R A Price

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FLORA OF PENNSYLVANIAN PICTOU GROUP OF NEW BRUNSWICK

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PICTOU GROUP
OF NEW BRUNSWICK

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PREFACE

The Pictou group underlies more than 9,000 square miles in central and southeastern New Brunswick, and contains all coal seams in the province. This report describes all identifiable fossil plants in the collections of the Geological Survey of Canada that were made from the group during the past century, and presents the resulting conclusions on the stratigraphic ages of the rocks containing them. These should greatly assist the field geologist in more accurate correlation of some of the rock-units and in interpreting rock structures in which the group is involved. They should also lead to a fuller knowledge of an important epoch in the geological history of the province.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, JUNE 22, 1961

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FLORA OF PENNSYLVANIAN PICTOU GROUP OF NEW BRUNSWICK

Abstract

In New Brunswick, the Pictou group, which underlies an area of about 9,500 square miles, is the only Carboniferous group that contains workable coal. Most of the plant remains described are from the Minto and Clifton formations, and from shales above a thin coal seam at Beersville. Those from the two formations are approximately the same age, and are equivalent to that of a lower part of the *Linopteris obliqua* zone of Sydney coalfield. Plants from Beersville and from a few other localities in the southeastern part of the province are younger and correspond in age to an uppermost part of the *Linopteris obliqua* zone, or less probably to a basal part of the *Ptychocarpus unitus* zone.

Of fifty-eight specifically named species described, fifty-three are assigned to species previously described, and forty-two of these occur also in the Sydney coalfield; four of them, viz., *Bellopteris corsini* (Radforth and Walton), *Pecopteridium sullivanti* (Lesquereux), *Saportaea dispar* (Dawson), and *Cordaitanthus rhabdocarpi* (Dawson), are given new combinations. Four new species are described, viz., *Sphenopteris barbalata, Sphenopteris hirticula, Pecopteris (Asterotheca) acadica,* and *Gymnostrobus wilsoni,* of which *Pecopteris acadica* occurs also in the Sydney coalfield.

Résumé

Au Nouveau-Brunswick, le groupe Pictou, qui recouvre une aire d'environ 9,500 milles carrés, est le seul groupe carbonifère dans lequel se trouve de la houille exploitable. Le gros des restes de végétaux décrits proviennent des formations Minto et Clifton, ainsi que de schistes qui reposent sur une mince couche de charbon située à Beersville. Les débris provenant des deux formations ont à peu près le même âge; ils équivalent à ceux qu'on retrouve dans une portion inférieure de la zone à *Linopteris obliqua* du champ houiller de Sydney. Les plantes provenant de Beersville et de quelques autres endroits de la partie sud-est de la province sont plus récentes et correspondent chronologiquement à une portion supérieure de la zone à *Linopteris obliqua,* ou, ce qui est moins probable, à une portion inférieure de la zone à *Ptychocarpus unitus.*

Parmi les cinquante-huit espèces spécifiquement désignées qui ont été décrites, cinquante-trois sont rattachées à des espèces antérieurement décrites, et quarante-deux d'entre elles se retrouvent également dans le champ houiller de Sydney. Quatre des dernières espèces, à savoir *Bellopteris corsini* (Radforth et Walton), *Pecopteridium sullivanti* (Lesquereux), *Saportaea dispar* (Dawson) et *Cordaitanthus rhabdocarpi* (Dawson) comptent maintenant de nouvelles combinaisons. Quatre nouvelles espèces sont décrites, à savoir *Sphenopteris barbalata, Sphenopteris hirticula, Pecopteris (Asterotheca) acadica* et *Gymnostrobus wilsoni,* parmi lesquelles *Pecopteris acadica* se retrouve également dans le champ houiller de Sydney.

Chapter I

INTRODUCTION

In New Brunswick, the land area underlain by Pennsylvanian rocks is about 10,000 square miles. It forms roughly an equilateral triangle, about 130 to 150 miles to a side, with seaward side on Gulf of St. Lawrence and Northumberland Strait, northwestern side bordering the central highlands of New Brunswick, and southern side the Caledonian upland and extension of the Kingston upland. The eastern part of the southern border is irregular — owing to the Moncton sub-basin of Carboniferous deposition — lying between the extension of the Kingston upland and the Caledonian upland.

East of the present termination of the Caledonian upland the area underlain by Pennsylvanian rocks in Westmorland county merges with that underlain by Pennsylvanian rocks in Nova Scotia. The latter rocks were deposited in part of the Cumberland sub-basin of deposition that lies between the Caledonian upland, its subsurface extension, and the Cobequid upland. In this area of coalescence, the Pictou group has not generally been mapped separately from the older Riversdale group upon which it lies unconformably or disconformably, the two groups having been mapped collectively as the Petitcodiac group. W. C. Gussow (1953, pp. 1753, 1755-1758)[1], however, mapped the Pictou and Riversdale groups as independent units in this and in bordering areas of Westmorland and Kings counties. It is probable that the Pictou group underlies 9,000 to 9,500 square miles of the triangular area of central and southeastern New Brunswick, mentioned above. J. E. Muller (1951, p. 2) referred to its occurrence as forming part of the "Eastern Plain of New Brunswick, the site of a great area of nearly flat-lying Pennsylvanian strata". The surface of this area, which rarely rises higher than 500 feet above sea-level, is largely forested, and is covered with a variable thickness of Pleistocene glacial deposits, so that outcrops of bedrock are restricted mainly to sea-cliffs and along rivers and streams.

For information on the stratigraphic geology of the area the reader is referred to reports of W. S. Dyer (1926), J. E. Muller (1951), and W. C. Gussow (1953). The last-mentioned author presented a rather full bibliography of other relevant published articles and reports.

The Pictou group of New Brunswick was first studied in detail by W. S. Dyer (op. cit., 1926) in the Minto-Chipman area, where a thin coal seam has been profitably mined for many years. Dyer named that part of the Pennsylvanian (recognized unequivocally as equivalent to the Pictou group) the Grand Lake formation, and divided it into three members, respectively 300, 75, and 100 feet thick in ascending sequence, of which the middle member contains the Minto coal seam, 18 to 24 inches thick. The Grand Lake formation lies with apparent conformity upon extrusive rocks up to 100 feet thick, which conformably overlie the predominantly red conglomerate, named by Dyer the Newcastle Creek member. The basal contact of this formation is

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[1] *Dates in parentheses are those of references cited at the end of this report.*

one of marked angular unconformity with underlying pre-Carboniferous slate and sandstones. The volcanic rocks and underlying coarse clastic sediments named the Newcastle Creek member were provisionally considered by Dyer to be Pennsylvanian, mainly owing to their apparent conformable relationships with the Grand Lake formation above.

Muller (1951) as a result of further field studies in Minto-Chipman area modified Dyer's subdivisions of the Pictou group, raising the status of the members to formations. The classification as emended by him was in descending order as follows:

	Thickness (feet)
Pictou group	
trachyte and quartz-porphyry extrusive rocks	30±
Sunbury Creek formation	
light red, green, and grey sandstone, and conglomerate member at top; middle member of grey sandstone and shale, including thin coal seam; basal member of grey sandstone and conglomerate Total	300
Hurley Creek formation	
red and greenish grey sandstone, conglomerate and shale	150
Minto formation	
upper member of grey sandstone, shale, conglomerate, including Minto coal seam; lower member of grey sandstone and conglomerate Total	350-450
Pre-Pictou (?) group	
basalt and andesite	0-80
Newcastle Creek formation	
conglomerate, dominantly red, and some tuff	0-50
unconformable contact	

Muller, like Dyer, was unable to establish the age of the Newcastle Creek formation or of its overlying volcanic rocks. He did, however, transfer local trachytic flow rocks, which Dyer considered to be part of the volcanic rocks below the Minto formation, to a position above the Sunbury Creek formation, and by doing so gave some support for the inclusion of earlier volcanic rocks and rocks of the Newcastle Creek formation within the Pictou group.

Practically all plants in collections from the Minto area were gathered from the upper member of the Minto formation from roof shales of the Minto coal seam, so that the only relevance that the problem of the age of the Newcastle Creek formation has to this report is whether or not it belongs to the Pictou group. According to Muller (op. cit., p. 16), the plant-bearing beds lie about 215 feet above the base of the Minto formation, if the volcanic beds are excluded. If the Newcastle Creek sediments are considered as part of the Pictou group, the plant-bearing beds would lie, also excluding volcanic rocks, not more than 265 feet above base of this group.

The Pictou group of Westmorland county and that of a part of Kings county were studied in some detail by W. C. Gussow (1953, pp. 1755-1766). He divided them in descending sequence into the following four lithological units:

	Thickness (feet)
Tormentine formation	
red sandstone and conglomerate	500+
disconformable (?) contact	
Richibucto formation	
grey arkosic sandstone, siltstone and shale; minor conglomerate and rare thin coal seams	1,000±
disconformable contact	
Scoudouc formation	
grey arkosic sandstone, conglomerate; a few red zones; rare thin coal seams	500+
gradational contact	
Salisbury formation	
predominantly red shale, siltstone, sandstone and conglomerate; rare grey to black thin shale	2,000-2,700

Small plant collections from Kent and Westmorland counties were made by various workers from (a) Beersville, from roof shales of a thin coal seam, (b) Pollett River area, southeast of Petitcodiac, (c) Maringouin Peninsula, on Wood Creek, south of Sackville, and (d) Richibucto River, opposite Molus River. The writer has concluded (*see* pp. 9-11) that the beds containing them, with possible exception of those on Richibucto River, were equivalent in age to those contained in uppermost part of the *Linopteris obliqua* zone of the Sydney coalfield. The plants from Pollett River area came from Gussow's Salisbury formation (Gussow, 1953, p. 1721), and those from Wood Creek, Maringouin Peninsula, from Pictou beds undifferentiated by Gussow. According to Gussow (1953, p. 1764), the plant-bearing beds overlying the Beersville coal occur in his Scoudouc formation, and those from Richibucto River seem to belong to either the Scoudouc or the Richibucto formation.

The plants from the Pollett River area are not known to be associated with a coal seam. A thin coal seam, however, is known to occur about 14 miles southwest of the Pollett River plant locality, and this coal should lie in beds much lower in the stratigraphic sequence, for it occurs in the vicinity of Dunsinane in the area of the 'nose' of the northeastern-plunging Dunsinane syncline. To the writer, therefore, it seems possible, if not probable, that this Dunsinane coal is equivalent or nearly so in age to that of the Minto coal seam. Because fossil megascopic plant material from strata overlying Dunsinane coal is lacking in Geological Survey of Canada collections, this assumed age cannot at present be verified. At any rate, the plants occurring in that part of the Salisbury formation outcropping near Pollett River settlement indicate an age equivalent to that of the Beersville flora, which is late Westphalian C or early Westphalian D, and younger than the Minto flora. Consequently the provisional age correlation of Gussow (1953, p. 1760) of the Scoudouc formation with any part of the Minto formation is incorrect. No megascopic plants from the Sunbury formation of Minto, have been seen by the writer, but, if that formation lies conformably upon the Minto, it is doubtful whether it contains any flora as young as that of Beersville or as young as that contained within the middle or upper part of the Salisbury formation in the Moncton basin.

F. J. Alcock (1936, pp. 94, 95) divided Pennsylvanian strata in coastal area of Chaleur Bay east of Bathurst into two formations, Bathurst below (at least 125 feet thick) and Clifton above (about 700 feet thick). The Bathurst formation westward of Bathurst lies unconformably upon Devonian granite and Ordovician slate. It consists mainly of red sandstone and shale, and minor red quartzose conglomerate. This formation grades upwards into the Clifton with apparent conformity, the Clifton comprising mostly grey sandstone and shale, but gradually passing upwards into a sequence of purplish red shales, sandstone, and conglomerate.

Several unworkable coal seams, none more than 10 inches thick, are known to occur in the Clifton formation. Alcock (p. 95) noted a 6-inch seam near the base of the formation and an 8-inch seam about 130 feet higher.

The Bathurst formation has yielded no plant material so far. All plants from the Clifton formation in Geological Survey of Canada collections, including those recorded by Alcock (p. 95 of above reference), were gathered from roof shales of a thin coal seam — apparently the 8-inch seam reported by Alcock — from outcrops on Chaleur Bay shore or near it in the vicinity of Clifton and Stonehaven.

Chapter II

AGE OF THE FLORAS

The *Linopteris obliqua* Zone

The age of the known floral assemblages that have been derived up to the present from the Pictou group of New Brunswick is based upon the writer's interpretation of evidence for the age of the collective flora of the *Linopteris obliqua* zone of the Sydney coalfield. For the flora of that zone embraces all the significant plant species that have been collected from New Brunswick Pictou beds. The upper part of the Pictou group in New Brunswick has not yet yielded plants indicative of age.

Reasons for assigning the age of the flora of the *Linopteris obliqua* zone to Westphalian C were previously given (Bell, 1938, pp. 12-19), and need no further comment beyond reference to results of subsequent palaeobotanical and stratigraphic studies in Europe or elsewhere, in so far as they may support or contravene such assignment.

Figures 1 and 2 of the writer's 1938 report, which present the known stratigraphic ranges of individual species of the flora of the *Linopteris obliqua* zone, clearly show that that flora comprises two subfloras or florules, the earlier one occurring in a lower part of the zone, in strata lying between the top of the Tracy coal seam and top of the Mullins seam, and the later in strata between top of Mullins and top of the Emery coal seams. The differences in these two floral assemblages are indicated by the appearance in the roof shales of the Mullins coal of species that do not occur within the lower part of the zone. Specifically, these are *Alethopteris scalariformis, Asterotheca herdi, Boweria schatzlarensis, Cordaianthus spinosus, Corynepteris winslowii, Crossotheca compacta, Hymenotheca broadheadi, Linopteris muensteri* var. *dawsoni* (= *L. dawsoni*), *Linopteris obliqua* var. *bunburii* (= *L. bunburii*), *Mariopteris soubeirani*?, *Neuropteris flexuosa, Odontopteris subcuneata, Pecopteridium sullivanti, Senftenbergia*? *obtusa,* and *Sphenopteris brittsii.* Some of these species may have little age significance, and the distribution of others is unknown; collectively they show a definite change in the floral assemblage, brought about by the first appearance of the species enumerated above and the disappearance of others.

The boundary between the *Linopteris obliqua* zone and the overlying *Ptychocarpus unitus* zone, or between Westphalian C and D in the Sydney sequence, was chosen at top of the Emery coal seam, owing to the first appearance above the Emery of a number of species that are lacking in the *Linopteris obliqua* zone. Upon these additions to the flora was based the assignment of the flora of the *Ptychocarpus unitus* zone to Westphalian D. *Neuropteris ovata,* a rare species in the floral assemblage of the uppermost part of the *Linopteris obliqua* zone, merits particular attention because in recent years a number of stratigraphic palaeobotanists regard it as one of the best guide fossils to a Westphalian D age of strata containing it, and some of them designate these strata the *Neuropteris ovata* zone. In the Sydney coalfield sequence of strata *N. ovata* makes its first appearance in roof shales of the McRury coal seam, which stratigraphically lie 115 to 150 feet below the Emery coal seam. That circumstance gives rise to the question whether its entry denotes any change within the flora of the *Linopteris obliqua* zone sufficient to lower the Westphalian D-C boundary from its inferred stratigraphic position at top of the Emery seam. The writer would answer in the negative for the following reasons:

(a) *Neuropteris ovata* is rare to very rare in the upper part or upper subzone of the *Linopteris obliqua* zone and only reaches its acme in the *Ptychocarpus unitus* zone.

(b) Only three other species, *Calamites discifer, Pecopteris sterzeliformis,* and *Sphenopteris neuropteroides,* make their first entry into the *Linopteris obliqua* zone at the same horizon as that of *Neuropteris ovata. Calamites discifer* may be ruled out as having no peculiar age significance, and outside distribution of *Pecopteris sterzeliformis* is unknown. *Sphenopteris neuropteroides,* like *Neuropteris ovata,* is rare to very rare in uppermost part of the *Linopteris obliqua* zone, but common in the overlying *Ptychocarpus unitus* zone. Its stratigraphic range is comparable to that in the Valenciennes coal basin where it is rare in beds of Westphalian C age, and becomes common only in beds of Westphalian D. It occurs in the Staffordian series (Westphalian C) of England where it makes its first appearance, and occurs in the Lower Coal Measures of Missouri, assignable to Westphalian C, as well as in the later Allegheny series.

(c) *Neuropteris ovata* and *Sphenopteris neuropteroides* occur in uppermost part of *Linopteris obliqua* zone in association with such characteristic species of that zone as *Neuropteris tenuifolia, Sphenopteris cantiana,* and *Linopteris obliqua,* all of which do not range above horizon of the Emery coal seam.

It is concluded that the first appearance of *Neuropteris ovata* near the top of the *Linopteris obliqua* zone in the Sydney coalfield sequence does not make any significant change in the floral content of the upper part of that zone, and, if the horizon marking the boundary between Westphalian D and C is to be lowered stratigraphically, it should be lowered not to the entrance of *Neuropteris ovata,* but to the top of the Mullins coal seam, and include thereby all strata designated the upper part, or upper subzone, of the *Linopteris obliqua* zone. On present evidence the writer would reluctantly accept such a boundary between D and C, for of the more significant newcomers in roof shales of the Mullins coal, those which have outside distribution, e.g. *Alloiopteris (Corynepteris) winslowii, Hymenotheca broadheadi, Pecopteridium sullivanti,* and *Sphenopteris brittsii,* all occur in the Lower Coal Measures of Missouri, which series is generally regarded as being of Westphalian C age.

Gothan (1938, p. 147) listed the following association as particularly common in, and more diagnostic of beds of Westphalian C age in the Ruhr coalfield: *Sphenopteris crépini, S. striata, Mariopteris nervosa, M. sauveri, Neuropteris rarinervis, N. scheuchzeri, N. tenuifolia, Linopteris muensteri, Sphenophyllum emarginatum, S. majus, Annularia sphenophylloides, Sigillaria cumulata, S. princeps, S. tessellata,* and *Asolanus camptotaenia,* stressing particularly *Neuropteris scheuchzeri, Linopteris* *muensteri,* and *Sphenophyllum emarginatum.* The last three and most of the others are likewise common in the *Linopteris obliqua* zone of Sydney. *Neuropteris tenuifolia* extends throughout the zone, and does not range above it. *Sphenophyllum cuneifolium,* a holdover from the *Lonchopteris* zone, likewise does not range above the *Linopteris obliqua* zone. *Sphenopteris cantiana* is restricted to the *Linopteris obliqua* zone as is *Linopteris obliqua.*

Dix (1937, pp. 63, 169) recorded a marked change in flora and fauna in passing from her plant-bearing zone F (late Westphalian B) to her zone G (early Westphalian C) in the South Wales coalfield. In zone G she records among the more characteristic species: *Crossotheca boulayi, Sphenopteris spiniformis, Mariopteris latifolia, M. hirta, M. nervosa* (probably, in part at least, *M. carnosa*), *M. nobilis* (cf. *M. hirsuta*), *Neuropteris tenuifolia, Linopteris muensteri, Alethopteris serli, A. lonchitica,* and *Asolanus camptotaenia,* an assemblage of species comparable to that occurring in the *Linopteris obliqua* zone of Sydney coalfield and lower part of the Pictou group of New Brunswick, mostly in the Minto and Clifton formations, but some ranging upwards into the Pictou group of Beersville.

Darrah (1937, p. 111) noted that *Neuropteris tenuifolia, N. rarinervis,* and *Linopteris muensteri* are particularly abundant in lower Allegheny beds to which he assigns a Westphalian C age.

P. Bertrand (1937, pp. 68-73) lists *Linopteris muensteri, Neuropteris tenuifolia, N. rarinervis,* and *Mariopteris latifolia* among the most common species of Westphalian C in northern France. *Linopteris muensteri* is lacking in Saare and Lorraine, but *Neuropteris tenuifolia, Pecopteris pennaeformis* are listed as common species, and *Neuropteris rarinervis* and *Mariopteris latifolia* are both present. Bertrand excluded *Neuropteris scheuchzeri, Alethopteris serli, Alethopteris friedeli-aquilina* (= *A. davreuxi*), *Sphenophyllum emarginatum, S. majus,* and *Asolanus camptotaena* from dominantly Westphalian C species, on account of the extension of their ranges into Westphalian D, and in Sydney coalfield all these forms with the exception of *Asolanus camptotaena* occur in both the *Linopteris obliqua* and *Ptychocarpus unitus* (Westphalian D) zones.

In conclusion, results of work of Gothan, Dix, Darrah, and P. Bertrand, and of others not mentioned here, within the past twenty-five years, lend support to an age correlation of the total flora of the *Linopteris obliqua* zone with Westphalian C.

Flora from Minto Area (Sunbury County)

Identified forms of the Minto flora comprise the following species: *Alethopteris lonchitica, A. serli, Annularia pseudostellata, A. sphenophylloides, Asterophyllites longifolius, Cordaitanthus rhabdocarpi, Cordaites principalis, Calamites ramosus, C. suckowi, Lepidodendron bretonense* n. comb., *Lepidostrobophyllum majus, Lepidostrobus mintoensis, Linopteris muensteri, Mariopteris carnosa, M. hirta, M. latifolia, Mintopteris hirsuta, Myriotheca desaillyi, Neuropteris (Bellopteris) corsini, N. heterophylla, N. pseudogigantea, N. rarinervis, N. scheuchzeri* forma *angustifolia, N. tenuifolia, Oligocarpia brongniarti, O. missouriensis, Pecopteris miltoni, P. pennaeformis,* *Samaropsis bisecta, S. cornuta, Sigillaria tessellata, Sphenophyllum cuneifolium, S. emarginatum, S. majus, S. myriophyllum, S. trichomatosum, Sphenopteris barbalata* n. sp., *S. hirticula* n. sp., *S. pseudofurcata, S. spiniformis, S. whitii,* and *Stigmaria ficoides.*

For age determinations within the Pennsylvanian *Annularia sphenophylloides, Cordaites principalis, Calamites ramosus, Calamites suckowi, Stigmaria ficoides,* and *Samaropsis cornuta* are much too long ranging to have particular significance, and *Mintopteris hirsuta* and the new species *Sphenopteris barbalata* and *Sphenopteris hirticula,* of which outside distribution is unknown, may also be disregarded. This leaves thirty-three species, of which twenty-five occur also in the Morien (Pictou) group of the Sydney coalfield. Five of these twenty-five, viz., *Neuropteris pseudogigantea* (*N. aculeata* Bell 1938), *Pecopteris pennaeformis, Sphenopteris spiniformis, Sphenophyllum cuneifolium,* and *Linopteris muensteri* do not range at Sydney above the *Linopteris obliqua* zone, and the first three are restricted there to the basal part of that zone. The writer therefore concludes that the age of the Minto flora is equivalent to a basal part of the *Linopteris obliqua* zone. The flora occurs in the roof shales of the Minto coal seam, and the age of the Minto coal itself must be slightly older, and probably the equivalent or near-equivalent to that of the Tracy seam. The Tracy coal seam itself, is best regarded as the uppermost bed of the *Lonchopteris* zone, and not as the basal bed of the succeeding *Linopteris obliqua* zone. Likewise, the Emery coal seam marks the uppermost bed of the *Linopteris obliqua* zone, and not the basal bed of the *Ptychocarpus unitus* zone.

The floral assemblage in roof shales of the Tracy seam indicates an initial appearance of significant species, e.g. *Mariopteris latifolia, M. carnosa, Neuropteris rarinervis, Oligocarpia missouriensis, Pecopteris (Senftenbergia) pennaeformis,* and *Sphenopteris whitii,* all of which occur in the Minto flora.

Flora from Clifton Formation (Gloucester County)

Of the thirty-three selected species listed above as occurring in the Minto formation twenty-one occur also in the Clifton formation. They comprise *Alethopteris serli, Annularia pseudostellata, Lepidodendron bretonense, Lepidostrobus mintoensis, Linopteris muensteri, Mariopteris carnosa, M. latifolia, Neuropteris heterophylla, N. pseudogigantea, N. rarinervis, N. scheuchzeri, N. tenuifolia, Oligocarpia missouriensis, Pecopteris miltoni, Sphenophyllum cuneifolium, S. emarginatum, S. majus, S. myriophyllum, S. trichomatosum, Sphenopteris spiniformis,* and *S. whitii.*

Minto species lacking in present collections from the Clifton formation are *Alethopteris lonchitica, Asterophyllites longifolius, Lepidostrobophyllum majus, Mariopteris hirta, Myriotheca desaillyi, Neuropteris* (*Bellopteris*) *corsini, Oligocarpia brongniarti, Pecopteris pennaeformis, Samaropsis bisecta, Sigillaria tessellata,* and *Sphenopteris pseudofurcata.* Of these eleven species all except *Neuropteris* (*Bellopteris*) *corsini* are rare or very rare in the Minto formation, and their absence from Clifton collections may be due to the fact that no coal seam has been worked at Clifton, for practically all the Minto collections were made from the roof shales of an extensively worked single seam.

Occurring in the Clifton formation, but lacking in Minto collections, are *Asterophyllites grandis, Crossotheca boulayi, Lepidodendron pictoense, Mariopteris hirsuta,* and *Saportaea dispar.* All these with exception of *Lepidodendron pictoense* are rare or very rare.

