils within redbeds of the Pictou Group makes any detailed study of their distribution within the sub-environments of the fluvial system difficult. The plant fossils present are predominantly ferns and *Calamites* which are most abundant in the levee and proximal overbank sub-environments of Carboniferous river systems. The presence of a few ostracods in some of the mudrocks indicates that small lakes and ponds probably developed on the floodplain adjacent to the streams. The rarity of *Lepidodendron* and *Sigillaria* suggests poor floral development in areas away from the streams.

Palynology

In an effort to better understand the age relationships of the various lithostratigraphic units in the Cumberland Basin over 350 palynological samples were taken (Fig. 3-11). The samples included a detailed section through all of the Mabou to Cumberland strata along the Joggins shore, scattered samples throughout the basin where exposure permitted, samples from geographically advantageous shallow drillholes, and numerous stratigraphic samples from the available deep drilling in the basin. G. Dolby of Dolby and Associates identified the palynomorphs from the samples and assigned ages to the assemblages found. Sample locations, numbers and assigned ages are listed in Appendix I. Detailed species lists, rationale for the age determinations, and stratigraphic positions for the spore samples are presented in Dolby, 1989.

The palynological studies by Dolby (1989) have refined the age range and relationships of lithostratigraphic units in the Cumberland Basin. The Mabou Group is late Viséan to Namurian, the Cumberland Group is late Namuriam-Westphalian A to early Westphalian D? and the Pictou Group is late Westphalian D to Stephanian.

At least part of the Middleborough Formation appears to be time equivalent to the Upper Windsor Group. Rocks on the north limb of the Scotsburn Anticline near West Branch River John have been previously assigned a Late Devonian age (Nabiscumb Brook Formation by Donohoe and Wallace, 1982); however, palynology indicates a Viséan age. These rocks are, therefore, equivalent in age as well as lithologically similar to the Middleborough Formation and they are included in that formation in this report.

Cumberland Group strata can be subdivided into seven distinct spore zones that can be traced throughout the basin. Dolby (in press) recognized seven miospore concurrent range zones in the Claremont, Boss Point, Joggins, Springhill Mines and Ragged Reef formations and the lower part of the Malagash Formation. The zones are: *Spelaeotriletes arenaceous - Florinites spp.* Zone, *Cannanoropollis mehtae - Raistrickia fulva micra* Zone, *Vestispora tortuosa* Zone, *Punctatosporites spp. - R. fulva micra* Zone, *Florinites junior - Punctatosporites spp.*