On present evidence the writer concludes that the Clifton flora is practically the same age as that of the Minto. If slightly younger, it seems unlikely to be later in age than the Mullins coal seam of Sydney, and, if so, would be assigned, like the Minto, to a lower part of the *Linopteris obliqua* zone.

Pictou Group from Napadogan Map-area (York County)

Small collections from Pictou group as it occurs in Napadogan and Burtts Corner map-areas yielded the following seventeen species: *Alethopteris lonchitica, A. serli, Annularia pseudostellata, A. sphenophylloides, Asterophyllites longifolius, Calamites suckowi, Cordaitanthus rhabdocarpi, Cordaites principalis, Lepidostrobus mintoensis, Neuropteris flexuosa, N. pseudogigantea, N. rarinervis, N. scheuchzeri, N. tenuifolia, Pecopteris miltoni, Sphenophyllum cuneifolium* and *Sphenopteris whitii.*

All of these species with possible exception of *Neuropteris flexuosa* occur in the Minto flora; it is concluded that they are of the same Westphalian C age, and that the strata containing them are equivalent in age to a lower part of the *Linopteris obliqua* zone of the Sydney coalfield.

Pictou Group of Beersville Area (Kent County)

Roof shales of a thin coal seam, which has been intermittently mined at Beersville, yielded the following seventeen plant species: *Alethopteris davreuxi, Asolanus camptotaenia, Asterophyllites grandis, Boweria schatzlarensis, Calamites ramosus, Corynepteris similis, Gymnostrobus wilsoni, Lepidodendron bretonense, Mariopteris latifolia, Neuropteris rarinervis, N. tenuifolia, Oligocarpia missouriensis, Pecopteridium sullivanti, Pecopteris acadica, Sphenophyllum emarginatum, S. majus,* and *Sphenopteris whitii.*

Nine of the above species occur in the Minto flora and an additional one in the Clifton flora. Of the remaining seven species the most significant for evaluation of age relationship of the flora are *Alethopteris davreuxi, Boweria schatzlarensis, Corynepteris similis,* and *Pecopteridium sullivanti.* At Sydney none of these is known to range below the *Linopteris obliqua* zone. *Alethopteris davreuxi* (*A. friedeli* Bell 1938) ranges from lower part of *Linopteris obliqua* zone to near top of the *Ptychocarpus unitus* zone. *Boweria schatzlarensis* is confined to upper part of *Linopteris obliqua* zone and base of *Ptychocarpus unitus* zone. *Corynepteris similis* (*C. sternbergi* Bell 1938) occurs only in the base of *Ptychocarpus unitus* zone, and *Pecopteridium sullivanti* in upper part of *Linopteris obliqua* zone. It is on this evidence that the Beersville flora is considered by the writer to be equivalent in age either to an uppermost part of the *Linopteris obliqua* zone at Sydney or alternatively to a basal part of the *Ptychocarpus unitus* zone (Westphalian D). Weighing these two possibilities the writer thinks the former to be more likely on present evidence. Only if *Pecopteris unitus* is discovered in the future in the Beersville flora would the balance of evidence favour an early Westphalian D age.

Pictou Group of Pollett River Area

A small collection from a bed outcropping at water's edge at a locality on Pollett River southeast of Petitcodiac, made by the writer in 1946, permitted identification of thirteen species, viz., *Alethopteris serli, Annularia sphenophylloides, A. stellata, Asolanus camptotaenia, Cordaites principalis, Mariopteris ribeyroni, Neuropteris scheuchzeri, N. tenuifolia, Pecopteris acadica, P. hemitelioides, Sphenophyllum cuneifolium, S. emarginatum,* and *Sphenopteris whitii.*

Excluding from consideration the long-ranging *Alethopteris serli, Annularia sphenophylloides, A. stellata, Cordaites principalis, Neuropteris scheuchzeri,* the remaining eight species include five, viz., *Asolanus camptotaenia, Neuropteris tenuifolia, Pecopteris acadica, Sphenophyllum emarginatum,* and *Sphenopteris whitii,* all of which are held in common with the flora at Beersville. This common element, particularly *Pecopteris acadica,* indicates a high probability that the Pollett River plants are of the same age as those from Beersville. The three additional species, *Sphenophyllum cuneifolium, Mariopteris ribeyroni,* and *Pecopteris hemitelioides* found at Pollett River are significant. For *Sphenophyllum cuneifolium* like *Neuropteris tenuifolia* at Sydney ranges only to the highest beds of the *Linopteris obliqua* zone. *Mariopteris ribeyroni* at Sydney ranges from top beds of the upper part of the *Linopteris obliqua* zone through the *Ptychocarpus unitus* zone, and *Pecopteris hemitelioides* (*P. robbi* Bell, 1938) ranges from base of *Linopteris obliqua* zone through the *Ptychocarpus unitus* zone. Independently evaluated, the evidence of the age of flora at Pollett River agrees essentially with that at Beersville, i.e. that it is certainly later than the Minto flora, and most probably is equivalent in age to an uppermost part of the *Linopteris obliqua* zone, which is considered, as stated above, to be of late Westphalian C age.

Pictou Group of Miscellaneous Areas

1. Kent county; south shore of Richibucto River, opposite mouth of Molus River.

   A small collection made by W. C. Gussow (1953, p. 1761) yielded specimens of *Pecopteris miltoni* forma *abbreviata (= P. acadica).* The locality is about 18 miles north-northeast of Beersville. The occurrence of a single species *P. acadica* is not indicative of a precise age within the Pictou group. The form is common in roof shale of coal at Beersville, but at Sydney it occurs in rocks of both Westphalian C and D ages.
2. Westmorland county; on small branch of Wood Creek, about 3 miles south of Sackville.

   Two small collections from the above locality made by Gussow (op. cit., p. 1761) yielded species that were identified shortly afterwards by the writer as *Crossotheca boulayi, Pecopteris herdi, P. robbi (= P. hemitelioides),* and

Annularia stellata forma *mucronata*. This florule is considered to indicate an age equivalent to that of the Beersville flora, i.e. late Westphalian C. The Pictou group of Maringouin Peninsula in which the locality lies, overlies beds of the Riversdale group (Westphalian A) with marked angular unconformity.

3. York or Sunbury county; about 18 miles south of Fredericton.

The precise locality at which W. J. Wright in 1946 collected a few plants from a roof of a 16-inch coal seam is not known beyond the information given above. Three species were identified by the writer, viz. *Alethopteris serli, Neuropteris tenuifolia,* and *Cordaites principalis*. These are not sufficiently diagnostic for basing an age relationship, but the occurrence of beds in the Napadogan and Burtts Creek map-areas to the north, which carry a flora containing characteristic species occurring at Minto, probably indicates that these beds too are equivalent to a basal part of the *Linopteris muensteri* zone at Sydney.

Table I

Distribution of Species within Pictou Group of New Brunswick, and Comparison with the Sydney Coalfield of Nova Scotia

	New Brunswick					Nova Scotia (Sydney Coalfield)				
	Westphalian C *Linopteris obliqua* zone					Westphalian C			Westphalian D	
	Lower			Upper						
	Minto formation	Clifton formation	Napadogan area	Beersville	Pollett River	Lonchopteris Zone	Lower Linopteris Zone	Upper Linopteris Zone	Lower Ptychocarpus Zone	Upper Ptychocarpus Zone
Alethopteris davreuxi				x			x	x	x	x
A. lonchitica	x		x			x				
A. serli	x	x	x		x	x	x	x	x	
Alloiopteris (Corynepteris) similis				x					x	
Annularia pseudostellata	x	x	x							
A. sphenophylloides	x	x	x		x	x	x	x	x	x
A. stellata					x		x	x	x	x
Aphlebia sp. A	x									
Aphlebia sp. B		x								
Asolanus camptotaenia				x	x				x	
Asterophyllites grandis		x		x						
A. longifolius	x		x							
Boweria schatzlarensis	?xr[1]			x				x	x	
Calamites ramosus	x			x						
C. suckowi	x		x			x	x	x	x	x
Cordaitanthus rhabdocarpi	x		x							
Cordaites principalis	x		x		x	x	x	x	x	x
Crossotheca boulayi		x					x	x		
Cyclopteris sp.	x			x						
Gymnostrobus wilsoni				x						
Lepidodendron bretonense	x	x		xr				x	x	x
L. pictoense		x						x	x	x
Lepidostrobophyllum majus	x									
Lepidostrobus mintoensis	x	x	x							
Linopteris muensteri	x	x				x	x	x		
Macrostachya sp.			x							
Mariopteris carnosa	x	x					x	x	x	x
M. hirsuta		x					x	x	x	x
M. latifolia	x	x		xr			x	x	x	
M. hirta	x									
M. ribeyroni					x			x	x	x
Mintopteris hirsuta	x									
Myriotheca desaillyi	x								x	

Table I — *continued*

	New Brunswick					Nova Scotia (Sydney Coalfield)				
	Westphalian C *Linopteris obliqua* zone					Westphalian C			Westphalian D	
	Lower			Upper						
	Minto formation	Clifton formation	Napadogan area	Beersville	Pollett River	Lonchopteris Zone	Lower Linopteris Zone	Upper Linopteris Zone	Lower Ptychocarpus Zone	Upper Ptychocarpus Zone
Neuropteris (Bellopteris) corsini	x									
N. (Mixoneura) flexuosa	?x		x					x	x	x
N. heterophylla	x	x	x				x	x	x	
N. pseudogigantea	x	x	x			x	x			
N. rarinervis	x	x	x	x			x	x	x	x
N. scheuchzeri	x	x	x		x	x	x	x	x	x
N. tenuifolia	x	x	x	x	x	x	x	x		
Oligocarpia brongniarti	x						x	x	x	
O. missouriensis	x	x		xr			x	x	x	x
Pecopteridium sullivanti				x				x		
Pecopteris (Asterotheca) acadica				x	x	x	x	x	x	x
P. (Asterotheca) hemitelioides					x		x	x	x	x
P. (Asterotheca) miltoni	x	x	x							
P. (Senftenbergia) pennaeformis	x						x			
Radiospermum? sp.			x							
Samaropsis bisecta	x									
S. cornuta	x					x	x	x	x	
Saportaea dispar		x								
Sigillaria tessellata	x								x	
Sphenophyllum cuneifolium	x	x			xr	x	x	x		
S. emarginatum	x	x		x	x		x	x	x	x
S. majus	x	x		x					x	x
S. myriophyllum	x	x					x	x	x	
S. trichomatosum	x	x					x	x	x	
Sphenopteris barbalata	x									
S. hirticula	x									
S. pseudofurcata	x									
Sphenopteris sp. cf. *S. dufayi*		x								
S. spiniformis	x	x					x			
S. (Diplotmema) whitii	x	x	x	x	x		x	x	x	x
Stigmaria ficoides	x					x	x	x	x	x
Trigonocarpus? sp.	x									

[1]r = rare (one or two specimens)

Chapter III

DESCRIPTION OF SPECIES

Summary List

Oligocarpia brongniarti Stur
O. missouriensis D. White
Boweria schatzlarensis Kidston
Crossotheca boulayi Zeiller
Myriotheca desaillyi Zeiller
Alloiopteris (Corynepteris) similis Sternberg
Mintopteris hirsuta Radforth and Walton
Sphenopteris (Diplotmema) whitii Bell
S. barbalata n. sp.
S. hirticula n. sp.
S. pseudofurcata Kidston
S. spiniformis Kidston
S. sp. cf. *S. dufayi* Danzé
Mariopteris latifolia (Brongniart)
M. carnosa Corsin
M. hirsuta Corsin
M. hirta (Stur)
M. ribeyroni (Zeiller)
Pecopteris (Asterotheca) miltoni Artis
P. (Asterotheca) acadica n. sp.
P. (Asterotheca) hemitelioides Brongniart
P. (Senftenbergia) pennaeformis Brongniart
Aphlebia sp. A
Aphlebia sp. B
Alethopteris lonchitica (Schlotheim)
A. serli (Brongniart)
A. davreuxi (Brongniart)
Pecopteridium sullivanti (Lesquereux) n. comb.
Neuropteris pseudogigantea Potonié
N. (Bellopteris) corsini (Radforth and Walton) n. comb.
N. tenuifolia (Schlotheim)
N. (Mixoneura) flexuosa Sternberg
N. heterophylla Brongniart
N. rarinervis Bunbury
N. scheuchzeri Hoffman
Cyclopteris sp.
Linopteris muensteri (Eichwald)

Sphenophyllum cuneifolium (Sternberg)
S. emarginatum Brongniart
S. myriophyllum Crépin
S. trichomatosum Stur
S. majus Bronn
Calamites suckowi Brongniart
C. ramosus Artis
Asterophyllites grandis (Sternberg)
A. longifolius (Sternberg)
Annularia stellata (Schlotheim)
A. pseudostellata Potonié
A. sphenophylloides (Zenker)
Macrostachya sp.
Lepidodendron pictoense Dawson
L. bretonense Bell
Lepidostrobus mintoensis Wilson
Lepidostrobophyllum majus (Brongniart)
Sigillaria tessellata (Steinhauer)
Stigmaria ficoides (Sternberg)
Asolanus camptotaenia Wood
Gymnostrobus wilsoni n. sp.
Saportaea dispar (Dawson) n. comb.
Cordaites principalis (Germar)
Cordaitanthus rhabdocarpi (Dawson) n. comb.
Samaropsis cornuta (Dawson)
S. bisecta (Dawson)
Trigonocarpus? sp.
Radiospermum? sp.

Detailed Descriptions

Oligocarpia brongniarti Stur

Plate I, figure 3

?*Oligocarpia splendens* Dawson, Geol. Surv., Canada, Rept. of Prog. (1871), p. 53, Pl. 16, fig. 186; Stopes, Geol. Surv., Canada, Mem. 41, p. 40, Pl. 16, fig. 24; Text-fig. 4 (1914).
Oligocarpia brongniarti Bell, Geol. Surv., Canada, Mem. 215, p. 42, Pl. 29; Pl. 30, figs. 1, 2 (1938); Memoir 225, p. 117 (1940).

Remarks. The best sterile fragment of this species from Minto is GSC No. 917 (Pl. I, fig. 3). It is part of a primary pinna, with rachis 2 mm wide, practically smooth, but under hand lens shows a central cord as well as very minute scattered pits, apparently the bases of fine hairs, as well as microscopic, close, longitudinal striae and on certain specimens scattered, short transverse bars. The ultimate (tertiary) pinnae are regularly oblique, and have nearly straight, moderately thick, winged, striated rachides. They are about 10 mm long by 4.5 mm wide, deltoid-lanceolate, and have three to six pairs of alternate pinnules and a very small bilobate or trilobate terminal one. The smallest pinnules near apex are oblong and pecopteroid, the remainder becoming progressively constricted at base by a narrow sinus that runs nearly parallel to the rachis. The margins are bluntly toothed or crenate, with tendency of the crenae to be emarginate or truncate, but owing to slight folding of the margins the details do not show up well in a photograph. The short crenae or blunt teeth, commonly two or three pairs, are fed by oblique, simple, or once divided (near margin), lateral veins from a slightly flexuous midvein that runs to the apex or divides close to it when the terminal leaflet is emarginate or trilobed; the midvein is oblique or slightly decurrent.

GSC No. 916 (not figured) shows a few circular sori that consist of a central sporangium surrounded by six or seven sporangia.

M. Stopes (1914, p. 40) considered the type of *Sphenopteris splendens* Dawson to be conspecific with *Oligocarpia brongniarti* as described and figured by Stur and Zeiller, and in this was supported by Zeiller. M. L. Abbott (1954, p. 58), however, was of opinion that pinnules of *S. splendens* differed in marginal characters from those of *O. brongniarti* Stur, without stating what these differences are. Certainly the pinnule outline, if correctly represented by Stopes in figure 4 of above reference, differs in no essential character from that of *Oligocarpia brongniarti,* but, owing to lack of information on the sori, Dawson's species is entered somewhat doubtfully in the synonomy.

Occurrence. Minto formation, localities 856, 857, 945.

Types. Hypotypes, GSC Nos. 916, 917.

Oligocarpia missouriensis D. White

Plate I, figures 1, 2; Plate II, figures 1-5; Plate III, figure 4; Plate IV, figure 3

?*Sphenopteris canadensis* Dawson, Acadian Geology, 2nd ed., p. 483, fig. 71 (p. 243), (1868).
Oligocarpia missouriensis Bell, Geol. Surv., Canada, Mem. 215, p. 43, Pl. 30, figs. 3, 4; Pl. 31, figs. 1-6; Pl. 83, figs. 1, 2; Pl. 86, figs. 2-3 (1938).

Remarks. The frond is quadripinnatifid or quadripinnate. One specimen from Clifton (No. 914, Pl. II, fig. 1) has associated with it, although not in organic connection, a principal rachis, about 4 mm wide, showing basal parts of three primary pinnae with rachides 1.5 mm wide, which are given off at very open, oblique angles, and which in turn give off poorly preserved remnants of secondary pinnae, at right angles to parent rachis on one side and obliquely on other. The principal rachis in this specimen appears smooth, except for microscopic striae; it bears filiform flexuous aphlebiae that branch at wide angles. What D. White and the writer consider to be long secondary pinnae are referred by M. L. Abbott (1954, p. 51) to primary pinnae. Specimen No. 914 (Pl. II, fig. 1) shows a curved, incomplete, secondary pinna that is 15 cm long; it bears tertiary pinnae up to 2.5 cm long, which carry about twelve pairs crenulate or slightly lobed pinnules, about 4 mm long by 2 mm wide. In other specimens, e.g. No. 913 (Pl. II, fig. 2) pinnatifid pinnules, about

7 mm long by 3 mm wide, bear three or four pairs alternate, obtusely rounded, simple or slightly undulating lobes that are separated by narrow sinuses reaching about halfway to midrib. These pinnules are suboblong and have well-rounded, slightly asymmetrical, terminal lobes. The midrib, although thin, is well marked, flexuous, slightly decurrent, bifurcating close to apex, and giving off on each side three or four oblique laterals that divide at rather broad angles one to three times. Pinnules from higher positions on a frond are rectangular to ovate, commonly 5 or 6 mm long by 2.5 or 3 mm wide, with crenulate or entire margins, much less constricted at base; nervation is similar to that of the pinnatifid pinnules, but the laterals are generally only once divided. Towards the apex of a pinna the pinnules become progressively smaller, less constricted at base and finally pecopteroid.

Specimen No. 915 (Pl. II, fig. 3) from Clifton is partly fertile; the sori are few and scattered on pinnules close to the apex of the pinna; they are 0.75 to 1 mm diameter, and consist of a circular group of four or five annulate sporangia. No. 933 (Pl. I, fig. 1) has abundant sori, each comprising four to six, or rarely seven, sporangia. Although little doubt exists that *Sphenopteris canadensis* Dawson is conspecific with *Oligocarpia missouriensis,* the figure and description of the former species is wholly inadequate for establishment of a species, and the name should be discarded.

Occurrence. Minto formation, localities 856, 946, 1028, 3859; Clifton formation, localities 1172, 4983; Pictou (undifferentiated) group, locality 1076.

Types. Hypotypes, GSC Nos. 618, 885, 913, 914, 915, 933, 980, 4451 (labelled *Sphenopteris canadensis* Dawson).

Boweria schatzlarensis Kidston

Plate III, figures 1, 2, 3; Plate IV, figures 1, 2; Plate V, figures 1, 4;
Plate VI, figures 1, 2

Boweria schatzlarensis Bell, Geol. Surv., Canada, Mem. 215, p. 40, Pl. 26, figs. 2, 3; Pl. 28, fig. 1 (1938).

Remarks. The Beersville specimens, mostly fertile, conform with the original description of Kidston (1923, p. 292, Pl. 71, figs. 1-6; text-fig. 20) and the later one of J. Danzé (1956, p. 366). The latter author recorded the development of pinnules from those in apical region of a penultimate pinna through pinnatifid to short-lobed ultimate pinnae. A poorly preserved fragment from Beersville (No. 923) shows parts of three delicate, practically smooth rachides, presumably belonging to primary, secondary, and tertiary pinnae so that the frond described by Kidston as tripinnate, was actually quadripinnatifid or quadripinnate. The fertile pinnules have the form of the sterile ones, but with laminae slightly reduced in size. Specimen No. 921 (Pl. IV, fig. 2) shows a deltoid tip of a penultimate (secondary) pinna, with ultimate pinnae having winged rachides that are attached obliquely at very open angles; specimen No. 918 (Pl. VI, fig. 1), a fragment of a secondary pinna from a lower position, has more oblong-lanceolate, ultimate pinnae, each bearing eight or nine pairs of lobed pinnules, of which the most developed have three pairs of marginal lobes. Other fragments have pinnules with four or five pairs of lobes, which have forwardly directed, short, blunt, marginal lobes or teeth.

One of the specimens from Beersville shows that the slender penultimate rachides, generally appearing smooth, are provided with microscopic hairs, about 0.5 mm long, which penetrate the rock matrix.

It is possible that *Sphenopteris selbyensis* Kidston may be conspecific with *Boweria schatzlarensis*. Kidston (1923, p. 130, Pl. 29, fig. 1) figured only a single specimen; his species is stated to be very rare in the Westphalian series of Yorkshire, and the type specimen is sterile. In habit and dissection of frond the main difference from *B. schatzlarensis* seems to be the deltoid rather than lanceolate outline of the ultimate pinnae, but this may be a variable character according to position on a frond.

Gothan (1941a, p. 23, Pl. 59, fig. 2) described and figured a form that he considered conspecific with Kidston's species, which has slender, lanceolate, ultimate pinnae like those of *B. schatzlarensis,* bearing up to twelve pinnatifidly lobed pinnules. Gothan's specimen is very like specimen No. 924 (Pl. III, fig. 1; Pl. VI, fig. 2), in which some pinnules have the submarginal, annulate sporangia characteristic of *B. schatzlarensis*. Danzé (1956, Pl. 79, figs. 2-4) described a specimen as *Sphenopteris* cf. *selbyensis* that he considered conspecific with *S. selwynensis* Gothan. One of Danzé's figured specimens shows small sporangia at or near the margins of some pinnules, but they were too poorly preserved to show their true nature.

A single lateral vein enters each major lobe of a pinnule, and a single annulate sporangium occurs submarginally at ends of its lateral branches. Owing to the closeness of these branches the sporangia commonly form groups of two or three, but are independent and sessile and not attached to a common receptacle as in *Oligocarpia.*

Occurrence. Pictou group (undifferentiated), localities 963, 1076; ? Minto formation, locality 857.

Types. Hypotypes, GSC Nos. 918-924 inclusive, 986.

Crossotheca boulayi Zeiller

Plate V, figures 2, 3; Plate VII, figures 1, 2

Crossotheca boulayi Bell, Geol. Surv., Canada, Mem. 215, p. 47, Pl. 36, figs. 1-4 (1938); Mem. 225, p. 117, Pl. 6, fig. 9 (1940).

Crossotheca cf. *compacta* Radforth and Walton, Senckenbergiana Lethaea, vol. 41, p. 106, Pl. 4, figs. 16, 17 (1960).

*Remarks***.** GSC No. 960 (Pl. V, fig. 3) is a small sterile fragment having ultimate (tertiary?) pinnae up to 8 mm long by 4 or 5 mm wide, each having three or four pairs of well-rounded, small, subovate to subtriangular pinnules, which are decurrent on a stout, longitudinally and irregularly striated, winged rachis, about 0.5 mm wide. The rachis is decurrent upon, and makes a very open angle with a parent penultimate rachis. The latter is attached obliquely to an almost smooth, penepenultimate rachis, about 2 mm wide, which has a raised and lightly channelled central, and a flattened marginal area. The pinnules are small, well rounded, up to 2 mm broad and nearly as wide at base; each is supplied by a single ascending, decurrent vein that bifurcates two or three times.

Specimen No. 962 (Pl. VII, figs. 1, 2) shows a number of more or less deltoid secondary pinnae, made up of closely spaced, somewhat triangular tertiary pinnae, 8 or 10 mm long by 5 mm wide, the largest has four pairs of pinnules, which are 3 mm long by 2 mm wide; the midrib of the pinnule is flexuous, decurrent, and gives off three pairs of laterals, the largest of which are once divided, or upper arm dividing again. The thickness of the veins imparts to the pinnules a rough surface similar to that of pinnules of *Pecopteris miltoni*.

Specimen No. 961 (Pl. V, fig. 2) shows three fertile pinnules (probably representing tertiary pinnae) which have an elongated elliptical lamina, up to 18 mm long by 2 to 2.5 mm wide, and pendant, compact sporangia forming a fringe to the lateral margin. One small imprint of upper surface of the sporophyll (not figured) has a coalized coat, now largely stripped off, and shows a narrow median furrow, transverse to which are alternating, thread-like furrows and intervening, slightly raised rectangular areas, about as wide as the sporangia.

The details of the sporangia, which number about thirty to a side and are coalized and longitudinally striated, are obscured by compression and by a rectangular coat of carbonized tissue, which represents apparently the 'volets' of J. Danzé (1956, pp. 137, 154), who in description of *C. boulayi* stated that "Les volets ont une forme sub-rectangulaire sur les côté de la fructification . . .". Each individual sporangium is about 2.5 mm long by 0.5 mm wide. The sporophylls are highly ascending and apparently have only a short pedicle.

The fertile pinnae or pinnules in the Clifton forms are almost twice as long as specimens of the species from the Sydney coalfield of Nova Scotia, but otherwise no differences of specific value were found.

Occurrence. Clifton formation, localities 1172, 5095.

Types. Hypotypes, GSC Nos. 960, 961, 962.

Myriotheca desaillyi Zeiller

Plate VIII, figure 2; Plate LVI, figure 6

Myriotheca desaillyi Bell, Geol. Surv., Canada, Mem. 215, p. 42, Pl. 28, figs. 3, 4 (1938).

Remarks. A very small fertile fragment was the only specimen of this species noted in collections of Pictou group from New Brunswick. No outline of pinnules is preserved, but the sporangia are grouped ten to twenty in subcircular areas, as if covering whole surface of rounded lobes of small pinnules. They are exannulate, free, ovoid, about 0.25 mm in diameter, and marked only by walls of elongate cells.

Occurrence. Minto formation, locality 3859.

Types. Hypotype, GSC No. 867.

Alloiopteris (Corynepteris) similis Sternberg

Plate VIII, figure 1

Remarks. A single fragment of an ultimate pinna occurs in collections from Beersville. It represents a pinna with little-developed pinnules, about 1.5 mm long, that are basally united for about one half of their length, the united part forming a relatively broad wing to the rachis. The pinnules are openly oblique to the rachis, their free parts deltoid, but with rounded and not pointed apices. Natural maceration destroyed the original margin, but it was evidently entire or undulate, or at least not marked by teeth or lobes of appreciable size. The nerves are very prominent and relatively thick. A decurrent midrib bifurcates close to apex, and lies closer to the catadromous than to the anadromous margin. Otherwise, there is no marked asymmetry. Laterals, two or three alternate pairs, are simple, the basal anadromous one slightly curved towards apex of pinnule and longer than the basal catadromous one, which originated earliest at the junction of the midrib and rachis. The rachis itself is prominent (marked by discontinuous longitudinal striae) and slightly channelled medially.

The species differs from *Corynepteris angustissima* Sternberg markedly in its more pecopteroid nervation as well as in the lack of teeth or lobes on the pinnules, which are, moreover, inserted less obliquely on the rachis.

Occurrence. Pictou group (undifferentiated), locality 1076.

Types. Hypotype, GSC No. 983.

Mintopteris hirsuta Radforth and Walton

Mintopteris hirsuta Radforth and Walton, Senckenbergiana Lethaea, vol. 41, p. 103, Pl. 1, figs. 1-6 (1960).

Original description. "Fertile frond at least pinnate. Divisions (pinnae?) of the frond deeply lobed. Lobes irregularly crenulate. Venation open. Median vein of lobe subgeniculate with simple or forked lateral veins. Veins terminating in the crenulations of the lamina. Scattered, filamentous, occasionally branched, septate hairs, on rachides and veins. Sori of 5 or 6 closely bunched sporangia, free or possibly very slightly connected at their bases. The sori are marginal, and are attached to the extremities of the crenulations of the laminae which are curved abaxially so that the sori hang down on abaxial (?) side of the frond. Sporangia lageniform about 1 mm. in length with swollen base (ϕ0.44 mm) and narrow upper portion (ϕ0.23 mm) terminating in a rounded apex which has very short simple hairs. Spores unknown." (p. 103).

Remarks. No specimens of this form were recognized by the writer in collections from Minto in Geological Survey of Canada, Ottawa.

Occurrence. Very rare, roof shales of Minto coal seam, Welton Henderson mine, Minto coalfield.

Types. In Hunterian Museum, University of Glasgow.

Sphenopteris (Diplotmema) whitii Bell

Plate VIII, figure 3; Plate X, figure 1

Sphenopteris whitii Bell, Geol. Surv., Canada, Mem. 215, p. 20, Pl. 1, figs. 2-5; Pl. 2, figs. 1-3 (1938).

Remarks. A bifurcation at a wide angle of a rachis of a primary pinna of this species was illustrated on Plate I, figure 4 of above reference, and may be inferred from a specimen of *Pseudopecopteris obtusiloba* D. White (1899, Pl. 8), which the writer considered to be conspecific with the Canadian species. White (op. cit., p. 21) also compared the species with *Sphenopteris trifoliata* (Artis), and specimen No. 794 (Pl. X, fig. 1), although it shows only a small part of a primary pinna, permits further comparison, e.g. with a specimen of *S. trifoliata* figured by Kidston (1923, Pl. 1), inasmuch as the major rachis of both specimens is about 8 mm wide. The carbonized rachis of specimen 794 in addition to longitudinal lineation has in places numerous short, transverse bars. The secondary pinnae are attached at very open angles or even normal to the parent rachis; their rachides are about 2 mm wide. They give off tertiary pinnae at openly oblique or right angles, have rachides about 2 mm wide, and are commonly about 2.5 cm long by 1 cm wide. The tertiary pinnae have up to four pairs of broad, rounded pinnules, of which the basal ones are spreading and asymmetrically bilobate, the succeeding pair somewhat bilobate owing to a spreading, posterior lobe, and the remainder commonly entire. The termination of these pinnae in this specimen is concealed, but similar pinnae elsewhere on the same rock fragment end in a triangular pinnule with a basal lobe on one side, which represents a coalescent pinnule. These tertiary pinnae differ from those on the Kidston specimen, which in addition to being longer (3 to 3.5 cm) include deltoid, pinnatifid pinnules or pinnae of a lower order, each of which may have two lateral pairs of deeply cut rotund lobes or pinnules. The less deeply cut, ultimate pinnae of *S. whitii* have pinnules that resemble more closely those of *S. obtusiloba* than of *S. trifoliolata.* Nonetheless, they are smaller than those of *S. obtusiloba,* are more coriaceous; the tertiary pinnae are shorter, and the terminal pinnules are generally pointed rather than broadly rounded. Discontinuous striae on the pinnules noted by the writer in his original description of the species under higher magnification are seen to be due to an epidermal cellular structure that comprises longitudinal rows of cells that are several times longer than wide.

Specimen No. 932 (Pl. VIII, fig. 3) from the Clifton formation shows a section of a rachis of a primary pinna, from which five secondary pinnae branch off alternatively. A sixth secondary pinna at the base of the specimen obliquely overlaps the pinna above on the same side, and belongs to another division of the major rachis, resulting from its dichotomy; this bifurcation is indicated at the extreme base of the specimen a little below the part figured, the angle between the two arms being about 110 degrees.

Occurrence. Minto formation, localities 948, 990, 1042, 1144, 5093; Clifton formation locality 1172; Pictou group (undifferentiated), localities 1434, 5025, 5353.

Types. Hypotypes, GSC Nos. 794, 932.

Sphenopteris barbalata n. sp.

Plate IX, figure 3; Plate X, figure 2

Description. Principal rachis 8 mm or more broad, flattened, marked by close, microscopic striae and abundant hairs, about 1.3 mm long, disposed in various directions. Penultimate (primary) pinnae, attached at very open angles or at right angle, alternate; rachis, 2 mm broad, villous-like parent rachis, with linear hairs about 0.75 mm long. Ultimate (secondary) pinnae up to 17 mm or more long by 9 mm broad, attached at very open angles, alternate; rachis with short hairs. Pinnules coriaceous, nearly smooth, orbicular to oval to reniform, slightly convex upwards; lower ones, commonly about 4 or 5 mm long by nearly as broad, stoutly stalked, bifid or trifid; upper ones sessile, slightly decurrent, and entire; terminal pinnules, obtuse with two or three obtuse marginal lobes. In lower pinnules a strong nerve branches close to base and sends off radially spreading, dichotomously divided system of nerves in each lobe as in *S. nummularia,* the ultimate branches being 0.25 to 0.4 mm apart. In the upper, decurrent pinnules one or two nerves may enter directly from parent rachis. The nerves are strong, although semi-immersed.

Remarks. The trifid pinnules are commonly inequilateral, the posterior segment being deeply cut off and spreading, and the anterior bifid by a shallow sinus or entire and united to terminal segment. The bifid and trifid pinnules resemble basally situated pinnules of *Sphenopteris nummularia* Gutbier, but the veins of *S. barbalata* are more prominent than those of *S. nummularia,* and the occurrence of adpressed hairs and lack of short crossbars on the rachides is a distinguishing character.

Occurrence. Minto formation, locality 857.

Types. Holotype, GSC No. 928.

Sphenopteris hirticula n. sp.

Plate IX, figures 1, 2, 4

Description. Penultimate (secondary?) pinnae, incompletely known, elongate-lanceolate, with deltoid apices, reaching length of more than 5 cm; rachis, slender, terete, commonly curved, provided with scattered, fine hairs up to 1.3 mm long. Ultimate (tertiary?) pinnae, lanceolate-deltoid, up to 15 mm long by 8 mm broad, generally not touching, alternate, inserted at very open angles, in some instances dissymmetric, with some on one side of parent rachis slightly reflected backward; rachis slightly flexuous, delicate, consisting of a terete central cord surrounded by a relatively broad wing. Pinnules, small, up to 4 mm long by 2 mm wide, ovate to rectangular-ovate, five or six alternate pairs, openly oblique, merging slightly and decurrently into wing of rachis; when mature they are well separated and constricted at base by a broadly rounded sinus on catadromous side and narrow sinus running nearly parallel with ultimate rachis on anadromous side. Mature pinnules have two or three pairs of alternate, oblique, generally rather flatly rounded lobes, of which margins may be simple, undulate or slightly emarginate; terminal pinnule small, flatly rounded or slightly and asymmetrically bilobate or obscurely emarginate. Lower surface of pinnules microscopically rugose, owing to short adpressed hairs; the finer nervation is mostly concealed by this villosity. Midvein slender, well marked for about three fourths of its length, commonly slightly decurrent, running to apex or more commonly bifurcated before reaching same, its true apical course difficult to see owing to villosity and flexuous nature. Laterals oblique, one to each lobe, nondecurrent, bifurcating generally once in mature pinnules.

Remarks. The species is well differentiated from *Sphenopteris mixta* Schimper (Lesquereux, 1866, p. 435, Pl. 39, figs. 5, 6) by its larger pinnules that are almost twice as long, by their greater decurrence and by lack of trilobate pinnules similar to those so common in *S. mixta*. It is differentiated from *Sphenopteris mixta* D. White and *Sphenopteris mixta* Kidston by last-mentioned character as well as by its relatively short, and basally broad, deltoid ultimate pinnae. The ultimate pinnae of *S. hirticula* near apex of a penultimate pinna are more nearly like mature pinnae of *S. mixta* D. White or *S. mixta* Kidston, but more developed pinnae, preceding the first mentioned on the same penultimate pinna, bear pinnules that have two pairs of lobes. In short, the development of segments of *Sphenopteris hirticula* is according to the 'equilateral' organization of Danzé whereas that of *S. mixta* of all authors is apical. In this respect the species agrees with *Sphenopteris footneri* Marratt and *S. rotundiloba* Danzé, but differentiated from both these species by less deeply segmented pinnules and villosity. It has a more lax habit than that of *S. rotundiloba,* and thinner, more flexuous, and more broadly winged rachides of last order.

Occurrence. Minto formation, locality 990.

Types. Holotype, GSC No. 886; paratype GSC No. 619.

Sphenopteris pseudofurcata Kidston

Plate XI, figures 1, 3-6

Remarks. Only three fragments of penultimate pinnae are included here. The segmentation is like that of *Sphenopteris pseudofurcata,* but the surface of the pinnules is marked by microscopic, discontinuous striae that are arranged longitudinally to the axis of the pinnule, and are probably the remnants of cellular structure of the epidermis. This striation conceals all the veins in two of the specimens, but in No. 970 (Pl. XI, fig. 1), a single bifurcating vein is seen in one of the ultimate segments.

The penultimate rachis, which is stout for the size of the pinnules, is somewhat flexuous and canaliculate. The ultimate pinnae, which have similar rachides, are about 12 mm long, the upper ones oblique and decurrent, the lower at more open angles and nondecurrent. The pinnules, four or five in number, are alternate, well spaced, and commonly bifid or asymmetrically bilobate at summit, the apices being narrowly rounded. The lowest pinnules represented in the fragments are bifid or trifid and more spreading than the more distal ones. The general appearance of the fragments is *Diplotmema*-like, comparable with that of *Diplotmema furcata* or *D. intermedium* (Ettingshausen).

Occurrence. Minto formation, locality 945, 5074.

Types. Hypotypes, GSC Nos. 943, 944, 970.

Sphenopteris spiniformis Kidston

Plate XI, figure 2; Plate XII, figure 1; Plate XIII, figure 1

Remarks. The specimens, all from Clifton, are well carbonized, and only rarely do the blunt or flatly rounded ultimate segments reveal occurrence of stout teeth or short spinous endings. Most specimens show that the stout rachides are generally straight, but No. 929 (Pl. XI, fig. 2), which apparently represents the apical end of a primary pinna, has a somewhat flexuous, deeply channelled rachis. Surface of the pinnules under a binocular shows close longitudinal striae, and the veins, being semi-immersed, are in most instances concealed. A single vein enters each ultimate segment and divides several times, the ultimate branches being about half a millimetre apart.

Occurrence. Clifton formation, locality 1172.

Types. Hypotypes, GSC Nos. 929, 930, 931.

Sphenopteris sp. cf. *S. dufayi* Danzé

Plate XII, figure 2

Remarks. This form is represented by a single fragment that is altogether inadequate for specific diagnosis. The penepenultimate (primary?) rachis is almost flat and smooth except for very close, microscopic striae. Penultimate pinnae are given off alternatively at very open angles; their rachides are similar to that of the parent rachis. Ultimate (tertiary?) pinnae are subrectangular with well-rounded summit, about 13 mm long by 6 mm wide, inserted at very open angles, commonly touching; rachis, winged, nearly straight. Pinnules, four to six alternate, oblique pairs; largest on this specimen being 3 to 3.5 mm long by 2 to 2.5 mm wide, lobate, with a basal pair of oblique, subrectangular lobes, with well-rounded or blunt apices, slightly spreading; an additional more ascending lobe may occur on catadromous side, and terminal segment is deeply or shallowly bilobate. Midvein, oblique, non-decurrent or slightly decurrent, nearly straight, running to near apex where it divides and sends a branch to each apical lobe. Each lateral lobe of pinnule is provided by an oblique branch from midvein, most commonly simple, but in largest lobes, which may be slightly bifid at summit, the lateral is once divided.

In pinnule size and lobation the form resembles fairly closely *Sphenopteris dufayi* Danzé (1956, p. 415, Pl. 67, figs. 5, 6; Pl. 68, figs. 4-6; text-fig. 43), which occurs in France at an early Westphalian horizon. The pinnule lobation is not developed to an equal extent, a circumstance that may be due to derivation from higher position on a primary pinna. Comparison as regards pinnule cutting may also be made with *Sphenopteris sauveri* Crépin (*see* Stur, 1885, Pl. 20; and Zeiller, 1886, Pl. 9, fig. 6), but in *S. sauveri* the lateral veins divide several times, and the basal lobes of a pinnule are more spreading.

Occurrence. Clifton formation, locality 1196.

Types. GSC No. 936.

Mariopteris latifolia (Brongniart)

Plate XIII, figure 3; Plate XIV, figure 2; Plate XV, figures 1, 2; Plate XVI, figure 2

Sphenopteris latior Dawson, Acadian Geology, 2nd ed., p. 483, fig. 70, (p. 243), (1868).
Mariopteris latifolia Bell, Geol. Surv., Canada, Mem. 215, p. 49, Pl. 39, figs. 2-4; Pl. 40, fig. 2 (1938).
Mariopteris latifolia Radforth and Walton, Senckenbergiana Lethaea, vol. 41, p. 106, Pl. 4, fig. 14 (1960).

Remarks. The primary pinna is quadripartite, as shown by GSC No. 872 (Pl. XV, fig. 1) the primary rachis R_1, only partly exposed, being naked, striated longitudinally and bifurcating at wide obtuse angle into two short, naked rachides of second order (R_2), each 1 to 2 cm long, longitudinally striated, and with central vascular cord. Each R_2 bifurcates into two rachides (R_3) that bear the secondary pinnae. R_3 is commonly curved to somewhat zigzag flexuous, has a central cord and is microscopically striated like the higher order rachides. The secondary pinnae are elongate-lanceolate, with deltoid apex, and may reach a length of more than 10 cm; they bear tertiary pinnae, up to 5 cm or more long, of which the rachis (R_4) has a central cord (or channel) on upper surface and wing-like borders to which large lobed, or distally entire pinnules are obliquely attached at rather open angles. The tertiary pinnae are commonly curved towards the apex of its parent secondary one; they are asymmetric to the parent rachis, those on external sides of the bifurcation of R_3 being longer than those on the interior sides. In apical region of a secondary pinna the tertiary pinnae are represented by pinnatifid, and finally by entire, slightly decurrent pinnules. The pinnules thus vary greatly in size and outline according to their position in a primary pinna. Those on R_4 of No. 873 (Pl. XV, fig. 2) are more or less ovate and decurrent, and only slightly constricted, if at all, at the base where they are slightly united. The basal pair are a little larger than the succeeding ones and more rotund, about 7 mm long by 6 mm broad. Towards the apex of R_3 the pinnatifid pinnules that correspond to the tertiary pinnae are oblong-lanceolate and 2 cm or even more long; approaching yet closer to the apex, they are shorter and marginally lobed, and finally entire, more or less ovate pinnules. On this specimen (No. 873) the external secondary pinna shows a superior basal tertiary pinna situated near the bifurcation of R_3; it is quite different from the succeeding ones in that it is spreading, deltoid and markedly asymmetric, having an abnormally large posterior basal lobe, the margin of which has a basal pair of secondary lobes.

GSC No. 874 (Pl. XVI, fig. 2) is interpreted to be a part of a secondary pinna derived from a position low down on one of the sections of a primary pinna. It shows an external, lanceolate tertiary pinna, a little more than 5 cm long, bearing exceptionally large pinnules, which, except the basal pair, are suboblong, about 10 mm long by 7 mm wide, the proximal ones free or united only at extreme base where they are little constricted; the basal pair are spreading, deltoid to subrhomboid, almost pedicellate, and asymmetrically bifid, with a large posterior lobe almost as long as the anterior lobe. The lower surfaces of the pinnules are exposed, and the veins well marked. The midrib is decurrent, somewhat flexuous, bifurcating at apex close to summit of pinnule. The laterals are rather highly ascending, comprising about four pairs, the lowermost dichotomising three or four times, the succeeding ones twice or once divided. The posterior large lobes of the basal pinnule are supplied with a midrib that has about three pairs of divided laterals, the midrib originating near the central vascular cord of the parent rachis.

The pinnules, whether they are divisions of tertiary pinnae, or take the place of tertiary pinnae, have serrate teeth, each fed by one of ultimate divisions of the veins. A peculiar feature of the pinnules on all the Minto specimens are small circular elevations that are not glandular or bases of hairs, but like elevations on pinnules of *Telangium*? *potieri* (Zeiller) Kidston, which are commonly referred to *Excipulites* Goeppert.

Occurrence. Minto formation, localities 856, 947, 948, 977, 978, 979, 990, 1000, 1020, 1037, 1042, 1079, 1099, 1100, 1120, 1130, 1144, 3859, 5074, 5090; Clifton formation, localities 1152, 1172, 1196; Pictou group (undifferentiated), localities 963, 1076.

Types. Hypotypes, GSC Nos. 866, 872, 873, 874, 875.

Mariopteris carnosa Corsin

Plate XVI, figure 1; Plate XX, figures 1, 2

Alethopteris nervosa Dawson, Acadian Geology, 2nd ed., pp. 242, 484 (1868).

Mariopteris nervosa Bell (pars); Geol. Surv., Canada, Mem. 215, p. 49, Pl. 37, fig. 5; Pl. 39, fig. 1 (*non* Pl. 40, fig. 1 = *Mariopteris hirta*) (1938).

Original description. "Espèce caractérisée par ses pinnules, allongées, larges à la base, à bord libre ondulé, très peu adhérentes entre elles, souvent libres jusqu'à la base. Nervures principales fortment marquées, nervures secondaires paraissant inclus dans l'épaisseur du limbes épais et charnu." (Corsin, P., 1932, p. 135).

Remarks. The writer is doubtful whether *M. carnosa* is sufficiently well differentiated from *M. nervosa* to have specific recognition. Corsin stated that his species was distinguishable from *M. nervosa* by (1) its more deltoid pinnules, (2) its pinnules commonly free to their bases, (3) undulate margins of free pinnules and (4) secondary nerves buried in the thick leaf substance. The writer, judging from a suite of specimens that are associated in the same beds both in the Sydney coalfield and in New Brunswick, regards size, outline, and marginal undulations as variable characters dependent upon position of secondary and tertiary pinnae and pinnules in relation to the principal axis. In description of pinnules of *M. nervosa* P. Danzé-Corsin (1953, p. 153) stated that they are small, varying between 4 and 6 mm. Yet many pinnules on specimens of that species figured by P. Corsin (e.g. Pl. 61, fig. 2; Pl. 63, fig. 4; Pl. 64, figs. 1, 3; Pl. 65, fig. 1; Pl. 66, fig. 1) are 10 mm or more long, nearly equalling the size of large pinnules of *M. carnosa*.

GSC No. 4470e (Bell, 1938, Pl. 39, fig. 1) from Sydney coalfield shows parts of two primary pinnae, one small and one large, on the same surface of rock. The smaller one would readily pass for *M. nervosa,* for it bears small pinnules, united for an appreciable part of their length, whereas the larger has pinnules typical of *M. carnosa,* practically free to base. In both the pinnules appear deltoid, owing to inrolling of pinnule margins. The venation in both is immersed; that the veins are thick is indicated by the pronounced furrows they make on the upper surface.

Specimen No. 967 (Pl. XX, fig. 1) from Clifton shows ultimate pinnae bearing broadly ovate, basally united pinnules; this specimen could justifiably be identified as *M. nervosa*. Here, too, the veins are immersed. It is chiefly on account of the immersion of the veins that the writer assigns most specimens from Nova Scotia previously considered as *M. nervosa* to *M. carnosa*. In doing so he assumes, perhaps wrongly, that the veins of *M. nervosa* are not immersed, but stand in strong relief on lower surfaces of pinnules. The burial of the veins, which implies an original, rather thick fleshy consistency of the leaves, is complemented in some Nova Scotian specimens by a false appearance of hairiness on imprints of the pinnules, particularly of their lower surfaces; under a binocular pseudo-hairs appear as longitudinal filaments, crowded on the midvein, more scattered and spreading on the lamina. The filaments also occur longitudinally on the ultimate and penultimate rachides; at least some of them appear to branch at acute angles, and it is inferred that all these hair-like filaments are only remnants of the walls of hypodermal tissue. On carbonized compressions the pinnule surfaces are microscopically striated, owing to cellular epidermal structure.

Specimen No. 868 (Pl. XX, fig. 2) shows in addition to pinnules of characteristic *carnosa* appearance, remains of two principal axes, probably belonging to the species; they have a few longitudinal costae and abundant, short, transverse bars.

That some secondary pinnae end apically in a long naked rachis is illustrated by a specimen from Nova Scotia, GSC No. 2890 (Bell, 1938, Pl. 37, fig. 5). These ends extend well beyond what is seen in the photograph.

If two closely related species are actually represented in the Nova Scotia material, their close association in the same bed would be quite remarkable. Moreover, they could only be separated by making use of extremes and ignoring transitional forms.

Occurrence. Minto formation, localities 856, 990; Clifton formation, localities 1171, 1172, 1196, 3408.

Types. Hypotypes, GSC Nos. 868, 967, 969.

Mariopteris hirsuta Corsin

Plate XVI, figure 3; Plate XXI, figure 4

Mariopteris hirsuta Bell, Geol. Surv., Canada, Mem. 215, p. 51, Pl. 41, figs. 3, 4 (1938).
Mariopteris sphenophylloides Bell, op. cit., p. 50, Pl. 40, figs. 3-5; Pl. 41, figs. 1, 2 (1938).

Remarks. This species is represented by several specimens from the Clifton formation. Specimen No. 870 (Pl. XXI, fig. 4) shows a large part of a secondary pinna and a single tertiary pinna, obviously belonging to an adjacent secondary. Its rachis is slightly flexuous, and where exposed is almost smooth, possessing only a few obscure longitudinal striae, and on its imprint are a few microscopic punctae that represent bases of hairs. Tertiary pinnae are somewhat asymmetrically disposed on the parent rachis, those on one side being more obliquely attached than those on other; the rachides are smooth and canaliculate, straight or curved towards the summit of the parent pinna. The pinnae are 3 or 4 cm long, and the apex, where exposed, is a short, naked extension of the rachis. The pinnules are attached obliquely at broad angles, free, and mostly sphenopteroid, being more or less constricted at base according to position on the rachis, the basal pair having a short stout stalk, and base of remaining pinnules becoming progressively wider towards the apex of the pinna, where they are slightly decurrent. The pinnules show also a progressive change in outline; the basal pair are spreading and asymmetrically bilobate, having a large, obtuse, posterior major lobe and a longer anterior lobe; however, on the basal inferior pinnule in an isolated tertiary pinna of this specimen the two major lobes are about equal in length. The major lobes of these pinnules may be entire, or possess one or more, shallowly cut, rounded lobes; although the margins of the lobes appear entire, it is possible that a few short teeth may be embedded in the rock. Pinnules succeeding the basal pair towards the apex of the pinna are narrower and more deltoid-ovate, becoming more ovoid and rapidly smaller. The specimen is a carbonized compression, showing the dorsal surfaces of the pinnules. The veins are concealed by numerous elongate furrows, which correspond to stiff hairs on the lower surface; for, where the carbonized lamina has been stripped off thereby revealing an imprint of the lower surface of the pinnule, it is marked by furrows that could only be formed by such hairs. The hairs are 1.5 to 2 mm long and, although more abundant, are comparable in appearance with those of *Neuropteris scheuchzeri*. They impart to the species a very characteristic appearance that differentiates it from *Mariopteris muricata,* where the hairs are glandular, from the non-villous *M. acuta,* and seemingly also from *M. sphenopteroides* Lesquereux, of which the pinnules, according to D. White (1899, p. 32) are "very finely striate in the direction of the nervation, probably by rows of minute hair-like scales". White's description is ambiguous, and, until the character of these markings is established, it is preferable to consider *M. hirsuta* Corsin as a valid, well-documented species. Certainly the hairs on its pinnules have variable alignment.