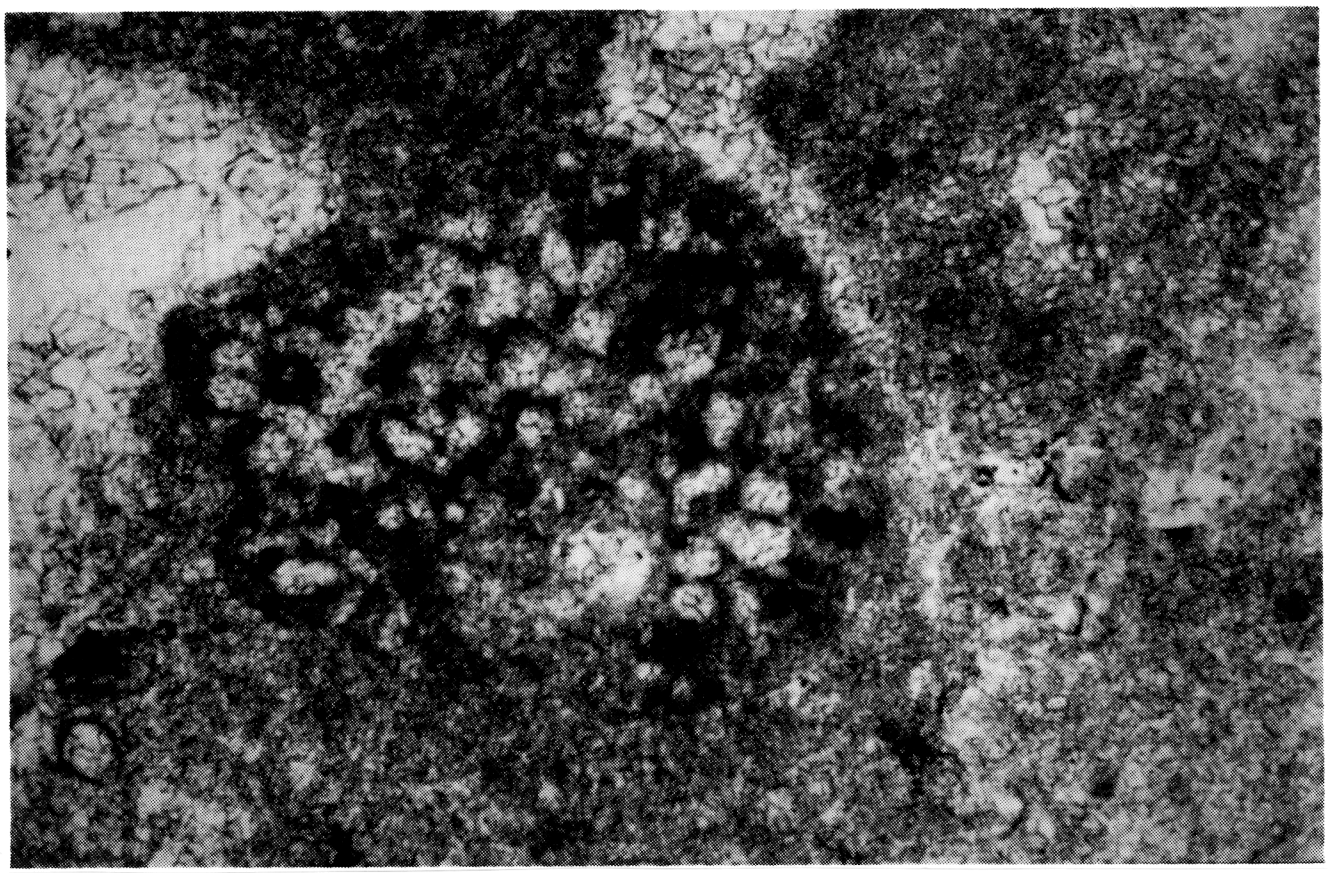

Figure 3-9. *Photomicrograph of Garwoodia* sp? from Salisbury Point, identification verified by B. Mamet (pers. comm.).

Zone, *Vestispora magna - Vestispora pseudoreticulata* Zone, and the *Illinites boehnerii* Zone.

Palynostratigraphic correlations of the Cumberland Group in the western part of the Cumberland Basin with Western Europe and the United States indicate that the Cumberland Group is of Westphalian A to transitional Westphalian B-C age, although the possibility exists that the Claremont and Boss Point formations may include latest Namurian strata. The upper part of the Malagash Formation in the eastern Cumberland Basin extends into the late Westphalian C to earliest Westphalian D. Preliminary correlations indicate that the coal-bearing strata of the Joggins Formation are older than the Springhill coal measures (Springhill Mines Formation).

Two new species and one new variety are described by Dolby (in press): *Rugospora robusta, Illinites boehnerii* and *Raistrickia fulva var.* micra. Dolby also proposes two new combinations: *Murospora sibleyana* and *Caheniasaccites crenatus*. Assemblages thought to be early Permian can be found in some of the Pictou Group strata in the Tatamagouche Syncline area.

Spores of the Pictou Group range from Westphalian D to Stephanian in age. The predominant red colour of the fine- grained rocks in the Pictou Group indicates conditions not favourable to preservation of good palynological samples and, therefore, the palynology is not as well documentated as it is for the Cumberland Group. No formal Pictou Group spore zones have been suggested to date.

Extensive reworking of Viséan to Namurian palynomorphs from older strata was recorded in the basal Boss Point Formation and Claremont Formation in the Joggins section. Similar reworking is also present in drillhole TF 86-1 drilled on the southern border of the Tatamagouche Syncline where early Carboniferous palynomorphs were abundant in the Cumberland Group strata. Well preserved Devonian material was also recovered in samples taken in and near the bases of major sandstone channel bodies and channel lag mud in the Ragged Reef Formation type section.

Palynology in the Cumberland Basin delineates distinct spore zones which range in age from Viséan to

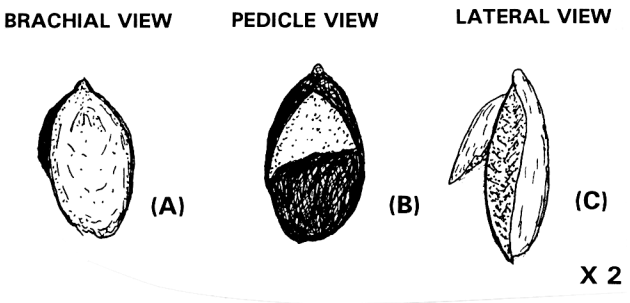

Figure 3-10. Drawings of a possible *Lingula* mold from Salisbury Point.