The hairs on *M. nobilis* Kidston are smaller and more scattered, although otherwise like those on *M. hirsuta.* Yet *M. nobilis* has much shorter tertiary pinnae than has *M. hirsuta,* and its pinnules are deltoid to deltoid-lanceolate, so united as to resemble pinnatifid pinnae.

Specimen No. 871 (Pl. XVI, fig. 3) shows parts of two neighbouring tertiary pinnae, apparently derived from a low part of a frond. The pinnules are suboblong, the largest possessing marginal lobes that are very similar to those of a specimen figured by P. Corsin (1932, Pl. 77, fig. 1), except that they are more distant and more constricted at base. In all characters they are comparable to a specimen of *M. muricata* Kidston (1925, Pl. 138, fig. 1) that both P. Corsin and P. Danzé-Corsin assign quite properly to *M. hirsuta.* Specimen No. 871, although it is a carbonized compression showing only the upper surface of the pinnules, exhibits in places faint traces of the lateral veins, which are rather distant, highly ascending, divided once, and with the upper arm commonly divided again close to margin.

Occurrence. Clifton formation, localities 1172, 1196.

Types. Hypotypes, GSC Nos. 870, 871.

Mariopteris hirta (Stur)

Plate XIII, figure 2; Plate XVII; Plate XVIII, figures 1-3;
Plate XIX, figures 1, 2; Plate LVI, figure 2

Remarks. Frond, seemingly large. Specimen No. 878 (Pl. XIX, fig. 2) shows part of a primary pinna consisting of a rachis (R_1) divided by dichotomy at angle of nearly 180 degrees into two short equal branches (R_2), one of which is shown to divide into two unequal rachides (R_3) that carry the secondary pinnae. One of these rachides is very short and is narrower than the other. It bears a secondary pinna that gives off at very open angles short tertiary pinnae that almost have the form of pinnatifid pinnules. The specimen has analogy with the excellent quadripartite specimen figured by Kidston (1925, Pl. 141), but apparently is a smaller primary pinna from a more distal part of a frond. The primary rachis is 8 mm wide, and each arm of its division is about 4 mm; all are marked by inconspicuous, longitudinal striae, by numerous short transverse bars, and by punctae. The rachides of the two divisions R_3 also have bars and numerous punctae. The tertiary pinnae are constricted at base, and consist of up to four pairs of subrhombic to ovate, decurrent, squat pinnules, confluent for about a quarter of their length, having greatest width at attachment to rachis, except the basal pair, which are slightly constricted posteriorly; the imprint of the rachis has numerous punctae. Punctae also occur on the pinnules in addition to microscopic, circular pits that may be due to a parasitic fungus.

Specimen No. 879 (Pl. LVI, fig. 2) is partly a compression, partly an imprint of a rachis, 7 mm wide, and evidently is comparable to R_1 noted above. Irregular, longitudinal striae, and particularly numerous, short, transverse bars show clearly; under a hand lens short, stout spine-like bases of hairs, about 1.5 mm long by 0.5 mm wide can be seen.

The remaining specimens from Minto formation include fully developed, tertiary pinnae. No. 880 (Pl. XVII) has somewhat flexuous, lanceolate pinnae about 3 cm long, consisting of five or six pairs ovate-deltoid pinnules, up to 6 mm long by 4 mm or so wide. Except for the basal pair, they are attached by their whole base. In the subapical region the pinnules rapidly become smaller and more deltoid, and the pinnae end in a relatively long spine-like prolongation of the parent rachis. The inferior basal pinnule is more rotund-deltoid to subrhomboid, and has a relatively large, somewhat spreading, rounded, posterior lobe; the superior basal pinnule is entire margined or has a smaller and shallower, posterior lobe. The specimen is a compression showing the lower surface of the pinnules and prominent apiculi (bases of hairs) occur on the veins. The midvein is moderately thick, somewhat flexuous, progressively decurrent towards the apex of the pinnae. The laterals are semi-immersed and hence not conspicuous; they comprise three or four pairs, the lowermost one of which on posterior side unites with the midrib at its exit from the rachis and abruptly ascends and dichotomises twice at rather a wide angle, or only the upper arm may dichotomise. The succeeding pair of laterals ascend obliquely in nearly a straight line and divide only once. This specimen (No. 880) was part of a larger primary pinna than GSC No. 878. Specimen No. 883 (Pl. XVIII, fig. 1) has pinnules of about the size of those in No. 880; the rachis of the secondary pinna has abundant transverse bars, but exhibits only a few scattered apiculi; a naked rachis, about 1 cm long, terminates the only tertiary pinna of which the apex is preserved. Specimen No. 869 (Pl. XVIII, fig. 3) shows fragments of secondary pinnae derived from a central or low position in a frond. Its pinnules are up to 7 mm long by 5 mm wide at base, where they are adherent; the apiculi or hair bases on lower surfaces of pinnules are again conspicuous. Specimen No. 884 (Pl. XIII, fig. 2) is a secondary pinna from a part of a frond where the tertiary pinnae consist of three or four pairs of deltoid pinnules that are more or less decurrent and united for some distance at the base; the lowermost pinna is much broader and shorter than the succeeding ones, is deltoid and not lanceolate and has a large posterior lobe that bears a subordinate lobe. The base of the rachis of the secondary pinna is missing, but the character of this basal pinnule suggests that it is close to a bifurcation of a rachis of the second order (R_2).

M. hirta may be separated from *M. nervosa* by the presence of conspicuous apiculi or short hairs on rachides and under surface of pinnules, by common preservation of short, transverse bars on the rachides, by ubiquitous occurrence of a long naked rachis at summit of tertiary pinnae, and by more distant, partly immersed, and less prominent, lateral veins, which divide at more open angles.

Occurrence. Minto formation, localities 978, 990, 1020.

Types. Hypotypes, GSC Nos. 869, 878-884.

Mariopteris ribeyroni (Zeiller)

Plate XIV, figure 1

Mariopteris? ribeyroni Bell, Geol. Surv., Canada, Mem. 215, p. 52, Pl. 44, figs. 1-8 (1938).

Remarks. Specimen No. 982 is a small fragment of an ultimate pinna of this species. The pinnules are highly ascending (about 40 degrees) and triangular-ovate, constricted at base on anadromous side by a narrow sinus and on catadromous side less constricted by a rounded sinus, and decurrent. The specimen represents a carbonized upper surface, and veins are immersed. The surface of pinnules as well as the rachis is marked by close, microscopic striae.

Occurrence. Pictou group (undifferentiated), locality 1434.

Types. Hypotype, GSC No. 982.

Pecopteris (Asterotheca) miltoni Artis

Plate XX, figure 3; Plate XXI, figures 1, 2; Plate XXII, figures 1-3;
Plate XXIII; Plate XXIV, figure 2

Description. Frond, quadripinnate; primary (?) pinnae, large, contracting to deltoid apex; rachis macroscopically smooth, microscopically striated longitudinally. Secondary (?) pinnae, lanceolate, contracting rather abruptly to a narrowly rounded, acute apex; rachis, smooth or microscopically striated. Ultimate or tertiary (?) pinnae, oblong-lanceolate, up to 4 cm long by 1 cm wide, comprising up to fifteen pairs of apically rounded, oblong pinnules and an asymmetrical, well-rounded apical pinnule that is larger than those immediately preceding it, about as long as wide, and with one or two basal marginal lobes, representing confluent pinnules. Commonly the ultimate pinnae are 1.5 to 2 cm long by 4 or 5 mm wide, and comprise about eight pairs of pinnules in addition to the terminal one. The largest pinnules are suboblong, about 5 mm long by 2.5 or 3 mm wide, confluent at base, broadly rounded at apex; their midribs are very thick, running almost to apex, mostly more or less decurrent, except in those near the base of the parent pinna. The lateral veins in the largest pinnules are up to five or six pairs, oblique, generally dividing once near origin at rather acute angle, slightly curving towards margin; the basal inferior lateral vein arises where midrib leaves the parent rachis and is highly ascending, dividing like the succeeding ones only once. Pinnules of ultimate pinnae in higher parts of a frond are confluent for progressively greater distances from their bases, and their midribs are more strongly decurrent; they have three or four pairs of lateral veins, most commonly except the uppermost divided once and meeting margin obliquely. Upper, and seemingly lower, surface of pinnules, microscopically rugose, owing to striae running parallel with the veins; commonly five occur between adjacent veins near the margin. This striation is considered to be due to a cellular structure of the epidermis, and the writer was unable to prove the occurrence of hairs. The lower surface of pinnules is comparatively smooth, and the veins only moderately raised.

Fertile pinnules, which are similar to the sterile, bear synangia of *Asterotheca*-type; these cover the whole width, or nearly so, of the lamina between midrib and margin. The normal number of sporangia in a synangium is four.

Remarks. The identification of the species is based mainly upon the description and illustrations of *P. miltoni* presented by P. Corsin (1951, p. 286, Pls. 153, 154, 155, figs. 1-4; Pl. 158, figs. 1, 2). Specimens from Sydney coalfield, previously assigned by the writer to *P. miltoni,* were so designated on acceptance of opinion of Zeiller that *P. abbreviata* Zeiller (1886, Pl. 24; 1888, p. 186) and *P. miltoni* were conspecific, an opinion later shared by Kidston and more recently by Corsin (1951, pp. 286, 289). In the writer's opinion the union of these two forms is no longer tenable. *P. abbreviata* Zeiller differs from *P. miltoni* in its secondary pinnae being acuminate and not abruptly contracted apically. Its entire, free pinnules are commonly more than twice as long as wide, which is only true for pinnules in *P. miltoni* that occur on secondary pinnae in distal parts of a primary pinna, and which take the place there of tertiary pinnae. Moreover, the entire pinnules in *P. abbreviata* from middle positions of a frond rarely possess decurrent midribs, whereas more or less decurrent midribs are prevalent in larger pinnules of *P. miltoni,* which also differ in having confluent bases. Of the specimens illustrated by Kidston (1924) that represented in Plate 121, figure 2 and text-figure 55 belongs, in the opinion of the writer, to *P. acadica.* The identity of the pinnule shown by text-figure 56 of Kidston is doubtful, but it may represent an entire pinnule of *P. miltoni* from an apical end of a primary pinna.

In general, the secondary pinnae of specimens from Minto and Clifton here assigned to *P. miltoni* are commonly more lax or curved than those of *P. abbreviata* or of the very similar *P. acadica.* The very characters that separate *P. miltoni* from *P. abbreviata* Zeiller separate it also from *P. vestita* Lesquereux (= *P. abbreviata*?).

P. miltoni differs from *P. pilosa* Dawson in the abrupt apical contraction of the secondary pinnae, as well as in the character of the fructifications. It is quite distinct from *P. pilosa* Corsin (*non* Dawson) (Corsin, 1951, p. 335, Pl. 178), which has small pinnules on narrow, ultimate, acuminate pinnae, and a coarsely cellular epidermal structure on dorsal surface of pinnules like that of *P. hucheti* and *P. acadica.*

P. pseudovestita D. White (1899, p. 185, Pls. 28-32) is doubtfully conspecific with *P. miltoni.* Its secondary pinnae have a similar apical contraction, except that the tip is more extended, but the tertiary pinnae are more lanceolate and are constricted somewhat at the base. Furthermore, the lateral veins of the largest pinnules, if those represented by White are actually from large tertiary pinnae and not from apically situated secondary pinnae, are several times divided, a condition that occurs in *P. miltoni* only in the largest entire pinnules that correspond to tertiary pinnae.

The largest tertiary pinnae of *P. miltoni* resemble secondary pinnae of *P. villosa* Brongniart, but differ from the latter in apparent lack of villosity, in common decurrence of midribs of pinnules, in thicker veins, and in lack of punctae or apiculi on rachides.

P. Corsin (1951, p. 305) noted differences between *P. aspidioides* (Sternberg) and *P. miltoni.* Of major importance are (1) the more lanceolate secondary pinnae of *P. aspidioides,* which do not contract abruptly to summit,(2) the abnormal size and asymmetry of the basilar pinnules, and (3) the common occurrence of simple lateral veins in addition to singly divided ones.

Occurrence. Minto formation, localities 856, 857, 945, 978, 979, 1019, 1020, 1042, 1130, 1144; Clifton formation, localities 1172, 1196; Pictou group (undifferentiated), locality 5025.

Types. Hypotypes, GSC Nos. 849-855.

Pecopteris (Asterotheca) acadica n. sp.

Plate XXV, figures 1-3; Plate LVI, figure 7

Asterotheca miltoni Bell, Geol. Surv., Canada, Mem. 215, p. 71, Pl. 67, figs. 2, 4; Pl. 68; Pl. 69, figs. 1-3 (1938).

Description. Frond, quadripinnatifid; penultimate (primary?) pinnae, very large; rachis up to 1 cm or more broad, having irregular longitudinal striae and scattered emergences of uncertain nature, which are represented on external moulds by shallow, elongated punctae. Ultimate (secondary?) pinnae, elongate, up to 15 cm or more long by 2.5 cm wide, of equal breadth for two-thirds or more of length, thereafter acuminate to an acute apex; rachis, microscopically, irregularly striated and, when well preserved, having scattered, inconspicuous apiculi. Pinnules in middle region of frond, oblong, entire, or slightly triangular to a well-rounded apex, free to connate at base, inserted on rachis at very open angles to a right angle, commonly uneven in length and 5 to 7 mm long by 2 mm broad, moderately convex above, but channelled over midrib; upper surface is marked by a pustulose network of cells, commonly moderately elongated parallel to the veins; lower surface slightly rugose, owing to short linear elevations up to 0.5 mm long, which seem to be the result of short hairs that have been pressed down on the lamina. On the upper surface the thick cellular coat obscures or conceals the veins, but, when it has been partly or wholly removed by natural maceration, the veins are clearly visible. The midrib is very thick for about three-fourths of its course to the apex. In the largest entire pinnules eight or nine strong pairs of laterals are given off obliquely, each dividing at rather wide angles close to its point of origin, the upper branch commonly dividing again, the ultimate arms being nearly parallel and meeting margin at very open angles.

Pinnules in lower region of a frond are pinnatifidly lobed, the smallest with rounded marginal lobes, the largest with lobes free for about half of their length and approaching pinnae of a third order, their bases being somewhat constricted. Each rounded lobe or confluent pinnule is provided with an oblique, commonly curved vein that gives off from each side one or two simple, strongly ascending laterals; in the smaller lobes the veins are about equally strong, and instead of a distinct midvein the entering vein dichotomises close to origin at a wide angle, and the upper arm bifurcates again about halfway to the margin.

Remarks. The species is very close to *Pecopteris hucheti* (Corsin, 1951, p. 249), possibly a geographic subspecies and differing mainly in the following characters: (1) the entire pinnules and their midribs are generally not decurrent on their parent rachis, and very rarely are the midribs slightly decurrent; (2) the lateral veins in entire pinnules are thick and mostly divide twice, the ultimate branches curving to meet margin at more open angles; (3) pinnatifid pinnules are more common. The last two characters are seemingly complementary. In the long, acuminate, ultimate pinnae, and in form and venation of pinnules the species closely resembles *P. abbreviata* Brongniart, but differs from that species in the character of the dorsal surface, which in *abbreviata,* according to Zeiller (1888, p. 187), is marked by very fine or very short striae that resemble adpressed hairs. If that description be accurate, the dorsal surface of *abbreviata* is more comparable with the ventral surface of *P. acadica.*

The relation of the species to *P. vestita* Lesquereux is doubtful. The main difficulty of uniting the two forms is the apparent lack in *vestita* of a coarsely cellular dorsal coat on the pinnules; D. White (1899, p. 92) described the dorsal lamina of pinnules of *P. vestita* as "either rather densely covered with short scales or scaly hairs lying parallel to the nervation", a description hardly applicable either to *P. acadica* or to *P. hucheti,* unless individual pustulose cells owing to poor preservation were mistaken for scales. At any rate *P. acadica* differs from *P. vestita* in the same way that it does from *P. hucheti* in that the pinnules or their midribs are either non-decurrent or very rarely slightly decurrent. Corsin (1951, p. 337) considered *P. vestita* to belong probably to his species *P. pilosa* (a specific name preempted by J. W. Dawson, 1868), a view hardly supported by the entire pinnules of the latter species or by its apparent lack of pinnatifid tertiary pinnae. It is worthy of note that the size and shape of the dorsal epidermal cells is not in itself a character confined to a single species, for the appearance of the dorsal coat of *P. pilosa* Corsin (*non* Dawson) is comparable to that in *P. acadica*. *P. pilosa* Corsin is otherwise readily separable from *P. acadica* by its very short pinnules, which have decurrent midribs and generally only once divided lateral veins.

Pinnae of *P. acadica* with long, free, entire pinnules resemble closely pinnae of *P. cyathea* (Schlotheim) and of *P. lepidorachis* Brongniart. They differ from both of these species in the very common twofold division of the lateral veins whereby three ultimate branches meet the margin at very open angles.

Only a few doubtfully fertile pinnules were noted in collections from New Brunswick, but synangia of *Asterotheca* type occur in specimen No. 1266 (Bell, 1938, Pl. 69, fig. 3) from the Sydney coalfield.

Occurrence. Pictou group (undifferentiated), localities 963, 1076, 1434.

Types. Holotype, GSC No. 847; paratype, GSC No. 848.

Pecopteris (Asterotheca) hemitelioides Brongniart

Plate XXI, figure 3

Asterotheca robbi Bell, Geol. Surv., Canada, Mem. 215, p. 74, Pl. 72, figs. 3-6; Pl. 73, figs. 1, 2; Pl. 74, fig. 1; Pl. 76, fig. 1 (1938); Mem. 225, p. 122, (1940).

Remarks. In description of specimens of *Asterotheca robbi* from Sydney coalfield, the writer expressed doubt about its specific separation from *Pecopteris (Asterotheca) hemitelioides* Brongniart. Since that time P. Corsin (1951, p. 345, Pl. 183) in a description of specimens of *Pecopteris hemitelioides* from the Saar coal basin described the venation and epidermal characters, and this so fully applies to the Nova Scotia specimens of *Pecopteris robbi* that the latter species must be considered a synonym of *P. hemitelioides,* regardless of the fact that the last mentioned generally makes its appearance in Europe in Westphalian D.

P. hemitelioides occurs in only one collection from the Pictou group of New Brunswick, viz. from locality 1434 in the Pollett River area, Westmorland county. The specimens are fragmentary and add nothing to our knowledge of the species except that here again as in the Sydney and Pictou coalfields the species occurs in association with a flora that presents evidence of a late Westphalian C age.

The pinnules are upright or slightly oblique, generally free or united at extreme base, closely spaced and touching or more distant, rectangular, with parallel sides, and only slightly convergent to a well-rounded summit, commonly 6 or 7 mm long by about 2 mm wide. Upper surface of pinnules marked by rather coarse epidermal cellular network of cells that are elongated more or less parallel with midvein and laterals; when carbonized the thick epidermal coat hides or obscures the veins, but, when these are observed, they are nearly straight, simple, and rather openly oblique. The midvein is thick, nondecurrent and extends to apex.

The ultimate and penultimate rachides, in addition to discontinuous microscopic striae, have scattered pustulae or apiculi that may represent bases of hairs.

Occurrence. Pictou group (undifferentiated), locality 1434.

Types. Hypotype, GSC No. 939.

Pecopteris (Senftenbergia) pennaeformis Brongniart

Plate XXVI, figure 2

Senftenbergia pennaeformis Bell, Geol. Surv., Canada, Mem. 215, p. 79, Pl. 81, figs. 1-4; Pl. 82, fig. 3 (1938).

Remarks. A single sterile specimen occurs in collections from Minto, representing lower surface of a part of a secondary pinna, of which the rachis is marked by scattered elongated apiculae and discontinuous longitudinal striae, the last mentioned seemingly representing hypodermal strands. The tertiary pinnae are openly oblique, closely spaced linear-lanceolate, about 3 cm long by 8 mm wide. The pinnules are entire, triangularly ovate, about 4 mm long by half as broad, attached by whole base and united only by a wing of rachis; they converge at summit to a rounded apex. The midvein is outstanding, strong, oblique to very slightly decurrent, running nearly to apex. Secondaries, four or five alternate pairs, are moderately oblique, mostly once divided at rather open angles about midway in their course, similar in all respects to lateral veins of type specimen represented by Plate 118, figure 1A, Brongniart (1828). Surface of pinnules is microscopically rugose, being marked by pustular-like elevations that are elongated parallel to the veins.

Occurrence. Minto formation, locality 3859.

Types. Hypotype, GSC No. 981.

Aphlebia sp. A

Plate XXIV, figure 1

Remarks. Large, profusely branching, aphlebian leaves occur at Minto associated with, although not found attached to, *Pecopteris miltoni.* The leaves are a thallus-like lamina that branches freely by dichotomy, so that the summit appears laciniate. Each division of a lamina has a comparatively thick, central, microscopically striated, fibrous vein that is bordered on each side by a lamina of thin consistency. Stur (1885, Pl. 60, fig. 4) illustrated a similar *Aphlebia* that he assigned to *Pecopteris miltoni.*

Occurrence. Minto formation, locality 945.

Types. GSC Nos. 975, 976.

Aphlebia sp. B

Plate XXVI, figure 1

Remarks. GSC No. 977 is a small, rather sparingly branched species of '*Aphlebia*'. Like *Aphlebia* sp. A, each division of the lamina has a vein-like median strand bordered by a thin narrow lamina, but the latter bears abundant delicate hairs, 0.5 to 1 mm long, which project into the rock matrix.

Occurrence. Clifton formation, locality 5095.

Types. GSC No. 977.

Alethopteris lonchitica (Schlotheim)

Plate XLII, figure 4

Pecopteris (Alethopteris) decurrens Dawson, Geol. Soc. London, Quart. J., vol. 18, p. 322, Pl. XV, figs. 40a, b, c (1862).

Alethopteris discrepans Dawson, Acadian Geology, 2nd ed., p. 552, fig. 192 I (1868); Foss. Pl. Devon. and U. Silur. Can., Geol. Surv., Canada, Rept., p. 54, Pl. XVIII, figs. 203-205 (1871); Geol. Hist. Pl., p. 73, fig. 231 (1888).

Johannophyton discrepans (Dawson) Mathew; Roy. Soc. Can. Trans., vol. 3, p. 83, Pl. II, figs. 7-9; Pl. III, figs. 1-10 (1910).

Alethopteris lonchitica Stopes; Geol. Surv., Canada, Mem. 41, p. 47, Pl. XII, fig. 30; Pl. XIII, figs. 31-33; Pl. XVIII, fig. 46; Pl. XXII, fig. 57a, text-fig. 8 (1914).

Alethopteris lonchitica Bell, Geol. Surv., Canada, Mem. 215, p. 67, Pl. LXI, fig. 5 (1938); Mem. 238, p. 86 (1944).

Remarks. This form is extremely rare in the Pictou group of New Brunswick, and it is associated at Minto with abundant *A. serli*. As compared with most specimens of *A. serli* the pinnules are more distant, more nearly parallel-sided, and relatively more narrow in proportion to the length. The lateral nerves are about 30 per centimetre at the margin, which is around the minimum number for that distance in *A. serli*.

Occurrence. Minto formation, locality 945; Pictou group (undifferentiated), locality 5025.

Types. Hypotype, GSC No. 858.

Alethopteris serli (Brongniart)

Plate XXXIX, figure 1; Plate XLI, figure 4; Plate XLII, figure 1

Alethopteris serli Dawson, Acadian Geology, 2nd ed., pp. 242, 484 (1868).

Alethopteris grandis Dawson, op. cit., pp. 242, 484, fig. 72 (p. 243), (1868).

Alethopteris serli Bell, Geol. Surv., Canada, Mem. 215, p. 67, Pl. 61, figs. 6, 7; Pl. 62, fig. 1 (1938); Mem. 225, p. 120 (1940).

Remarks. Specimens of this species are abundant at both Minto and Clifton, and include forms with elongate pinnules (*A. lonchitifolia* Bertrand), (Pl. XLI, fig. 4); they are associated with forms possessing shorter or squat and more obtuse pinnules. At Minto, forma *lonchitifolia* predominates, whereas the reverse seems to be true at Clifton. At any rate, close association of the two forms, occasionally on the same primary pinna, as well as forms with pinnules of transitional character, precludes specific differentiation.

Specimen No. 856 (Pl. XXXIX, fig. 1) shows a large part of two primary pinnae and small parts of two other pinnae; towards the apex of the primary pinna the secondary pinnae gradually take on the form of elongated confluent pinnules. Specimen No. 966 (Pl. XLII, fig. 1) represents an apical part of a larger primary. Specimen No. 857 (Pl. XLI, fig. 4) shows part of a secondary pinna having the *lonchitifolia* form, and apparently was derived from a primary pinna lower down on a frond than specimen 856.

Occurrence. Minto formation, localities 945, 977, 990, 1020, 1130, 3859, 5093; Clifton formation, localities 1172, 1196; Pictou group (undifferentiated), localities 1434, 5025, 5026, 5027, 5245.

Types. Hypotypes, GSC Nos. 856, 857, 966.

Alethopteris davreuxi (Brongniart)

Plate III, figure 5; Plate XLI, figures 1, 2

Alethopteris friedeli Bell, Geol. Surv., Canada, Mem. 215, p. 68, Pl. 62, figs. 2-4; Pl. 63 (1938).

Remarks. The species, which is rather rare at Beersville, is characterized generally by strongly convex or inrolled pinnules, and, although united at base, commonly appear to be free and nondecurrent. Yet, when the rock matrix is entirely removed from the proximal regions of the narrow rounded sinuses that separate the pinnules, a narrow lamina uniting the pinnules may be seen to be provided with veins directly from the parent rachis as in other alethopterids. The midrib is thick and marked on dorsal surface by a strong channel; it falls a little short of the apex of a pinnule. The lateral veins, also thick, are about as close as those in pinnules of *A. serli,* where about thirty occur to a centimetre at the margin; they rise obliquely from the midrib, but curve rapidly, so that the ultimate veins produced by one or two divisions meet the margin at very open angles or at nearly a right angle. As in the Morien group of the Sydney coalfield, two extreme forms of pinnules occur: the one narrowly linear, and pecopteroid, with sides nearly parallel (Pl. III, fig. 5; Pl. XLI, fig. 1), commonly irregularly curved; the other (Pl. XLI, fig. 2), obtuse and stubby like small pinnules of *A. serli.* The apices of pinnules of both forms are well rounded. A review of descriptions of illustrations of *Alethopteris davreuxi* has convinced the writer that the differences between *A. friedeli* and *A. davreuxi* are too minor to warrant any longer specific or varietal designation.

Occurrence. Pictou group (undifferentiated), localities 963, 1076.

Types. Hypotypes, GSC Nos. 859, 860, 861.

Pecopteridium sullivanti (Lesquereux)

Plate XL, figures 1-5; Plate XLI, figures 3, 5

Pecopteridium sullivanti Bell, Geol. Surv., Canada, Mem. 215, Pl. 81, fig. 5 (1938).

Original description. "Frond bipinnate, pinna lanceolate, pinnules alternate, oblique, obovate or oblong, nearly contiguous, slightly decurrent by their base and united together with a slightly obtuse sinus. Medial nerve very broad, disappearing above the middle; secondary nerves arched, slender, close, many times forking, or dichotomous." (Lesquereux, 1858, p. 866.)

Description of New Brunswick specimens. Penultimate (primary?) pinnae very large, commonly dissymmetric, with heteromorphous ultimate pinnae. Ultimate (secondary?) pinnae, elongate, inserted at very open angles, closely spaced, of about equal width to near summit, which has a well-rounded, terminal leaflet; when immature (in the apical region of parent pinna) the ultimate pinnae have the form of long, subrectangular, commonly rather sickle-shaped, obtusely rounded pinnules, which are alethopteroid, decurrent and united at base by a lamina bordering the parent rachis. More mature ultimate pinnae are longer, becoming faintly lobed or undulating and progressively constricted at base until they are attached only by a stout midvein. Fully mature ultimate pinnae are pinnatifid to pinnate, and segmented into openly oblique lobes or pinnules, the lobes or pinnules being coriaceous, more or less subrectangular in outline, with truncated or rather broadly and asymmetrically rounded summits, confluent for half or less of their length. Veins of lobes or pinnules are odontopteroid, arising directly and at very open angles from parent rachis, each vein divided commonly two or three times, thick and semi-immersed. The ultimate pinnae in the apical region of parent pinnae are elongated pinnules, possessing a very thick midrib that ends rather abruptly about three fourths length of the pinnule where it branches fanwise into divided veins; the laterals from midrib are oblique, divided generally once close to midvein and each are commonly dividing again, or more rarely each arm divides twice, the veins gently curving to meet margin obliquely at open angles, the whole appearance being alethopteroid. Microscopically under rather high power the lamina between the veins is marked by a rather coarse network of nearly equidimensional, epidermal cells.

Remarks. The frond was apparently very large, and one pinna on specimen No. 940 (Pl. XLI, fig. 3 at arrow basal left), offset from the main primary rachis, suggests a bifurcation of the last mentioned. The organization of the frond is inferred by the writer to be much like that of *Pecopteridium cuvettei* Bertrand (1932, Pl. 59, figs. 1, 1b), a species distinguishable from *P. sullivanti* by its much smaller and bluntly pointed pinnules.

The original type specimen of the species is interpreted by the writer to be part of a primary pinna from an apical region of a frond where the pinnules represent alethopteroid ultimate pinnae. Such pinnules may be caducous, e.g. specimen No. 863 (Pl. XL, fig. 3).

Alethopteris grandini Zeiller, *non* Brongniart (Zeiller, 1886, Pl. 38, figs. 1, 2) much resembles *Pecopteridium sullivanti,* but differs in its large pinnules having thinner midribs, and its small pinnules being alethopteroid and not odontopteroid. Němejc (1936, p. 2) assigned Zeiller's species to *Alethopteris bohemica* Franke emended.

Specimen No. 865 (Pl. XL, fig. 5) has large pinnules (secondary pinnae) from near apical region of a primary pinna, which are subopposite in position, a character held in common with the closely related *Alethopteris grandini* Zeiller.

Occurrence. Pictou group, localities 963, 1076.

Types. Hypotypes, GSC Nos. 862, 863, 864, 865, 940, 941, 942.

Neuropteris pseudogigantea Potonié

Neuropteris aculeata Bell, Geol. Surv., Canada, Mem. 215, p. 56, Pl. 49, figs. 1, 2; Pl. 50, fig. 1 (1938).

Remarks. Neuropteris aculeata was somewhat doubtfully considered by Bell (1944, p. 89) to be a synonym of *N. pseudogigantea* Potonié. However, at that time he thought that *N. retorquata* Dawson, which Stopes (1914, p. 62) later assigned to *N. gigantea* Sternberg, was also synonymous with *N. pseudogigantea.* He no longer supports the last-mentioned synonymy, and differentiates *N. aculeata* (= *N. pseudogigantea*) from Dawson's *N. retorquata* (= *N. gigantea*) by the thicker, longer, and more prominent midrib of a pinnule, and by occurrence of apiculi on both penultimate rachis and pinnules. Stockmans (1933, p. 46, Pl. 100) assigned *N. gigantea* Renier (1910, Pl. 100) to *N. pseudogigantea* Potonié, and Renier's figure shows clearly that the penultimate rachis is marked not only by scars of cyclopteroid pinnules but by punctae or apiculi. Moreover, some of the pinnules in Renier's photographic reproduction show punctae or apiculi on the pinnules.

The pinnules of Minto specimens of *N. pseudogigantea* have a prominent midrib that extends commonly seven tenths of their length; commonly the ratio of length to width of a pinnule is 2:1 or a little greater, although one lateral side of a pinnule may be nearly straight and the other slightly convex, truly falcate pinnules are lacking.

N. pseudogigantea occurs in a lower part of the Pictou group (Westphalian C) in both Nova Scotia and New Brunswick, whereas *N. gigantea* seemingly does not extend beyond the Cumberland group (Westphalian B).

Occurrence. Minto formation, localities 856, 1130, 1144; Clifton formation, locality 1172; Pictou group (undifferentiated), locality 5027.

Types. Hypotype, GSC No. 4972.

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb.

Plate XXVII; Plate XXVIII, figures 1-4; Plate XXIX; Plate XXX;
Plate XXXI, figures 1-3; Plate XXXII, figure 5; Plate XXXIII, figures 1, 3, 4

Bellopteris corsini Radforth and Walton, 1960, Senckenbergiana Lethaea, vol. 41, p. 105, Pl. 3, figs. 10-13 (1960).

Description. "Fern-like fronds, at least bipinnate. Pinnae linear lanceolate. Those near the apex of the frond with alternating pairs of oval neuropteroid pinnules about 5 mm. long and 2.5 mm. broad. The basal pinnule on the katadromic side of the pinna is slightly shorter than those in the middle part of the pinna. Near the basal part of the fronds the pinnules are narrowly deltoid about 12.5 mm. long and about 4 mm. broad near the base. They are lobed and, with the exception of the basal pinnules on the katadromic side, sinuses between the lobes may reach more than halfway to the midrib of the pinnule, which may therefore be regarded as an ultimate pinna with closely webbed pinnules. The rachis in this region of the frond is 3.4 mm. wide. There are about three veins in each lobe.

"The basal pinnule on the pinna situated on the katadromic side of the pinna rachis where it joins the main rachis is not lobed; it is about 6 mm. long and 3.5 mm. broad, which is smaller than the lobed pinnules adjacent to it." (Radforth and Walton, 1960, p. 105.)

The material in collections of the Geological Survey of Canada adds substantially to knowledge of frond dissection of the species. The frond is large, tripinnatifid to tripinnate. Principal rachis, longitudinally striated, giving off primary pinnae obliquely at open angles as well as by asymmetric and symmetric bifurcation. Short intercalary pinnae occur between the primaries.

Primary pinnae elongate, deltoid at summit, broadest in middle region; rachis thick, 3 mm or more broad, longitudinally striated. Secondary pinnae elongate-lanceolate, attached 60 to 80 degrees to parent rachis, straight or commonly moderately curved forwards or backwards giving a rather lax appearance, closely spaced or touching or overlapping. Intercalary pinnae attached directly to principal rachis between primaries at nearly right angle; short, commonly not more than 4 cm long, asymmetrically bifurcated at wide angle at, or close to, union with principal rachis, a short division commonly running close to and subparallel with parent rachis or overlapping it, the other and longer, deltoid-lanceolate and bearing pinnules similar to those of normal secondary pinnae.

Pinnatifidly lobed pinnules or tertiary pinnae, ovate to triangular-ovate, oblique, alternating, with neuropteroid to sphenopteroid attachment, sessile or in more mature tertiary pinnae very shortly stalked, 7 to 13 mm long by 3 to 5 mm broad, possessing one or two basal pairs of oval, oblique lobes or pinnules that are confluent at base by wing of parent segment for a quarter to three quarters their total length from parent midvein. The parent midvein is moderately thick, nearly straight and runs to summit or divides very close to it. In tertiary pinnae the basal pinnules are supplied by a single vein from the tertiary rachis; it divides at, or close to, origin and resulting arms may divide once or twice. In lobed pinnules in apical part of a secondary pinna the posterior (abaxial) basal lobe is directly supplied in mixoneuroid fashion by a vein from the secondary rachis.

Entire pinnules, sessile, contracted at base, basal margin being generally truncate or feebly cordate, rectangular-ovate to triangular-ovate, 6 to 9 mm long by 2.5 to 4 mm broad, converging at summit to more or less broadly rounded apex. Pinnules within distal quarter of a secondary pinna decrease gradually in size to a small, elongate, terminal leaflet that is commonly about size of the third or fourth pinnule below it. The pinnules in more distal part of this apical region have a mixoneuroid attachment and venation. The basal pinnule on inferior or catadromous side of a secondary pinna (as also in pinnae with lobed pinnules) is generally more squat or shorter than the others and is also entire. The basal pair are commonly attached at wider angle to the rachis than are the remaining pinnules. Midvein of pinnules moderately strong, straight or nearly so, divided very close to apex; laterals comprise four or five pairs, obliquely and strongly ascending, with little downwards curvature; the basal laterals commonly divide so as to give rise to four to seven ultimate branches; succeeding laterals branch once or twice.

Remarks. The construction of the frond as described above, except for greater dissection into pinnatifid pinnules or tertiary pinnae, is precisely like that of *Neuropteris attenuata* Lindley and Hutton as that species is interpreted by V. Havlena (1953, pp. 133-140, Pl. 1, fig. 1; Pl. 2, fig. 1). A similar frond dissection is represented by *Neuropteris piesbergensis* Gothan (1941b, p. 423, fig. 1a), which in addition to intercalary pinnae similar to those of *corsini* bears cyclopteroid leaves on the principal rachis. Gothan (1953, p. 57, Pl. 32, fig. 2) subsequently included in his *N. piesbergensis* a specimen with slightly lobed pinnules in addition to entire ones. Havlena united Gothan's species to *N. attenuata.*

A fair proportion of fragments of pinnae of *corsini* in Geological Survey of Canada collections has only entire pinnules, or lobed ones occur rarely. Specimen No. 902 (Pl. XXXIII, fig. 3) shows part of a principal rachis, about 1 cm wide, and was derived evidently from a lower position in a frond than that represented by specimen No. 889 (Pl. XXVII). The former shows parts of a principal rachis provided with intercalary pinnae and basal parts of two primary pinnae. The upper primary represents one branch (on right side) of a dichotomy of the principal rachis; the lower an asymmetrical division of the same rachis. Both primaries bear lobed pinnules or tertiary pinnae up to 13 mm long. Other specimens show no definite relationship between dissection of pinnules and diameter of the parent primary rachides. Specimen No. 896, for example (Pl. XXXI, fig. 3), has a primary rachis 3 mm wide and the secondary rachis bears entire pinnules 8 to 10 mm long by 4 mm wide, whereas in specimen No. 894 (Pl. XXX), which has a primary rachis only 2.5 mm wide, the secondary rachis has lobed pinnules, 6 to 7 mm long by 2.5 mm wide. Moreover, abrupt development from entire pinnules to lobed pinnules occurs in specimen No. 893 (Pl. XXVIII, fig. 2). This specimen is considered to represent an apical part of a primary pinna in which short secondary pinnae with small entire pinnules in apical region are represented a little farther down by longer pinnatifid pinnules with a pair of basal lobes.

Fragments of fronds of *corsini* bearing only entire pinnules like *N. attenuata* are likely to be confused with *Neuropteris rarinervis.* Differentiating characters of *corsini,* however, like those of *attenuata* are the more lax habit of its pinnae and pinnules, the generally smaller sized pinnules, the common occurrences of ovate-deltoid rather than of broader tongue-shaped pinnules, the proportionately shorter and narrower terminal leaflets, and finally the considerably less thick or outstanding veins, which are generally more numerous, straighter and more ascending.

Pinnae of *corsini* with entire, or entire plus a few marginally lobed pinnules, apparently resemble closely *Neuropteris bockingiana* (Weiss) (1869, p. 7, figs. 1, 1a; Stockmans, 1933, p. 29, Pl. 9, figs. 1, 1a, 1b), which was designated a *Sphenopteris* by Weiss, but specimens from Belgium of like character were subsequently allocated to *Neuropteris* by Kidston (1911, p. 77) and this combination was accepted by Stockmans. The species is insufficiently known to make close comparison with *corsini.* The specimens from Belgium as described by Stockmans have oval to oval-triangular pinnules about the size of those of *corsini,* and a few of the largest have marginal lobes or crenae; the venation of Stockmans illustrated specimen resembles fairly closely the venation of *corsini.*

Occurrence. Minto formation, localities 856, 945, 948, 978, 990, 1000, 1005, 1017, 1020, 1037, 1042, 1054, 1061, 1072, 1120, 1130, 5074, 5090, 5093.

Types. Hypotypes, GSC Nos. 889, 890, 891, 892, 893, 894, 895, 896, 898, 899, 900, 901, 902.

Neuropteris tenuifolia (Schlotheim)

Plate XXXIV, figures 3, 4; Plate XXXVI, figure 2

Neuropteris tenuifolia Bell, Geol. Surv., Canada, Mem. 215, p. 54, Pl. 46, figs. 1-5 (1938); Mem. 225, p. 117 (1940).

Remarks. The specimens from Minto are comparable in all respects to those in the Morien (Pictou) group of Sydney coalfield, with pinnule outline and size variable according to the position they held on a frond. Parts of secondary pinnae, as well as a few isolated pinnules, are very common at Minto. No pinnules of *N. flexuosa* occur there in association, with the possible exception of one very large terminal pinnule which is detached from other parts of the pinna.

Specimens with small, subovate pinnules are the only ones likely to be confused with *N. rarinervis,* but are distinguishable from that species by lateral veins that branch and reach the pinnule margin at more acute angles.

Occurrence. Minto formation, localities 856, 857, 861, 979, 990, 1020, 1042, 1130, 3859, 5074; Clifton formation, localities 1172, 5477; Pictou group (undifferentiated), localities 963, 1076, 1434, 5245.

Types. Hypotypes, GSC Nos. 904, 972.

Neuropteris (Mixoneura) flexuosa Sternberg

Plate XXXIV, figure 2; Plate XXXVII, figure 3

Neuropteris flexuosa Bell, Geol. Surv., Canada, Mem. 215, p. 55, Pl. 46, figs. 6, 7; Pl. 47, figs. 1-4; Pl. 48, figs. 1, 2 (1938); Mem. 225, p. 118 (1940).

Remarks. Fragments of this species occur in a small collection from Tay Creek, about 17 miles north of Fredericton. The species differs from *Neuropteris tenuifolia* by having pinnules almost truncate and not definitely cordate at base, by the catadromous side of base being commonly slightly extended, by the midrib losing its identity farther from the apex of pinnule, by its mixoneuroid nervation, and by greater breadth of terminal leaflet in proportion to its length.

Occurrence. Minto formation, locality 1020; Pictou group (undifferentiated), locality 5431.

Types. Hypotypes, GSC Nos. 905, 910.

Neuropteris heterophylla Brongniart

Plate XXXIII, figure 2; Plate XXXIV, figure 1

Neuropteris heterophylla Bell, Geol. Surv., Canada, Mem. 215, p. 56, Pl. 50, fig. 2 (1938).

Remarks. The species is readily distinguishable from *Neuropteris tenuifolia* by its characteristic ovate pinnules and by the nervation; the lateral veins by final bifurcations commonly approaching so closely in places as almost to touch, resulting in a superficial resemblance to *Linopteris muensteri.*

The species is apparently as rare within the lower half of Pictou group in New Brunswick as it is in Nova Scotia.

Occurrence. Minto formation, localities 857, 5431; Clifton formation, locality 1172; Pictou group (undifferentiated), locality 5025.

Types. Hypotype, GSC No. 911.

Neuropteris rarinervis Bunbury

Plate XXXII, figures 1, 2; Plate XXXV; Plate XXXVI, figures 1, 3

Neuropteris rarinervis Bunbury, Geol. Soc. London, vol. 3, p. 425, Pl. 22 (1847).
Neuropteris rarinervis Bell, Geol. Surv., Canada, Mem. 215, Pl. 52, fig. 3; Pl. 53, figs. 1, 2; Pl. 54, fig. 4 (1938).

Remarks. V. Havlena (1953, pp. 133-140, Pl. 1, figs. 1-5; Pl. 2, figs. 1-3) presented the first clear conception of characters of *Neuropteris attenuata* Lindley and Hutton, and in doing so considered that it was quite distinct from *N. rarinervis* Bunbury. The criteria used by him to separate *N. rarinervis* from *N. attenuata* are equally applicable in its separation from those pinnae of *Neuropteris (Bellopteris) corsini* Radforth and Walton that bear entire pinnules. At Minto the last mentioned species is associated in some beds with *N. rarinervis*. The differentiating characters between *N. rarinervis* and the entire pinnuled secondary pinnae of *N. corsini,* noted by the writer, were as follows:

(a) The rachides of primary pinnae have not so regular or so pronounced lineation as those of *N. corsini.*

(b) The primary and secondary pinnae and pinnules have a more rigid appearance than corresponding parts of *N. corsini,* and the pinnules of *N. rarinervis* are generally more regularly spaced and farther apart.

(c) The pinnules are generally cordate rather than truncate at base, which is commonly expanded on anadromous side.

(d) Isolated pinnules of *N. rarinervis,* having cordate bases, are common, but similar pinnules of *N. corsini* so far as known are lacking.

(e) The terminal leaflets of secondary pinnae are proportionally larger and more hastate or tongue-shaped than those of *N. corsini.*

(f) The midveins of pinnules are thicker and more outstanding than those of *N. corsini,* whereas the laterals are farther apart and generally curved so as to reach the margin at more open angles.

The basal inferior (catadromous) pinnule on the secondary pinnae of *N. rarinervis* as in *N. corsini* is generally shorter and more squat than remaining ones and is attached to parent rachis at more open angle. This peculiarity is more pronounced in those secondary pinnae of *N. corsini* that bear lobed pinnules because the margins of these basal pinnules are entire in contrast to the lobed or pinnatifid margins of the other pinnules, commonly including the basal superior (anadromous) ones.

Occurrence. Minto formation, locality 1020; Clifton formation, localities 1152, 1172, 1196; Pictou group (undifferentiated) at Beersville, localities 963, 1076, 5353; Pictou group (undifferentiated) elsewhere, locality 5028.

Types. Hypotypes, GSC Nos. 903, 906, 925, 4588.

Neuropteris scheuchzeri Hoffmann, forma *angustifolia*

Plate XXXVII, figures 1, 2, 5

Neuropteris cordata var. *angustifolia* Bunbury, Quart. J. Geol. Soc. London, vol. 3, p. 424, Pl. 21, figs. 1A-1E (1847).
Neuropteris cordata Dawson, Acadian Geology, 2nd ed., p. 482, fig. 166B (p. 446), (1868).
Neuropteris scheuchzeri Bell, Geol. Surv., Canada, Mem. 215, p. 57, Pl. 50, figs. 3, 4; Pl. 51, fig. 5 (1938); Mem. 225, p. 119 (1940).

Remarks. Most pinnules (detached) of this species at Minto, which belong to forma *angustifolia,* are elongate-triangular, contracting acuminately to a narrow acute apex; some are 10 cm long. Commonly the pinnules have a sickle-shaped apical region; their bases are rounded or truncate and not cordate. Ultimate pinnae in apical region of parent pinnae may have an elongate, apically curved terminal pinnule, and a pair of small, squat, subovate lateral ones such as figured by Dawson (op. cit., above). Hairs, generally about 15 mm long, are extremely abundant, commonly represented on carbonized compressions by grooves on upper, or by emergences on the lower surface, indicating that they were borne on lower surface.

The Minto material like that of Sydney seems clearly to indicate that the species was imparipinnate.

Occurrence. Minto formation, localities 856, 3859; Pictou group (undifferentiated), localities 1434, 5025, 5431.

Types. Hypotypes, GSC Nos. 907, 908, 909.

Cyclopteris sp.

Plate XXXII, figures 3, 4

Remarks. Included here are semi-orbicular to oval, unattached leaves belonging to the group '*Cyclopteris orbicularis*' Brongniart, variable in size and outline, up to 6 cm diameter. The margin is entire or more or less undulate, and commonly dissymmetric in relation to an emarginate or cordate base from which numerous veins, dichotomising three or more times, radiate. All specimens from the Pictou group of New Brunswick so far collected are detached, but similar leaves have been found elsewhere attached to principal rachides of several species of *Neuropteris*. Those occurring at Minto may belong to *Neuropteris tenuifolia,* which occurs abundantly in the same beds. At Beersville, similar leaves have fewer veins and may belong to the associated *N. rarinervis*.

Occurrence. Minto formation, localities 945, 947, 948, 977, 1130; Pictou group (undifferentiated), localities 963, 1076.

Types. GSC Nos. 973, 974.

Linopteris muensteri (Eichwald)

Plate XXXVII, figure 4; Plate XXXVIII, figures 1-3

Linopteris muensteri Bell, Geol. Surv., Canada, Mem. 215, p. 65; Pl. 59, figs. 1-4 (1938); Mem. 225, p. 119 (1940).

Remarks. Specimen No. 887 (Pl. XXXVIII, fig. 2) is part of a very large, probably primary pinna. The rachis, nearly 1 cm wide, is longitudinally striated. It gives off nearly straight secondary pinnae alternately at angles of nearly 45 degrees. The pinnules are elongate-ovate, up to eleven alternate pairs in addition to an asymmetric terminal one that is short, but larger than those immediately preceding it; it has a basal lobe on one side, which gives it a subrhomboid outline. The inferior basal pinnule, situated in angle between the secondary and primary rachides, is reflected backwards to a position nearly parallel with the primary rachis, which it may overlap; it is differentiated from the others by having one or two more or less deeply cut basal lobes.

Occurrence. Minto formation, localities 857, 1079, 1130, 3859; Clifton formation, locality 5095.

Types. Hypotypes, GSC Nos. 876, 877, 887, 888, 912.

Sphenophyllum cuneifolium (Sternberg)

Plate XLIII, figures 1-5

Sphenophyllum erosum Bunbury, Quart. J. Geol. Soc. London, vol. 3, p. 430, Pl. 23, figs. 3A, B (1847).

Sphenophyllum erosum Dawson, Acadian Geology, 2nd ed., p. 429, fig. 165C (1868).

Sphenophyllum antiquum Dawson, Canadian Naturalist, vol. 6, p. 170, fig. 7; Acadian Geology, 2nd ed., p. 540, fig. 188B (1868).

Sphenophyllum cuneifolium Bell, Geol. Surv., Canada, Mem. 215, p. 89, Pl. 92, figs. 6-8 (1938); Mem. 225, p. 129 (1940); Mem. 238, p. 105, Pl. 75, figs. 5-6, Pl. 76, fig. 10 (1944).