Stephanian. These informal spore zones generally correlate with the major lithostratigraphic subdivisions of the basin. Palynology indicates that the range in age of the Cumberland Group should be extended into the Westphalian D from the previous Westphalian C determination, and that the base of the revised Pictou Group in the Cumberland Basin is of late Westphalian D age. These palynological dates facilitated regional mapping and correlation in areas where stratigraphic exposure and drillhole data are limited and determination of the lithostratigraphic position of beds was difficult.

Vertebrate Paleontology

The Joggins section of the Cumberland Basin has yielded a diverse assemblage of invertebrate and vertebrate fauna. The list of vertebrates is given in Table 3-3. Many of the arthropods listed in Table 3-3 were identified from specimens collected at Joggins. Carroll *et al.* (1972) summarized the faunal assemblages found at Joggins and paid particular attention to the vertebrate fauna discovered entombed in fossilized tree trunks. The assemblage of vertebrates found at Joggins is unusual because most Upper Carboniferous coal measures contain aquatic forms rather than the terrestrial forms found at Joggins. The vertebrates found at Joggins represent some of the earliest cited reports of these genera and species which became more abundant later in the Carboniferous. Particularly significant are the reptiles, which are extremely rare in coal-bearing strata of similar age elsewhere in the world.

Carroll *et al.* (1972) suggested that the fossil remains in three stumps provide a quantitatively accurate sampling of the vertebrate fauna living on land in the Joggins area. The stumps acted as traps to remove animals from their natural habitats. Preservation of vertebrates within tree stumps resulted from a very special set of tectonic and sedimentological events. Lycopod stumps were hollow because the lycopod vascular tissue was primarily restricted to a narrow layer just beneath the bark. The centres of stumps rapidly rotted, leaving a hollow cylinder. Animals walking on the land surface fell into these stumps and were unable to climb out.

Conclusions

Biota preserved in the Carboniferous strata of the study area are useful guides to the age and environmental settings of deposition within the complex Cumberland Basin.

Windsor Group fauna in the study area indicate an absence of Upper Windsor Group limestone. All of the limestone units studied were of B Subzone age, suggesting that marine carbonates of the Upper Windsor are not represented in outcrop and were probably not deposited in most of the basin. The faunal assemblage of the Windsor Group limestone units in the area suggests that they were deposited in a shallow marine sublittoral zone, at or near wave base.

The presence of thin, laterally extensive ostracod- and algae-bearing lacustrine limestone suggests that there was periodic large scale flooding of the alluvial plain during deposition of the Cumberland and Pictou groups. The presence of *Garwoodia* and possible brachiopod molds indicate that there may have been marine or lagoonal influence during the Upper Carboniferous in the Tatamagouche area. Periodic flooding of the alluvial plain may record external eustatic sea level changes, as well as regional to local tectonic events.

Trace fossils are abundant in the Upper Carboniferous strata. Distribution of bioturbated horizons indicates that there may have been frequent dry periods when organic material within and on the sediments became available as a food source for organisms. For instance, *Arthropleura* probably scavenged plant material from emergent channel bars. Further documentation of the type and distribution of trace fossils in the Upper Carboniferous strata may lead to a better understanding of the environmental significance of the various fossils.

The paleontology and paleobotany of clastic rocks exhibit patterns similar to the proposed environmental settings for the Carboniferous rocks in Great Britain (Scott, 1984). Distribution of the plant fossils is obscured by the reddening of Pictou Group strata in the area. If the present distribution of flora has not been altered by preferential preservation, it would suggest that much of the vegetation was restricted to the near channel and swamp areas of the floodplain. This restriction of the floral distribution suggests that seasonal drying may have

Table 3-3. Biota in clastic rocks of the Cumberland Basin (identified in this study).

Arthropoda	Vertebrates	Paleobotany
Carbonita inflata	*Eosarus acadianus*	*Neuroptreris rarinervis*
Leaia laevis	*Asaphestera intermedium*	*Calamites sp.*
Amynilypes springhillensis	*Hylerpeton dawsoni*	*Asterophyllites grandis*
Hiboldtina sp.	*Leiocephalikon problematicum*	*Cordaites principalis*
Candona sp.	*Novascoticus multidens*	*Pecopteris acadica*
Xylobius sigillariae	*Ricnodon sp.*	*Calamites ramosus*
Archiulus xylobioides	*Trachystegos megalodon*	*Amularia pseudostellata*
Archiulus euphoberoides	*Dendrerpeton acadianum*	*Alethopsteris sp.*
Mazonia acadica	*Calligenethlon watsoni*	*Lepidodendron pictoense*
Belinurus sp.	*Hylonomus lyelli*	*Sphenopteris whittii*
Eurypterus sp.	*Archerpeton anthracos*	*Sigillaria tessellata*
Ephemcroptera sp.	*Protoclepsydrops haplous*	*Stigmaria sp.*

Additional biota lists and descriptions are provided by Bell (1944), Copeland (1957), and Carroll *et al.* (1972).

inhibited vegetation development away from water sources. The younger floral assemblages reflect a stressed biome which may be related to a gradual drying of the paleoclimate through time or highly seasonal distribution of precipitation.