Sphenophyllum cuneifolium Radford and Walton, Senckenbergiana Lethaea, vol. 41, p. 102, Pl. 2, figs. 7-9 (1960).

Remarks. This readily identified species, consisting of narrow laterally branching stems with whorls of leaves at nodes, is abundant in roof shales of the coal seam at Minto, and includes more or less deeply divided leaves (forma *saxifragaefolium*) as well as the wedge-shaped simple type which have short sharp teeth confined to the margin. The number of leaves to a whorl is commonly six to twelve. A single vein enters a leaf and in undivided leaves dichotomises three or four times, resulting in an ultimate branch entering each tooth. The largest stems noted were about 1 cm wide, and the nodes, at which the stem is slightly dilated, are up to 2.5 cm apart. The stems are macroscopically smooth or more commonly irregularly ribbed; microscopically, they are longitudinally striated, and the surface of carbonized leaves under a lens is seen to have very fine longitudinal striae, which unite at relatively long intervals to form a network of elongated cells. The stems branch rather sparingly, with a single branch at a node, or a shortly stalked cone may occupy a corresponding position. The cones are cylindrical, up to 7 cm or more long and 1.5 cm wide, and externally consist of crowded, elongate, narrow sporophylls that proximally are attached nearly horizontally to the stem at closely spaced nodes, but which distally curve rather abruptly and ascend steeply to a height of about three internodes. These sporophylls in the specimens to hand effectively conceal any sporangia that may occur on their proximal surfaces.

Occurrence. Minto formation, localities 856, 945, 948, 990, 1020, 1037, 1038, 1042; Clifton formation, localities 1172, 5477; Pictou group (undifferentiated), localities 1434, 5025.

Types. Hypotypes, GSC Nos. 822-826.

Sphenophyllum emarginatum Brongniart

Plate XLIV, figures 1-4; Plate LVI, figure 1

Sphenophyllum emarginatum Dawson, Acadian Geology, 2nd ed., p. 480 (1868).
Sphenophyllum emarginatum Bell, Geol. Surv., Canada, Mem. 215, p. 89, Pl. 93, figs. 1-3 (1938); Mem. 225, p. 130 (1940).

Remarks. A description of this species was previously given by the writer, based on material from the Sydney coalfield (Bell, 1938, p. 89), and for fuller treatment the reader is referred to Zeiller (1888, pp. 409-412). Zeiller described and illustrated terminal cones, 2 to 4 cm long and 4 to 6 mm wide, that carried verticals of sporangia-bearing bracts, distant 2 to 3 mm from one another. The bracts are 3 to 5 mm long, proximally spreading nearly at right angles to parent rachis before curving strongly upwards; they are narrow, linear-lanceolate, and have acutely pointed apices. Ovoidal sporangia, about 1 mm diameter are attached by pedicels to the upper surface of these bracts a short distance from the axis of the cone.

Specimen No. 963 (Pl. XLIV, figs. 3, 4; Pl. LVI, fig. 1) possibly represents a wholly different kind of fertile shoot in that smooth macrospores *(Triletes),* with triradiate markings in the form of angular ridges, extending from centre to the margin of spore, occur free, but in loose groups, within 4 mm of the axes of a branched shoot bearing reduced leaves similar to sterile leaves of this species. The main axis of No. 963 (pars Pl. XLIV, fig. 4) is about 1 mm wide and in axil of a leaf is provided with a branch with axis 0.3 mm wide (Pl. XLIV, fig. 3; Pl. LVI, fig. 1). The whorls of leaves are about 4 mm apart. Loose macrospores, crowded together in groups of two to twelve close to the axes and between the leaves, occur in practically all the internodal areas of main stem and branch. They are about 1 mm in diameter and smooth except for the pronounced triradiate ridges. The wedge-shaped leaves, 2 mm broad at summit and 6 to 7 mm long, are oblique to the stem at rather open angles; at their summit are four to six rounded, marginal crenae, similar to those in sterile leaves of the species.

That the macrospores may be lycopodiaceous or spores of similar type that drifted into position against the *Sphenophyllum* shoots above described is possible, but rather questionable on account of their similar occurrence close to the axis between practically all the whorls of leaves; the probability of drift is further diminished by the very small size of the leaves as compared with other specimens of *S. emarginatum* occurring in the same beds. In described cones of *Sphenophyllum* the spores are presumably homosporous, and, although considerable variation in size in a single sporangium was noted by Seward (1910, p. 6), 120 μ was nearly the maximum diameter, which is far short of the macrospores in specimens here under consideration. If the latter were extruded from sporangiae and moved very little from their original position, it may be inferred that *S. emarginatum* possessed, in addition to terminal cones bearing microspores, fertile branched shoots provided with leaves similar to sterile ones, although reduced somewhat in size.

Occurrence. Minto formation, locality 5074; Clifton formation, localities 1172, 5477; Pictou group (undifferentiated), localities 963, 1076, 1434, 5353, 1430.

Types. Hypotypes, GSC Nos. 831, 834, 963.

Sphenophyllum myriophyllum Crépin

Plate XLII, figures 2, 3

Sphenophyllum myriophyllum Bell, Geol. Surv., Canada, Mem. 215, p. 90, Pl. 93, figs. 4, 5, 6 (1938); Mem. 225, p. 130 (1940).

Remarks. This species is rare in the Minto and Clifton formations. The leaves commonly bifurcate, generally close to the base, into long linear, acuminate segments with pointed apices similar to those of *Sphenophyllum trichomatosum*, but attaining greater length, and lacking any trace of hairs. The stems are indistinguishable from those of *S. cuneifolium*.

Occurrence. Minto formation, localities 945, 948, 990; Clifton formation, localities 1172, 5095.

Types. Hypotypes, GSC Nos. 829, 830, 984.

Sphenophyllum trichomatosum Stur

Plate XLII, figure 5

Sphenophyllum trichomatosum Bell, Geol. Surv., Canada, Mem. 215, p. 90, Pl. 93, figs. 7, 8 (1938).

Remarks. The species is very rare in collections from the Pictou group of New Brunswick examined by the writer. Except for occurrence of punctae visible under a hand lens, the stems are indistinguishable from those of *Sphenophyllum cuneifolium.* Fragments of whorls of linear *Asterophyllites*-like leaves, occurring in same bed as stems of *S. trichomatosum,* are figured on Plate XLII, figure 5 (at base). The leaves seemingly are in pairs that unite close to base, but the specimen does not clearly show the stems to which the whorls are attached, and consequently these leaves cannot presently be proved to belong to the species. They are inferred to do so, however, by the occurrence upon them, apparently attached to the midribs, of scattered stiff hairs, which may be seen projecting into the rock matrix for about half a millimetre. The leaf segments are up to 9 mm long by 0.75 mm wide. Except for the occurrence of hairs, the leaves resemble those of *S. myriophyllum.*

Occurrence. Minto formation, locality 948; Clifton formation, locality 1172.

Types. Hypotypes, GSC Nos. 827, 828.

Sphenophyllum majus Bronn

Sphenophyllum majus Bell, Geol. Surv., Canada, Mem. 215, p. 90, Pl. 94, figs. 1-2 (1938).

Remarks. The species resembles a large *S. cuneifolium,* although generally has only six to eight leaves to a whorl. These are commonly dissected by a medium sinus of variable depth, which may reach two-thirds or more of the length. The resulting segment may be cut by a shorter median sinus of varying depth, and ultimate segments still further divided by shallower sinuses, producing two or more long, triangular, apically pointed, ultimate segments or simply giving rise to marginal, pointed teeth. A single vein enters a leaf, dichotomises close to the origin, and by further dichotomies sends a vein into each ultimate segment or tooth.

Occurrence. Minto formation, locality 5074; Clifton formation, locality 5095; Pictou group (undifferentiated), locality 963.

Types. Hypotype, GSC No. 935.

Calamites suckowi Brongniart

Plate XLIV, figure 6

Calamites suckowi Dawson, Acadian Geology, 2nd ed., p. 442, Fig. 162A2, A4 (1868).
Calamites suckowi Bell, Geol. Surv., Canada, Mem. 215, p. 83, Pl. 84, fig. 2; Pl. 87, fig. 2 (1938); Mem. 225, p. 128 (1940); Mem. 238, p. 98 (1944).

Remarks. Some sandstone beds of the Pictou group in New Brunswick evidently contain pith casts of *Calamites* belonging to several species, but few were collected by officers of the Geological Survey. Of those contained in present collections *Calamites suckowi* is the most readily identifiable.

Occurrence. Minto formation, localities 945, 948, 990, 1020, 1042, 3859; Pictou group (undifferentiated), localities 3983, 5025.

Types. Hypotypes, GSC Nos. 843, 957.

Calamites ramosus Artis

Plate XLIV, figure 5; Plate XLV, figure 6

Calamites ramosus Bell, Geol. Surv., Canada, Mem. 215, p. 84, Pl. 86, fig. 1 (1938); Mem. 238, p. 99, Pl. 64, fig. 4 (1944).

Remarks. Specimen No. 841 (Pl. XLV, fig. 6) has at one node a branch-scar, 2.5 cm wide by 2.2 cm high, marked by a shallow central depression into which radial ribs from the main stem are directed. Part of a similar imprint of a branch occurs at next node 3 cm above. Ribs on the main stem are low and separated by shallow furrows, details being obscured by imprint of an overlying *Cordaites.*

Specimen No. 965 (Pl. XLIV, fig. 5) shows a single node, which has two branch scars about 1.8 cm apart, each scar being about 5 mm diameter. Low, flat ribs, about 1 mm apart, are separated by narrow furrows.

Occurrence. Minto formation, localities 990, 1028; Pictou group (undifferentiated), localities 1076, 5353.

Types. Hypotypes, GSC Nos. 841, 965.

Asterophyllites grandis (Sternberg)

Plate XLV, figure 3; Plate XLVII, figure 4

Asterophyllites grandis Bell, Geol. Surv., Canada, Mem. 215, p. 104, Pl. 67, fig. 5; Pl. 69, fig. 4; Pl. 70, figs. 3, 4; Pl. 72, figs. 1-4; Pl. 74, fig. 5; Pl. 75, fig. 1 (1938).

Remarks. Rather rare specimens of finer branches occur in collections from the Pictou group of New Brunswick. Specimen No. 937 (Pl. XLV, fig. 3) has internodes about 5 mm long and 1 mm broad. The nodes bear ascending, sickle-shaped, uninerved, apically pointed filiform leaves that rise to heights a little beyond the next node above; seemingly eight or more were attached at a nodal line, although the specimen shows only a pair along a plane of bedding. Specimen No. 938 (Pl. XLVII, fig. 4) on the reverse side of same rock fragment, with somewhat shorter internodes, shows three or four leaflets on each side of the axis — the total number probably was ten.

Occurrence. Clifton formation, locality 5430; Pictou group (undifferentiated), locality 5353.

Types. Hypotypes, GSC Nos. 937, 938.

Asterophyllites longifolius (Sternberg)

Plate XLV, figure 1

Asterophyllites longifolius Bell, Geol. Surv., Canada, Mem. 215, p. 86, Pl. 92, fig. 5 (1938).
Asterophyllites longifolius forma *striata* Bell, Geol. Surv., Canada, Mem. 225, p. 28, Pl. 3, fig. 5 (1940).

Remarks. To this comprehensive species the writer refers a form occurring very rarely in the Pictou group of New Brunswick. The leaves are up to 5 cm long by 1.5

mm broad, rather rigid, and have a strong midrib that forms a low carina as in *A. longifolius* forma *rigida* (Weiss, 1884, p. 192, Pl. 20, fig. 3). The specimens are not sufficiently well preserved to merit detailed description.

Occurrence. Minto formation, locality 856; Pictou group (undifferentiated), locality 5025.

Types. Hypotype, GSC No. 839.

Annularia stellata (Schlotheim) forma *mucronata*

Annularia stellata forma *mucronata* Bell, Geol. Surv., Canada, Mem. 215, p. 85, Pl. 89; Pl. 90, figs. 1-2; Pl. 91, fig. 1 (1938).

Remarks. A single specimen occurs in a collection from Pollett River area. It represents a small fragment of forma *mucronata,* and for description of the species the reader is referred to the reference above.

Occurrence. Pictou group (undifferentiated), locality 1434.

Types. Hypotype, GSC No. 982.

Annularia pseudostellata Potonié

Plate XLV, figures 2, 5; Plate XLVII, figures 2, 3

Remarks. Potonié (1899, p. 200, fig. 196) made no mention of the occurrence of small hairs, such as he noted on specimens of *A. stellata.* Yet certain Minto forms are considered to be conspecific with his *A. pseudostellata.* They differ in the same way from *A. stellata* in possessing narrower leaves, which have straight almost parallel sides and which rarely exceed sixteen to a whorl. Like *A. stellata,* they are provided abundantly, on one side at least, with small hairs, mainly divided. On the leaves, the hairs lie generally transverse to the midrib, and are seldom seen projecting into the containing rock. Seemingly they spring mainly from the midvein; their penetration into the rock can only be seen with a hand lens. The leaves are generally not more than 20 mm long and 1 mm wide, but may reach a length of 25 mm or more and a width of 1.5 mm. Their apical ends are most commonly buried in the enclosing rock, but where exposed they appear to contract abruptly to a short sharp point. They contract little if at all at the base, where they are attached to a very narrow collar around the stem. The midrib is thick relative to the width of the leaves, and has microscopic longitudinal striations. The lateral leaves of a whorl appear to be longer than the others, although the general appearance of many of the smaller whorls is more like *A. radiata* than *A. stellata.* The number to a whorl, commonly twelve to sixteen, is intermediate between that of these two species.

A. pseudostellata may well be a descendant of *A. acicularis* (Dawson), which occurs in the earlier Cumberland and Riversdale groups, the former being differentiated mainly by its leaves of greater length.

Occurrence. Minto formation, localities 856, 945, 947, 979, 990, 1000, 1019, 3859; Clifton formation, locality 1172; Pictou group (undifferentiated), locality 5027.

Types. Hypotypes, GSC Nos. 835, 836, 837, 838.

Annularia sphenophylloides (Zenker)

Plate XLIV, figure 7

Annularia sphenophylloides Dawson, Acadian Geology, 2nd ed., p. 444, Figs. B, B1, p. 479 (1868).

Annularia sphenophylloides Bell, Geol. Surv., Canada, Mem. 215, p. 84, Pl. 85, fig. 3, Pl. 87, fig. 1 (1938); Mem. 225, p. 129 (1940).

Annularia sphenophylloides Radforth and Walton, Senckenbergiana Lethaea, vol. 41, p. 102, Pl. 4, fig. 15 (1960).

Remarks. This readily identifiable species, is common in the Pictou group. Zeiller (1888, p. 390) noted that in well-preserved specimens from Valenciennes, the surface of the leaves seen under a lens was marked by what appeared to be very fine hairs, which diverged from the median nerve towards the leaf borders, but that this might be owing to the epidermal cellular structure. In specimens from Minto, hairs, 0.25 to 0.5 mm long, may be seen actually projecting from leaf-bearing stems into the enclosing rock. It is probable, therefore, that the leaves, which have a strong appearance of villosity similar in nature to that described by Zeiller, are actually villous, and that the hairs are mainly, if not wholly, attached to their midribs.

Occurrence. Minto formation, localities 948, 1020, 1100; Clifton formation, locality 1172.

Types. Hypotype, GSC No. 840.

Macrostachya sp.

Plate XLV, figure 4; Plate XLVII, figure 1

Remarks. Cone, cylindrical, of unknown length but more than 7 cm and width about 1.5 cm. Axis of cone slender, about 1 mm broad; internodes short, commonly 4 or 5 mm. Leaves united at base into a complete collar for about 3 mm, beyond which free ends, about 5 mm long, ascend by broad upward curve or more abruptly, and, if so, appearing subfalcate; they are widest (about 1.5 mm) at base at union with collar, lanceolate, acutely pointed. Collar is regularly creased radially, seemingly along junctions of united leaves; in some specimens it appears adpressed to stems, but probably this results from compression from an original oblique attitude. In specimen No. 832 (Pl. XLVII, fig. 1), probably a more mature cone than No. 833 (Pl. XLV, fig. 4), the collars are spread out first almost at right angles to axis then deflected somewhat downwards and there may be a narrow funnel-shaped depression in axial region. Positions of attachment of sporangia not revealed, but on account of lack of visible scars on central region of internodes, may have been in axial region of united leaves — corresponding to their positions in *Palaeostachya.* The form may be compared with *Macrostachya infundibuliformis* (Brongniart) and with *Huttonia spicata* Sternberg.

Occurrence. Clifton formation, locality 1172.

Types. GSC Nos. 832, 833.

Lepidodendron pictoense Dawson

Plate XLVI; Plate XLIX, figures 1, 3; Plate L, figures 1, 2, 3

Lepidodendron pictoense Dawson, Canadian Naturalist, vol. 8, p. 449 (1863); Acadian Geology, 2nd ed., pp. 454, 487, Figs. 169A-A7 (1868).

Lepidodendron lycopodioides Bell, Geol. Surv., Canada, Mem. 215, p. 93, Pl. 96, figs. 2, 3; Pl. 97, figs. 1-3 (1938).

Lepidodendron lanceolatum Bell, Geol. Surv., Canada, Mem. 225, p. 122 (1940).

Lepidodendron lanceolatum Bell, Geol. Surv., Canada, Mem. 238, p. 88, Pl. 48, fig. 3 (1944).

Original description. "Areoles (cushions) contiguous, prominent, separated in young stems by a narrow line, long oval, acuminate, breadth to length as 1 to 3 or less, lower half obliquely wrinkled, especially at one side. Middle line indistinct. Leaf scar at upper end of areole, small, triangular, with traces of three vascular points nearly confluent. Length of areole about 0.5 inch.

"Leaves contracted at base, widening slightly and gradually contracting to a point, ribs three, central distinct, lateral obscure, length 1 inch.

"Cones borne on sides (sic) of smaller branches, small, oval, obscurely scaly."

Emended description. Leafy shoots, branching at acute angles. Leaf cushions, contiguous, separated in smaller stems only by narrow shallow furrows, elongated rhombic to fusiform, commonly about four times as high as wide; lateral angles obtuse or commonly the lateral sides are broadly rounded; upper and lower angles acute. Leaf scar represented in upper half of cushion by two elevated lines which terminate downwards at margin at lateral angles, or about middle of margin in laterally rounded cushions, and upwards in an acute angle, which may have an ill-defined punctiform pit when well preserved. Upper field smooth or marked by an indistinct ligular pit about 1 mm above summit of leaf scar or about halfway from leaf scar to upper end of cushion. Rarely the ligular scar lies at summit of indistinct raised lines forming a second but minute triangle. Lower field for several millimetres below leaf scar has a well-defined median carina; remainder of field generally smooth or with a few inconspicuous, short, transverse bars or wrinkles in line or nearly so with that of the median carina above. Leaves 10 to 25 mm long by 1.5 to 3 mm wide, depending upon size of stem, uninerved, with a bordering channel on each side of a comparatively thick midvein, curved slightly S-shape close to strongly ascending base, owing to subsequent ascent commonly at about 45 degrees angle, fairly straight, or more generally slightly curved, in upper half to acuminate tip, occasionally resulting in a subfalcate appearance.

Remarks. The first figures of the species were presented by Dawson in 1868 (above reference). Although poor, Figure A3 shows the obliquely spreading leaves, which are about 15 mm long; the stem bearing these leaves is about 3 mm wide, and an enlarged leaf shows that its greatest breadth lies above the base, and that the tip is acuminate. Figure A shows a leafy stem with visible leaf cushions, one of which enlarged in Figure A5 is fusiform, with rounded lateral sides, and has a raised triangular leaf scar in its upper one quarter. This triangular area, however, is very inadequately portrayed. In a slightly emended description of the species Dawson (1868, p. 487) stated that oblong cones were borne at the extremities (not the sides) of smaller branches, and that the species resembled *Lepidodendron elegans*.

In making use of Dawson's name for the species from Clifton and elsewhere from the Pictou group, the writer is aware that Dawson's description and figures are inadequate for satisfactory diagnosis, and fall short of those provided later by Lesquereux for *L. lanceolatum*. The types of Lesquereux are considered by the writer to be conspecific with Dawson's species. Yet the identification of *L. lanceolatum* by European workers as well as by Arnold has given rise to uncertainty as to its relations with *L. lycopodioides* Sternberg (in part = *L. selaginoides* Sternberg and in part *L. simile* Kidston and *L. acutum* Presl). Nemejc (1947, p. 66), for instance, considered *L. lanceolatum* D. White, *L. lanceolatum* Arber and *L. lanceolatum* Crookall all to be conspecific with *L. acutum* Presl. A specimen from the Michigan coalfield assigned by Arnold (1949, Pl. 5) to *L. lanceolatum* belongs to *L. acutum* as the latter species is interpreted by Němejc, for it bears leaves at least 4 cm long on a stem about 2 cm wide. Rarely do the leaves on Dawson's species, even on larger stems, exceed 2.5 cm long and 3 mm wide. Nemejc contended that length and breadth of the leaves was the only safe method of differentiating between *L. acutum* and *L. simile* Kidston, the leaves of the former species being broader and reaching lengths of 3 to 7 cm, as compared with 1.2 to 2 cm in *L. simile*. Normally the leaves of *L. pictoense* are 1 to 2.5 cm long by 1.5 to 3 mm broad, depending upon size of the stem. These dimensions agree very well with those of *L. lanceolatum* as originally defined by Lesquereux (1880, p. 369) and also with *L. lanceolatum* Crookall (1929, Pl. 4, fig. b). The only significant difference between the leaves of one of the type specimens of *L. lanceolatum* and those of *L. pictoense* is the generally less-spreading disposition of the latter. The writer does not regard this as a character of specific importance and a specimen of *pictoense* with more spreading leaves is figured (Pl. L, fig. 2). An example of variation in degree of spreading of leaves on a single specimen may be seen in a specimen assigned by Zeiller (1886, Pl. 70) to *L. lycopodioides* (= *L. simile* Kidston).

Occurrence. Clifton formation, localities 1172, 1196, 5477.

Types. Hypotypes, GSC Nos. 804-808 inclusive.

Lepidodendron bretonense Bell

Plate XLVII, figures 5, 6; Plate XLVIII, figures 4, 6; Plate XLIX, figure 2

?*Lepidodendron plicatum* Dawson, Acadian Geology, p. 488, fig. 169E (1868).

Lepidodendron dichotomum var. *bretonensis* Bell, Geol. Surv., Canada, Mem. 215, p. 92, Pl. 95, figs. 5-6; Pl. 96, fig. 1; Pl. 97, fig. 4 (1938). Geol. Surv., Canada, Mem. 238, p. 89, Pl. 45, fig. 3 (1944).

Lepidodendron dichotomum Bell, Geol Surv., Canada, Memoir 225, p. 122, Pl. 7, fig. 4 (1940).

Remarks. Specimens from Minto agree closely with those from Sydney. In young specimens with rhomboid to napiform leaf cushions the leaf scars, which lie slightly above midheight of a cushion, occupy about four-fifths of its width, and that part (upper field) of a cushion lying above leaf scar is slightly vaulted. In these young cushions the lower field is marked more commonly by a median keel — although this is fretted with gashes or wrinkles — than in older cushions where a comparable transverse ornamentation alone is generally prevalent. Lines descending slightly from lateral angles of a leaf scar to meet lateral margins of a cushion about midlength occur rarely, and transpiration scars below the leaf scars are lacking. The upper acute ends of the leaf cushions are straight, the lower ends are more commonly slightly curved and meet the upper ends of the cushion lying nearly vertically below. In old stems the cushions are elongate-fusiform and separated by strips of longitudinally wrinkled 'bark' up to 5 cm or more wide.

The species differs from *Lepidodendron loricatum* Arber (1923, p. 201, Pl. 13, figs. 27-37) (= *L. subdichotomum* Presl) in that the line of vascular and parichnos scars lies in the lower half of a leaf scar as in *L. obovatum,* in the prevalence of transverse wrinkles on the cushions and common obsolescence of median keels.

Occurrence. Minto formation, localities 856, 857, 948, 977, 978, 979, 990, 1017, 1020, 1079, 1093, 1100, 1120, 1130; Clifton formation, locality 1172; Pictou group (undifferentiated), localities 5025, 5353.

Types. Hypotypes, GSC Nos. 803, 809-812 inclusive.

Lepidostrobus mintoensis Wilson

Lepidostrobus mintoensis Wilson, Geol. Surv., Canada, Mus. Bull. No. 1, p. 90, Pl. 9, figs. 3, 4, 5 (1913).

Lepidostrobophyllum triangulare Bell (*non* Zeiller), Geol. Surv., Canada, Mem. 215, p. 95, Pl. 97, figs. 5, 6 (1938); Mem. 225, p. 127 (1940).

Remarks. Cone, cylindrical, rounded, truncate at apex without other contraction, up to 7 cm or more long by 3 or 4 cm wide. Crowded laminae of sporophylls spread at open angles from central area of compressed proximal ends (or pedicels) of sporophylls that are cuneate and at least 5 mm long; sides straight, apex acute; midvein, strong in lower half, gradually thinning to apex. The cones with their obliquely ascending lanceolate sporophylls resemble those of *Lepidostrobus ovatifolius* Lesquereux (1870, Pl. 30, fig. 2; Janssen, 1940, Pl. 9, fig. 5), but do not contract to narrow apex and the laminae of sporophylls are more acuminate.