Palynological study of the Cumberland Basin strata has delineated several distinct spore zone which correlate with lithostratigraphic units. This work was of great benefit in mapping of the basin-fill units.

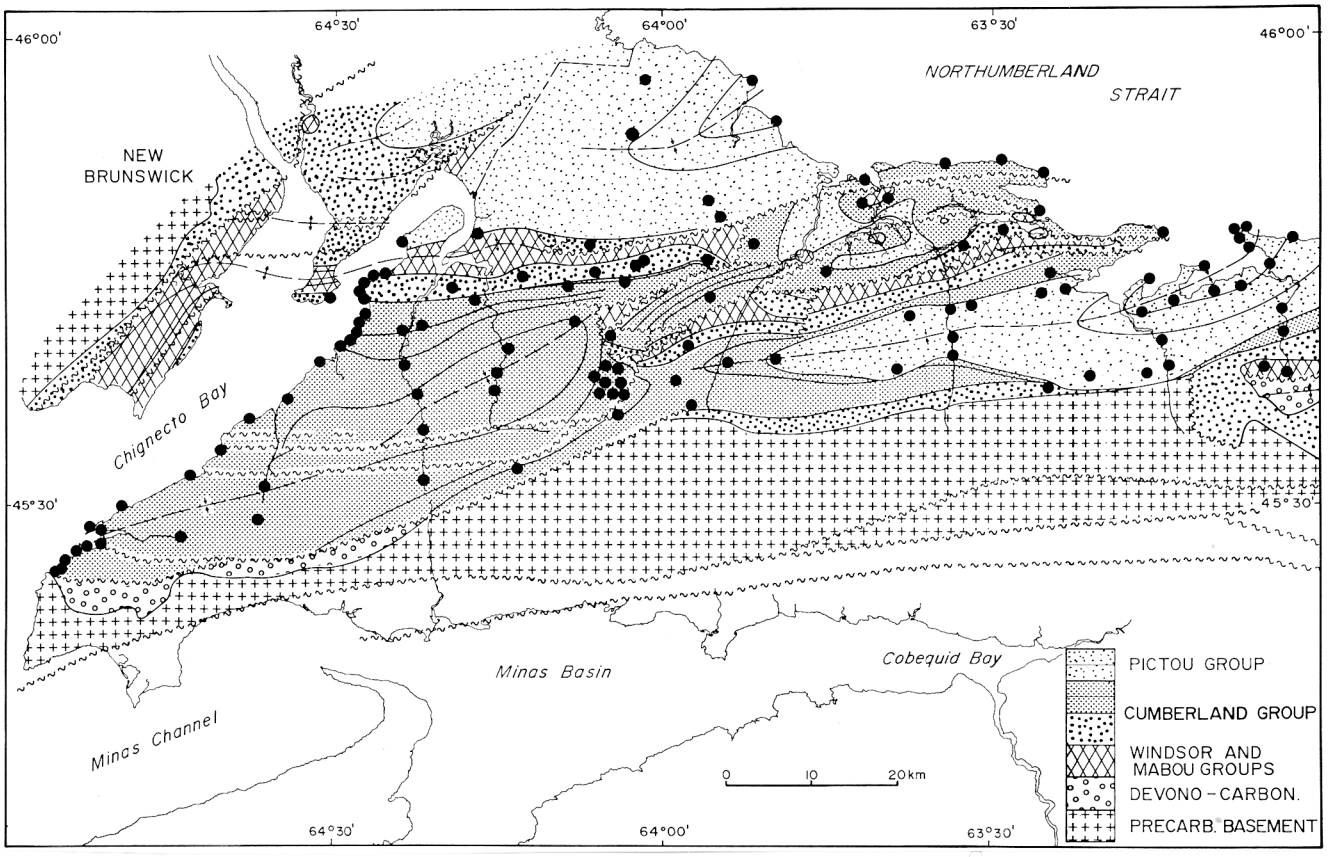

Figure 3-11. Palynological sample distribution, Cumberland Basin, Nova Scotia.