Isolated sporophylls are common, comprising a lamina, 12 to 15 mm long by 11 to 13 mm wide at union with pedicels. Basal angles of laminae rounded, the junction with pedicels being nearly a straight or slightly curved fold, without auricular or angular dilations of lamina. Pedicels triangular, nearly as wide as lamina at junction, and almost as long as greatest width; each pedicel consists of a narrow raised and keeled central area, which appears elevated on underside of pedicel, the flatter peripheral area being commonly buried in rock matrix, giving a false hastate appearance to sporophyll as a whole.

The species differs from *Lepidophyllum triangulare* Zeiller (1886, Pl. 77, figs. 4-6; 1888, p. 508) (= *Lepidostrobophyllum triangulare*) in the shorter and narrower pedicels of the sporophylls relative to the blades, as well as in the lack of angular basal edges of the laminae that in *triangulare* project to some extent obliquely downward.

Association of *Lepidostrobus mintoensis* with *Lepidodendron bretonense* at Minto suggests that the former may be cones of the latter.

Occurrence. Minto formation, localities 856, 857, 945, 978, 979, 990, 1019, 1020, 1028, 1038, 1042, 1120, 1130; Clifton formation, locality 4983; Pictou group (undifferentiated), locality 5025.

Types. Holotype, GSC No. 7544; paratypes, GSC Nos. 7545, 7545a, 7545b, 7545c; hypotype, GSC No. 818.

Lepidostrobophyllum majus (Brongniart)

Plate XLVIII, figure 5

Lepidostrobophyllum majus Bell, Geol. Surv., Canada, Mem. 238, p. 96, Pl. 53, fig. 3 (1944).

Remarks. Blade of leaf has greatest width, about 1.5 cm, near middle, contracts gradually to an acuminate apex, and to a truncate base, about 1 cm wide. The pedicel is missing from the two specimens occurring in collections from Minto. The midrib, about 2 mm wide, is bounded on each side by low rounded ridges; surface, otherwise macroscopically smooth. Length of blade, about 10 cm.

Occurrence. Minto formation, localities 990, 1100.

Types. Hypotype GSC No. 956.

Sigillaria tessellata (Steinhauer)

Plate LI, figure 4

Sigillaria bretonensis Dawson, Acadian Geology, 2nd ed., p. 475, fig. 161F (1868).
Sigillaria eminens Dawson, Acadian Geology, 2nd ed., p. 475, fig. 161H (1868).
Sigillaria tessellata Bell, Geol. Surv., Canada, Mem. 215, p. 98, Pl. 100, fig. 2 (1938).
Sigillaria tessellata var. *eminens* Bell, Geol. Surv., Canada, Mem. 215, p. 98, Pl. 100, figs. 1, 3; Pl. 101, figs. 1, 2 (1938).

Remarks. The ribs are 9 to 25 mm wide, depending upon age of stem, smooth except for an extremely fine, microscopic, shagreen appearance, separated by straight, narrow furrows. Leaf cushions, occupying one- to two-thirds width of ribs, from 2 to 12 mm apart, almost flush with surface of ribs, 5 to 8 mm high and generally nearly as wide or slightly wider; greatest width about one-third distance from base; upper border rounded, lateral angles obtuse, blunted or more rounded; inferior angles well rounded to truncated and straight, rarely slightly emarginate, basal border. Vascular scars situated in line about seven-tenths height of cushion from base, the central vascular scar transverse and slightly lunate, the parichnos scars, about 2 mm apart, elongated vertically. A transverse furrow, commonly not conspicuous, about as long as a cushion is wide, occurs on ribs about midway to next cushion above. Subepidermal surface (*Syringodendron* condition) marked by vertical rather coarse striae, about 0.5 mm apart, which anastomose at distant intervals (1 cm or more), and by leaf scars in form of two contiguous, elliptical areas up to 3 mm long by 1.5 mm wide, which represent the parichnos scars.

Specimen No. 795 (Pl. LI, fig. 4) shows part of a transverse band, in each of the widened furrows of which is a vertical row of contiguous irregularly elongate scars, representing according to Zeiller scars of attachment of cones. On the intervening narrowed ribs the cushions are subelliptical and up to twice as long as wide.

One of the specimens from same horizon as No. 795 reveals a fine wrinkled external surface of both ribs and leaf cushions, similar to surface wrinkling on some specimens of *Sigillaria tessellata* var. *eminens* Dawson (Bell, 1938, p. 98, Pl. 101, fig. 2). This is considered by the writer to be due to fossilization and is not to be regarded as a specific character. It differs from the discontinuous coarse surface lineation of *Sigillaria lorwayana* Dawson.

Occurrence. Minto formation, localities 977, 990.

Types. Hypotype, GSC No. 795.

Stigmaria ficoides (Sternberg)

Stigmaria ficoides Bell, Geol. Surv., Canada, Mem. 215, p. 103, Pl. 105, fig. 8 (1938).

Remarks. This fossil species is so ubiquitous, particularly in the pavement siltstones and mudstones of the coal seams, that it is rarely considered worth collecting. Nevertheless, a number of specimens, some with roots attached, were found in collections from Minto, and are noted here as a matter of record.

Occurrence. Minto fomation, localities 1020, 1028.

Types. Hypotype, GSC No. 842.

Asolanus camptotaenia Wood

Plate XLVIII, figures 1-3

Asolanus camptotaenia Bell, Geol. Surv., Canada, Mem. 215, p. 102, Pl. 104, figs. 1-3 (1938).

Description. Surface of stems marked with slightly elevated rounded-rhomboidal leaf cushions arranged in spiral rows. Areas between cushions, at least immediate subepidermal layer, ornamented by rather coarse, longitudinal, discontinuous striae that converge somewhat above leaf cushions and diverge slightly from basal part of cushions. Cushions outside of leaf scar macroscopically smooth, microscopically striated vertically. Leaf scar well marked, rhomboidal, occupying the whole width and most of upper half of cushions, with lateral angles acute and upper and lower corners well rounded, the upper more broadly than the lower, about twice as broad as high (6 x 3 mm); the upper margin has an inconspicuous minute central notch, but is rarely seen. Upper half of leaf cushion contains a circular scar, about 1¼ mm diameter, which has within it at or close to its upper margin a punctiform scar, about one-quarter mm diameter.

It may be significant that *Asolanus camptotaenia* occurs in same bed as *Gymnostrobus wilsoni.*

Occurrence. Pictou group (undifferentiated), localities 1076, 1434, 3859, 5353.

Types. Hypotypes, GSC Nos. 797, 802, 978.

Gymnostrobus wilsoni n. sp.

Plate LI, figure 2; Plate LIII, figure 3; Plate LV, figures 3-5

Description. Axis large, well over 5 cm wide; surface with microscopic, shagreen-like roughness, marked by spirally arranged oval scars, 3 or 4 mm long by 1.5 to 2 mm broad, 6 or 7 mm apart on a spiral row, and transverse distance between rows from 5 to 10 mm. Adjacent to, or touching one end of scars are rather ill-defined, slightly raised, horizontal lines appearing as narrow elevations or depressions depending upon whether surface is cast or mould, about 5 or 6 mm long, commonly slightly concave downwards, unless sporophylls are pendant. Attached to axis are oblique to transversely inserted, foliar organs, considered by writer to be sporophylls; they are subrectangular, up to 3 cm or somewhat more long and 12 mm broad, rounded truncate at apex, furnished with thick cord-like midrib which terminates bluntly about 3 mm from apical border. At base the midvein is traceable to an inflection of the blade analogous to that in basal part of *Lepidostrobophyllum.* Transverse to the midrib the lamina has very fine microscopic lines, after each of which is a row of more or less equidimensional cells.

Remarks. From the same beds as the holotype described above, are imprints of sporangia-like sacs (Pl. LV, fig. 4) 15 mm long and 10 mm wide or larger and approaching size of the supposed sporophylls, but differing from the last mentioned in lack of any trace of midrib. Microscopically they exhibit a network of cells resembling the microscopic ornamentation of the sporophylls.

Gymnostrobus wilsoni is probably identical with, or very close to one specimen figured by Lesquereux (1884, pp. 781, 782, Pl. 105, fig. 1, *non* figs. 2-4) and also with a specimen considered earlier by Lesquereux (1879, text p. 428, Atlas Pl. 68, fig. 6) to be a cone of *Lepidophloios.* The writer considers that the figure of this latter specimen should be oriented by turning it 90 degrees to the left, so that the scars are elongated vertically, whereby the sporophylls would be inserted obliquely to transversely. The axis therefore, like that of specimen No. 797 (Pl. LIII, fig. 3) is like that of *Asolanus camptotaenia* which occurs in the same beds at Beersville; *G. wilsoni* may possibly belong to that species.

Specimen No. 934 (Pl. LI, fig. 2) is a slightly crushed and torn sporangium, which contains a cluster of trilete circular spores, each about 1 mm diameter. Under a binocular, the walls of the sporangium and the spores themselves have a microscopic surface ornamentation similar to that described above.

The species is named after its collector, W. J. Wilson, one time palæobotanist of Geological Survey of Canada.

Occurrence. Pictou group (undifferentiated) localities 963 (1076), 5353.

Types. Holotype, GSC No. 796; paratypes, GSC Nos. 798, 799, 800, 801, 934.

Saportaea dispar (Dawson) n. comb.

Plate LV, figure 1

Noeggerathea dispar Dawson, Acadian Geology, 2nd ed., p. 480, fig. 73 (p. 244), (1868).

Original description. "A remarkable fragment of a leaf, with a petiole nearly three inches long, and a fourth of an inch wide, spreading abruptly into a lamina, one side of which is much broader than the other, and with parallel veins running up directly from the margin as from a marginal rib. It appears to be doubled at both edges, and is abruptly broken off."

Remarks. The petiole, which merges with the lamina, is 5.7 cm long by about 8 mm wide at top, slightly less at base. It bears close longitudinal striae, and the greater part on right side of specimen merges into a similar striated thick band at basal edge of lamina by means of a broadly rounded 120 degree curve. This band decreases slightly within a distance of 6 cm to a broken end. The left margin of the leaf lacks a comparable basal band of tissue, and the striae curve fanwise directly from the top of the petiole at angle of about 150 degrees. The lamina, although lacking a summit, is wedge-shaped, the two sides making an angle of about 115 degrees. It is marked by submicroscopic striae that in part may represent hypodermal strands. At the inner border of the basal band on right side of leaf, the striae are given off decurrently, but curve to a position transverse to it; here under a binocular they can be differentiated into striae about 0.5 mm apart, which have intervening weaker striae between them. Over a large part of the lamina, however, striae (about three per millimetre) show for the most part little or no differentiation in strength. Dichotomies of the striae were noted in places. The slits in the upper part of the lamina are apparently accidental. The more heavily marked striae in Dawson's figure are only folds in the lamina.

The species resembles in many characters *S. nervosa* Halle (1927, p. 194, Pl. 55, figs. 1-4), but differs in its greater asymmetry, wedge-shaped base, and in existence of a broader marginal band over the greater part of the leaf, which resembles, and merges into the petiole. The same differences separate it from the type species *S. grandifolia* Fontaine and White (1880, p. 101, Pl. 38, fig. 4) and from *S. salisburioides* Fontaine and White (ibid, Pl. 38, figs. 1-3), the latter being differentiated also by possession of a thin petiole.

Occurrence. Clifton formation, locality 1152.

Types. Holotype, GSC No. 4427.

Cordaites principalis (Germar)

Plate LV, figure 2

Cordaites borassifolius Dawson pars, Acadian Geology, 2nd ed., p. 490 (1868).
Cordaites robbi Dawson, Foss, Pl. Devon. Upp. Silur. Canada, Geol. Surv. Rept., pl. 14, fig. 156 (1871).
Cordaites principalis Stopes, Geol. Surv., Canada, Mem. 41, p. 84, Pl. 20, fig. 51; Pl. 21, fig. 53 (1914).
Cordaites principalis Bell, Geol. Surv., Canada, Mem. 215, p. 103, Pl. 105, fig. 1; Pl. 106, fig. 1 (1938); Mem. 225, p. 130 (1940); Mem. 238, p. 106 (1944).

Remarks. This species is very abundant in the Pictou group of Nova Scotia and New Brunswick. In addition, M. Stopes described and figured a specimen from the Cumberland group, where it is likewise abundant. The species is distinguishable from *Cordaites borassifolius* of the Cumberland group by the occurrence of commonly two or three, more rarely four or five, very fine striae between thicker, more prominent ones. The leaves, being so common and long, have not been extensively collected, but fragments up to 12 cm broad occur in collections from Minto. Specimen No. 979 (Pl. LV, fig. 2) is 7 cm broad at the top where the sides are still diverging.

Occurrence. Minto formation, localities 856, 945, 948, 990, 1042, 3859, 5090; Pictou group, localities 1434, 5025, 5027, 5245.

Types. Hypotype, GSC No. 979.

Cordaitanthus rhabdocarpi (Dawson) n. comb.

Plate LII, figures 1-3; Plate LIII, figure 1; Plate LIV

Antholithes rhabdocarpi Dawson, Acadian Geology, 2nd ed., p. 460 (Figs. B, B1); p. 477 (1868).

Original description. "Stem short, interruptly striate, with two rows of crowded ovate fruits (sic) and traces of floral leaves. Fruits half an inch long, striated longitudinally, attached by short peduncles."

Emended description. A cordaitean female strobilus, consisting of a linear, stout axis that bears two lateral rows of closely spaced, dwarf fertile shoots in axils of single linear bracts. Main axis is 20 cm or more long by 1 cm wide near basal end, contracting gradually at summit to a few millimetres, surface being marked by longitudinal striae. Bracts subtending the fertile shoots, up to 2 cm or more long by about 2 mm wide at locus of insertion, attached at right angle or nearly so to main axis, but curving gently and obliquely upward, about 1 cm apart.

The complex of a fertile shoot is 2 to 4 cm long, the basal leaves consisting of a few overlapping, ovate-triangular bracts 2.0 to 2.5 cm long by 1 cm wide near base, which is well rounded and contracted to a sessile attachment. The sides of the bracts contract to a bluntly pointed apex, and the surface is marked by close, microscopic striae. The sporophylls rise above the level of the bracts for 2 cm or more and comprise eight or more narrow, ribbon-like leaves or segments, 0.5 to 1 mm wide, which, like the bracts, are marked by microscopic striae; their apices are not revealed, but no contraction in widths or bifurcations was noted. Owing to compression and crowded conditions the character of the bases of the sporophylls is doubtful, and it is not known whether they are wholly free of attachment or consist of an unsegmented basal part and a distal laciniated one.

Remarks. The genus is transferred from *Cordaianthus* Grand'Eury to *Cordaitanthus* Feistmantel, owing to discovery by W. L. Fry (1955, pp. 486-490) that the latter has priority. The architecture of the strobilus is like that of *Cordaianthus pseudofluitans* Kidston emend. Florin (1939, pp. 547-551; 1944, pp. 462-466, Pls. 173, 174).

Specimen No. 946 (Pl. LII, fig. 1) shows part of an incomplete axis, 21 cm long, provided throughout with two lateral rows of fertile shoots. The exposed top is evidently near the original summit, for it has contracted to a width of about 2 mm. On this specimen most of the fertile shoots have broken ends and reveal only the basal tracts, but two or three show the narrow linear sporophylls rising above the level of the bracts; in specimen No. 945 (Pl. LIII, fig. 1; and Pl. LIV), all the shoots show the linear sporophylls. Specimen No. 950 (Pl. LVI, fig. 4) has a *Samaropsis cornuta* in the midst of the sporophylls, although unattached, and a second specimen (No. 951, Pl. LVI, fig. 3) of that species occurs near the strobilus on the same bedding plane. It is perhaps worthy of note that these two specimens of *S. cornuta* were the only two seen in collections from Minto, suggesting possibility that *S. cornuta* may be the seed of *Cordaitanthus rhabdocarpi*. Such a possibility is weakened by ubiquitous distribution of *S. cornuta* and rarity of *C. rhabdocarpi*.

C. rhabdocarpi is smaller in all its parts than either *C. pseudofluitans* or *C. pitcairniae* (Lindley and Hutton).

Occurrence. Minto formation, localities 857, 945, 990, 1020, 1130, 5074; Pictou group (undifferentiated), locality 5025.

Types. Hypotypes, GSC Nos. 945-949 inclusive.

Samaropsis cornuta (Dawson)

Plate LVI, figures 3, 4

Cardiocarpum cornutum Dawson, Quart. J. Geol. Soc. London, vol. 18, p. 324, Pl. 13, figs. 23, 24 (1862); Acad. Geol., 2nd ed., p. 55, fig. 194A (1868); Foss, Pl. Devon. and U. Silur. Canada, Geol. Surv., Canada, p. 60, Pl. 19, figs. 214-218 (1871); Geol. Hist. Plants, p. 82, fig. 31A (1888).

Cardiocarpon cornutum Stopes, Geol. Surv., Canada, Mem. 41, p. 89, Pl. 21, fig. 56; Pl. 22, figs. 58, 59; Pl. 23, figs. 60, 62 (1914).

?*Cardiocarpum fluitans* Dawson, Quart. J. Geol. Soc. London, vol. 22, p. 165; Pl. 12, fig. 74 (1866); Acad. Geol., 2nd ed., p. 460, fig. 173 I, p. 491 (1868).

Samaropsis cornuta Bell, Geol. Surv., Canada, Mem. 215, p. 104, Pl. 104, figs. 4, 5 (1938); Mem. 238, p. 107 (1944).

Remarks. This long-ranging species in the Pennsylvanian rocks of the Maritime provinces of Canada is rare in collections from Minto; two specimens from there were closely associated with *Cordaitanthus rhabdocarpi* (Dawson), and a third specimen from Pictou group of New Brunswick likewise occurred in close association with bracts of that species.

Occurrence. Minto formation, localities 945, 948, 1130, 5074.

Types. Hypotypes, GSC Nos. 950, 951.

Samaropsis bisecta (Dawson)

Plate LI, figure 3; Plate LVI, figure 5

Cardiocarpum bisectum Dawson, Acadian Geology, 2nd ed., p. 491, Fig. 173K (p. 460), (1868).

Original description. "Nucleus as in the last species *(Cardiocarpum fluitans),* but striate; margin widely notched at apex, and more narrowly notched below."

Emended description. Seed, winged, subelliptical, about 12 mm long by 7 mm wide; apical end of wing, deeply notched, opening into micropylar canal; nucellus pointed above, flask-shaped, about 8 mm long by 4 mm wide, with microscopic, irregular, longitudinal striae; base, deeply notched to base of nucellus; wing, about 2 mm broad at upper end, 1.5 mm in median part and to basal notch, longitudinally striated, and with light median keel.

Remarks. The seed is more elliptically elongate than *S. cornuta,* and more deeply notched at the basal end. Its apical end is not as abruptly constricted to a pronounced extension as in *S. ampullacea* Bell (1938, Pl. 104, figs. 6, 7), and the base is deeply emarginate.

Occurrence. Minto formation, locality 945.

Types. Hypotype, GSC No. 971.

Trigonocarpus? sp.

Plate LI, figure 1

Remarks. A seed of uncertain taxonomic position on account of its poorly preserved remains occurs at Minto. Specimen No. 952 (Pl. LI, fig. 1, right) is suboval, smooth except for very close microscopic longitudinal striae and doubtfully three-ribbed. The base is broadly rounded, and the apex converges to a narrowly rounded, seemingly somewhat extended apex. The total length is about 3 cm and greatest width 2 cm. Some specimens have the appearance of a crushed *Trigonocarpus,* with traces of ribs, and to this genus the species is questionably assigned. It may be compared with *Trigonocarpus ampullaeformis* Lesquereux (1884, p. 823, Pl. 109, figs. 18-21).

Occurrence. Minto formation, localities 857, 977.

Types. GSC Nos. 952, 953.

Radiospermum? sp.

Plate LIII, figures 2, 4

Remarks. Two imprints of remains of a seed having an elongate-elliptical outline occur in a collection from Napadogan map-area. The one specimen No. 954, is flat, 2.8 cm long by 1 cm wide, and marked by obscure longitudinal ribs in addition to longitudinal finer striae. Its base is well rounded and contracted to about 4 mm, whereas the apical end is bluntly pointed.

The second specimen, No. 955, represents probably not more than upper half of a seed. It is flatly convex and has eight very regular longitudinal ribs about 0.75 mm apart to a side of the seed. The apical end is again contracted to a blunt point, carrying about five costae. Longitudinal striae are lacking on this specimen, and, in view of the greater width and flatness of specimen 954, it is possible that the latter represents a striated cupule of a seed carrying ridges precisely like that of 955. If that be true, the seed was probably radiospermic, and specimen 955 owes a reduction of gibbosity to compression. It may be compared in outline and in ornamentation with *Radiospermum elongatum* Arber (1914, p. 101, Pl. 7, figs. 42, 43), which, however, is larger and provided with more distant costae.

Occurrence. Pictou group (undifferentiated), locality 5025.

Types. GSC Nos. 954, 955.

INDEX TO LOCALITY NUMBERS

(Catalogue numbers of Geological Survey, Canada)

817. Minto. Coll. (?)
856. Minto; King's mine. Coll. W. J. Wilson, 1910.
857. = 856
861. Minto; north fork, Newcastle Creek. Coll. W. S. Dyer, 1923.
945. Minto; Rothwell mine. Coll. W. J. Wilson, 1910.
946. = 945
947. = 856
948. = 856
963. Beersville. Coll. W. J. Wilson, 1910.
977. Minto; coal shaft of Minto Coal Co. Coll. W. S. Dyer, 1923.
978. Minto; Northfield Coal Co. mine. Coll. W. J. Wilson, 1909.
979. = 856
990. Minto; Rothwell coal mine. Coll. W. S. Dyer, 1923.
1000. = 856
1005. = 945
1017. = 856
1019. = 945
1020. Minto. Coll. W. J. Wilson, 1909.
1028. Minto; Gibbon's mine. Coll. W. J. Wilson, 1910.
1034. = 1020
1036. = 945
1037. Minto; Thurett's mine. Coll. W. J. Wilson, 1910.
1038. Minto; King's mine. Coll. W. J. Wilson, 1909.
1040. = 945
1042. = 856
1054. = 945
1061. = 945
1072. = Minto; Barne's mine. Coll. W. J. Wilson, 1910.
1076. = 963
1079. = 856
1091. = 1072
1093. = 1072
1099. = 1072
1100. Minto; Welton Henderson mine. Coll. W. S. Dyer, 1923.
1120. = 856
1130. Minto; Miramichi Lumber Co. mine. Coll. W. S. Dyer, 1923.
1144. Minto; Grand Lake Cal Company's mine. Coll. W. S. Dyer, 1923.
1152. Clifton. Coll. (?)
1171. Clifton; Cranberry Creek. Coll. W. E. Logan.
1172. Clifton., Coll. A. H. Foord, 1880.
1196. Clifton. Coll. (?)
1434. Near mouth of creek east of Pollett River, about ½ mile north of Pollett River village. Coll. W. A. Bell, 1936.

3408. = 1171

3859. Minto. Coll. J. E. Muller, 1948.

3983. Road-cut, Bathurst-Newcastle highway (route 8), just north of where Tabusintac River crosses road. Coll. J. D. McAlary, 1950.

4983. Clifton; shore section between red beds and small coal seam. Coll. L. M. Cumming, 1957.

5025. Napadogan map-area. Coll. W. H. Poole, 1957.

5026. Napadogan map-area; road-cut 300 ft. north of south boundary of map-area. Coll. W. H. Poole, 1957.

5027. Napadogan map-area; junction of highways on McCallum Brook. Coll. W. H. Poole, 1957.

5028. Burtt's Corner map-area, East Half, on McCallum Brook 0.3 mile above bridge on highway 8 and at coal prospect. Coll. W. H. Poole, 1957.

5029. Napadogan map-area; road-cut highway 8, 700 ft. south of Five Mile Brook bridge. Coll. W. H. Poole, 1957.

5030. Napadogan map-area; Cross Creek, 1,900 ft. above mouth. Coll. W. H. Poole, 1957.

5074. Minto; Newcastle Coal Co. mine, waste dump. Coll. D. C. McGregor, 1958.

5090. Minto; Avon Coal Mine. Coll. D. C. McGregor, 1958.

5093. Minto; Miramichi Coal Co. mine from waste dump. Coll. D. C. McGregor, 1958.

5095. Clifton; on beach. Coll. D. C. McGregor, 1958.

5245. Roof of 16-inch coal seam, south of Fredericton Junction. Coll. W. J. Wright, 1946.

5353. Beersville; from waste dump of mine on Mr. Glencross's property. Coll. D. C. McGregor, 1959.

5430. Clifton; from cliff above beach at old quarry between Clifton and Stonehaven; access road leaves highway on north side 14.3 miles east of junction of highways 8 and 11. Coll. D. C. McGregor, 1958.

5431. Tay Creek, about 5.6 miles south of Stanley. Coll. W. J. Wright, 1941.

5477. Quarry between Clifton and Stonehaven; about ½ mile east of Peter's store, north side of highway 11. Coll. D. C. McGregor, 1958.

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PLATES I to LVI

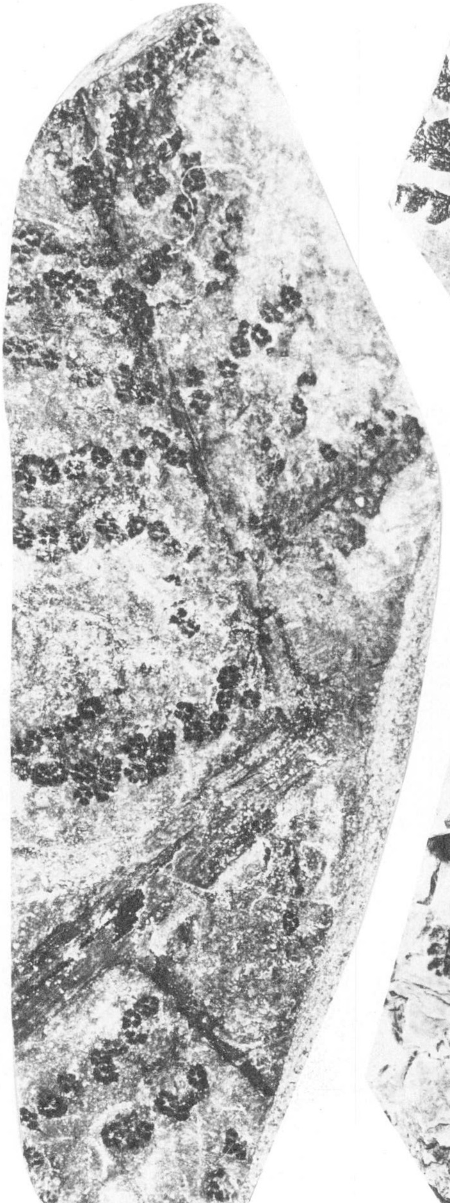
Plate I

Oligocarpia missouriensis D. White. (Page 16.)

Figure 1. Hypotype, No. 933 x6. Locality 856.
Figure 2. Hypotype, No. 980. Locality 3859.

Oligocarpia brongniarti Stur. (Page 15.)

Figure 3. Hypotype, No. 917. Locality 945.



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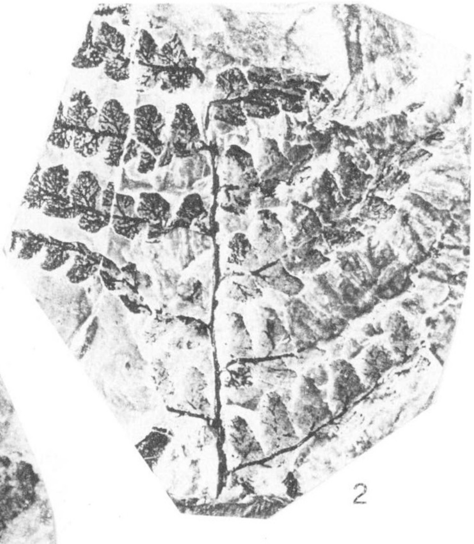

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PLATE II

Oligocarpia missouriensis D. White. (Page 16.)

Figure 1.	Hypotype, No. 914. Locality 4983.
Figure 2.	Hypotype, No. 913. Locality 1172.
Figure 3.	Hypotype, No. 915. Locality 4983.
Figure 4.	Hypotype, No. 618 (pars). Locality 1172.
Figure 5.	Hypotype, No. 885. Locality 1172.

PLATE II


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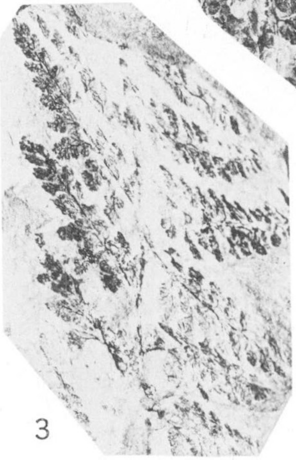
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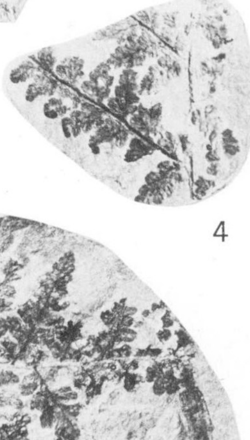
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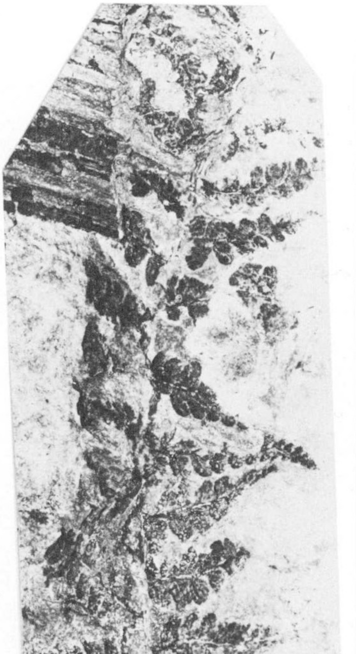
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PLATE III

Boweria schatzlarensis Kidston. (Page 17.)

Figure 1.	Hypotype, No. 924. Locality 1076.
Figure 2.	Hypotype, No. 923. Locality 963.
Figure 3.	Hypotype, No. 919 x5. Locality 963.

Oligocarpia missouriensis D. White. (Page 16.)

Figure 4.	Hypotype, No. 4451. Locality 1172.

Alethopteris davreuxi (Brongniart). (Page 37.)

Figure 5.	Hypotype, No. 861. Locality 963.

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PLATE IV

Boweria schatzlarensis Kidston. (Page 17.)

Figure 1. Hypotype, No. 922 x3. Locality 1076.
Figure 2. Hypotype, No. 921 x3. Locality 1076.

Oligocarpia missouriensis D. White. (Page 16.)

Figure 3. Hypotype, No. 618 x3 (*see* Pl. II, fig. 4). Locality 1172.

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PLATE V

Boweria schatzlarensis Kidston. (Page 17.)

Figure 1.	Hypotype, No. 920 x5. Locality 1076.

Crossotheca boulayi Zeiller. (Page 18.)

Figure 2.	Hypotype, No. 961 x3. Locality 5095.
Figure 3.	Hypotype, No. 960 x3. Locality 5095.

Boweria schatzlarensis Kidston. (Page 17.)

Figure 4.	Hypotype, No. 986 x3. Locality 963.

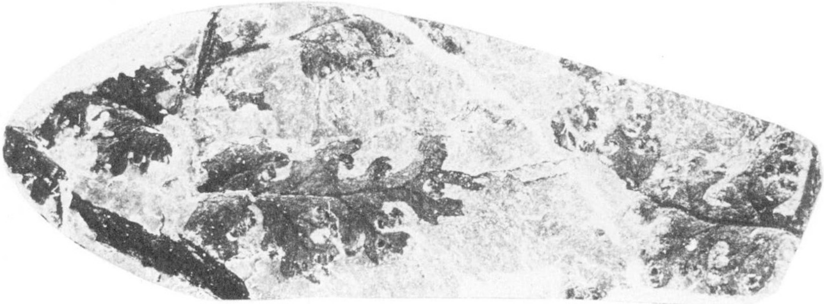

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PLATE VI

Boweria schatzlarensis Kidston. (Page 17.)

Figure 1.	Hypotype, No. 918 x3. Locality 963.
Figure 2.	Hypotype, No. 924 x2 (*see* Pl. III, fig. 1). Locality 1076.

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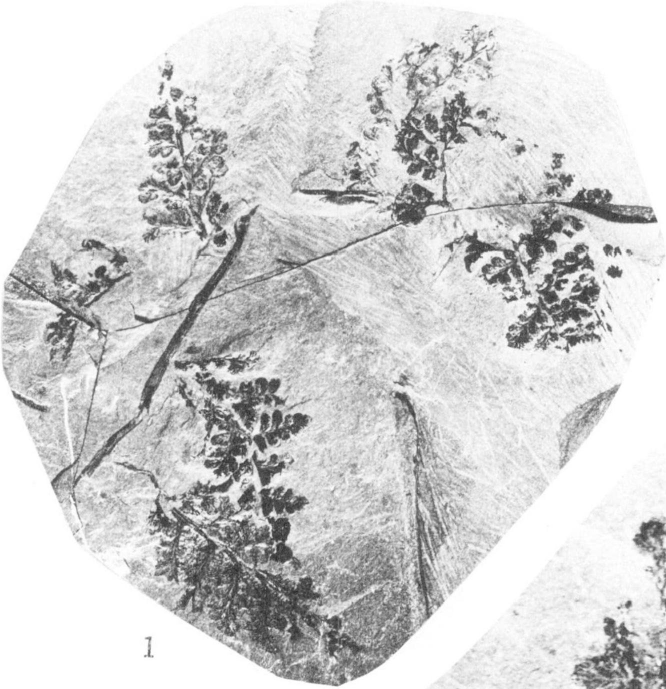
PLATE VII

Crossotheca boulayi Zeiller. (Page 18.)

Figure 1.	Hypotype, No. 962. Locality 1172.
Figure 2.	Hypotype, No. 962 (pars) x3. Locality 1172.



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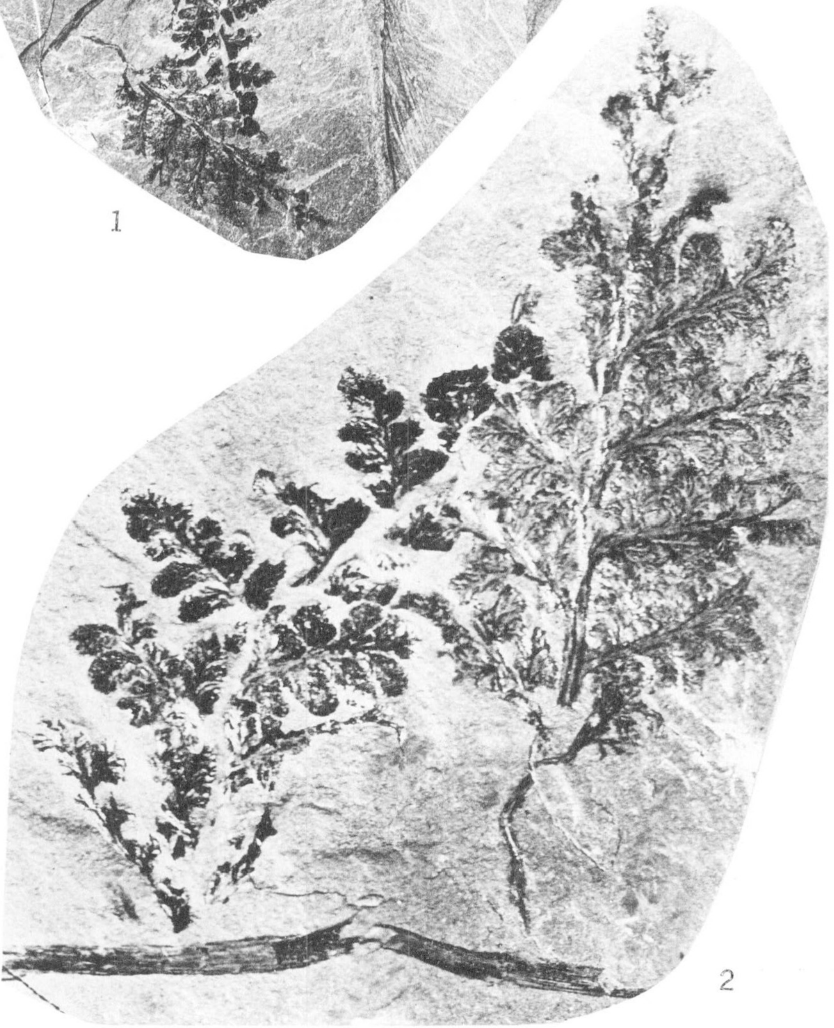

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PLATE VIII

Alloiopteris (Corynepteris) similis Sternberg. (Page 20.)

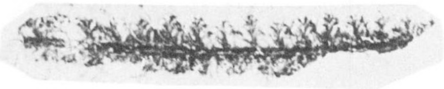
Figure 1. Hypotype, No. 983 x3. Locality 1076.

Myriotheca desaillyi Zeiller. (Page 19.)

Figure 2. Hypotype, No. 867 x10 (*see* Pl. LVI, fig. 6). Locality 3859.

Sphenopteris (Diplotmema) whitii Bell. (Page 21.)

Figure 3. Hypotype, No. 932. Locality 1172.



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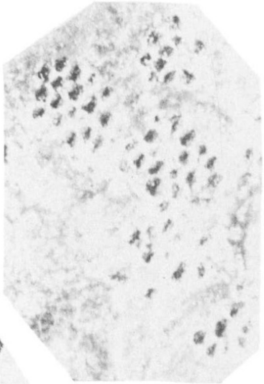

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PLATE IX

Sphenopteris hirticula n. sp. (Page 22.)

Figure 1. Paratype, No. 619. Locality 990.
Figure 2. Paratype, No. 619 x3. Locality 990.

Sphenopteris barbalata n. sp. (Page 22.)

Figure 3. Holotype, No. 928 (pars) x3. Locality 857.

Sphenopteris hirticula n. sp. (Page 22.)

Figure 4. Holotype, No. 886. Locality 990.

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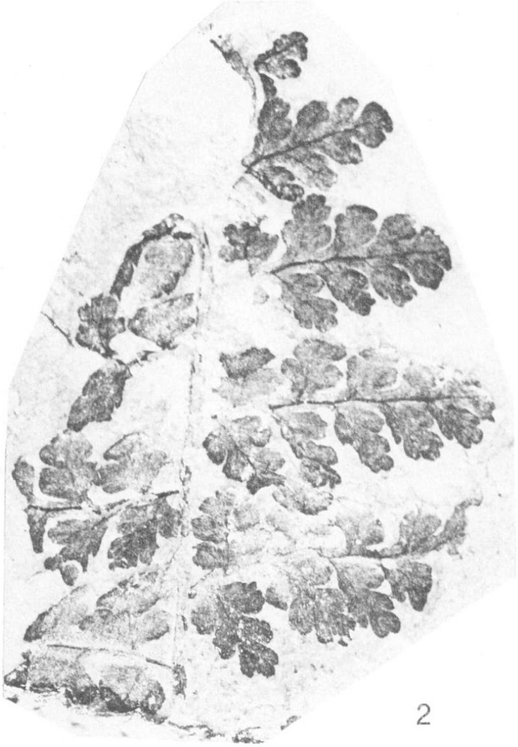

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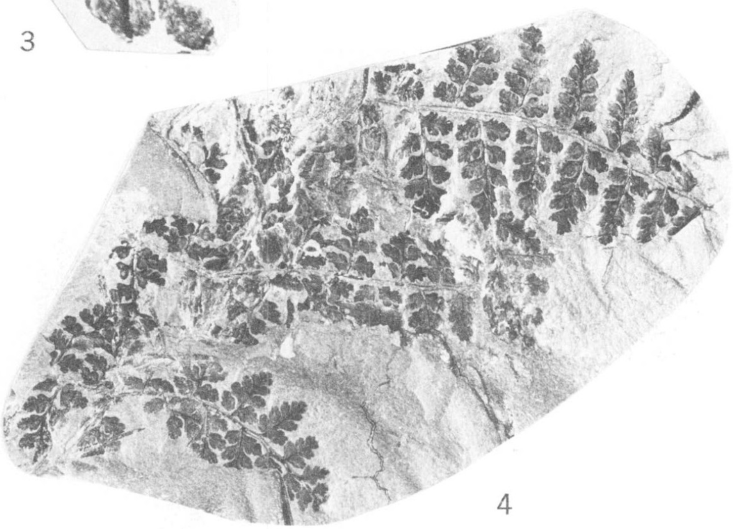

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PLATE X

Sphenopteris (Diplotmema) whitii Bell. (Page 21.)

Figure 1. Hypotype, No. 794. Locality 1172.

Sphenopteris barbalata n. sp. (Page 22.)

Figure 2. Holotype, No. 928. Locality 857.

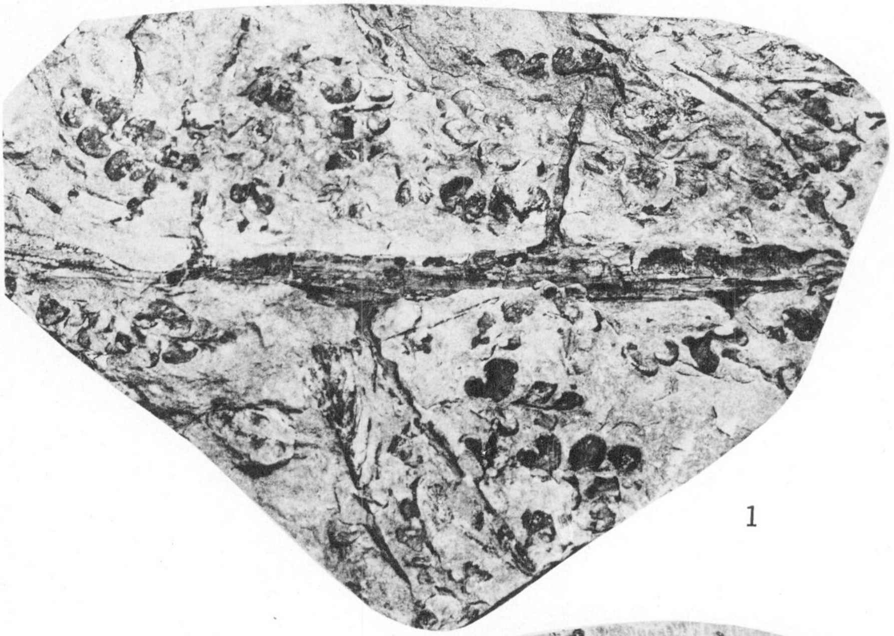

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PLATE XI

Sphenopteris pseudofurcata Kidston. (Page 23.)

Figure 1. Hypotype, No. 970 x3. Locality 945.

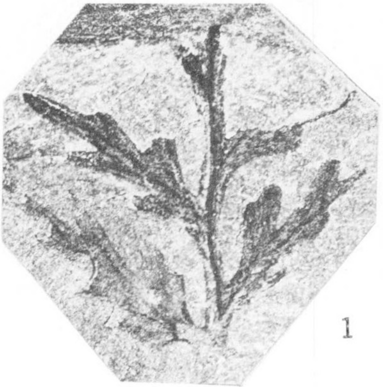
Sphenopteris spiniformis Kidston. (Page 24.)

Figure 2. Hypotype, No. 929. Locality 1172.

Sphenopteris pseudofurcata Kidston. (Page 23.)

Figure 3. Hypotype, No. 943, and *Asterophyllites longifolius* (Sternberg). Locality 5074.
Figure 4. Specimen 943 (*see* fig. 3) x3.
Figure 5. Hypotype, No. 944. Locality 5074.
Figure 6. Specimen 944 (*see* fig. 4) x3.

PLATE XI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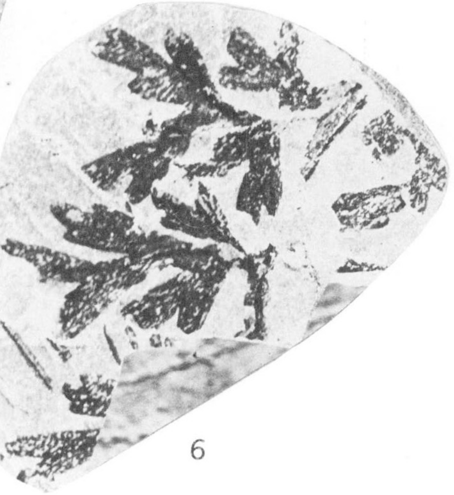
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PLATE XII

Sphenopteris spiniformis Kidston. (Page 24.)

Figure 1. Hypotype, No. 931. Locality 1172.

Sphenopteris sp. cf. *S. dufayi* Danzé. (Page 24.)

Figure 2. Specimen No. 936 x3. Locality 1196.

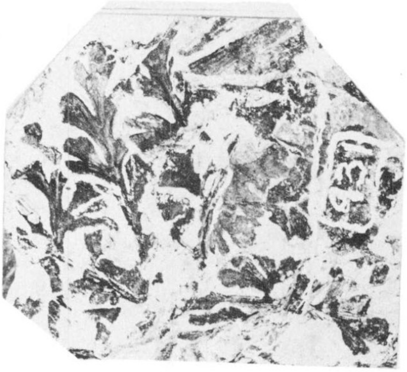

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PLATE XIII

Sphenopteris spiniformis Kidston. (Page 24.)

Figure 1. Hypotype, No. 930. Locality 1172.

Mariopteris hirta (Stur). (Page 29.)

Figure 2. Hypotype, No. 884. Locality 990.

Mariopteris latifolia (Brongniart). (Page 25.)

Figure 3. Hypotype, No. 866 x3. Locality 1020.

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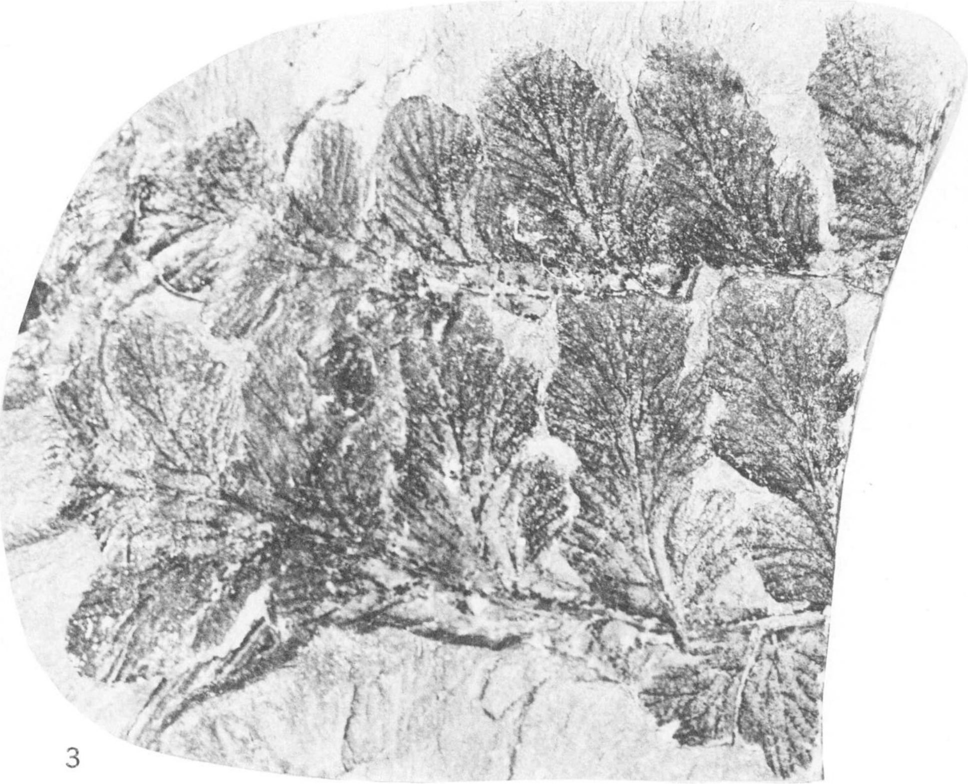

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PLATE XIV

Mariopteris ribeyroni (Zeiller). (Page 30.)

Figure 1. Hypotype, No. 982 x2. Locality 1434.

Mariopteris latifolia (Brongniart). (Page 25.)

Figure 2. Hypotype, No. 875 x2. Locality 1079.

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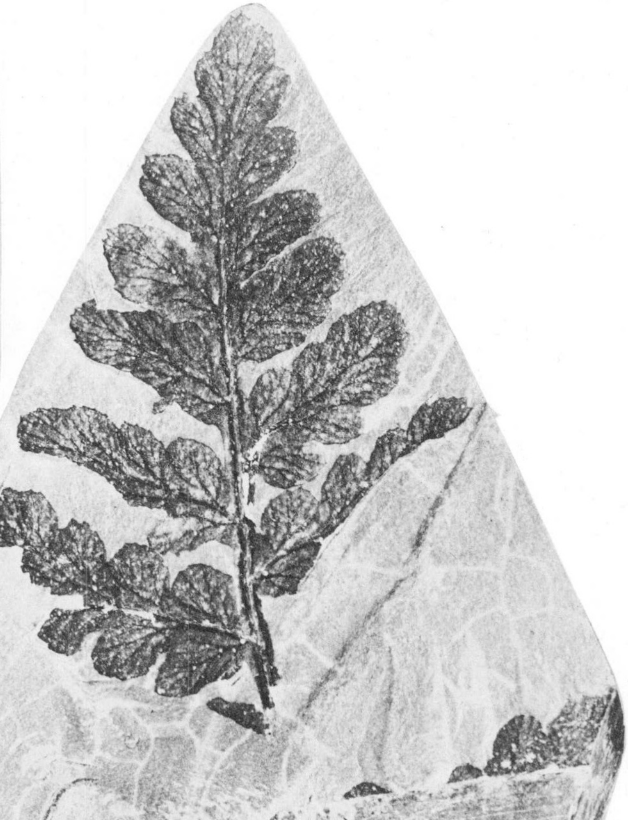

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PLATE XV

Mariopteris latifolia (Brongniart). (Page 25.)

Figure 1.	Hypotype, No. 872. Locality 1020.
Figure 2.	Hypotype, No. 873. Locality 990.

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PLATE XVI

Mariopteris carnosa Corsin. (Page 26.)

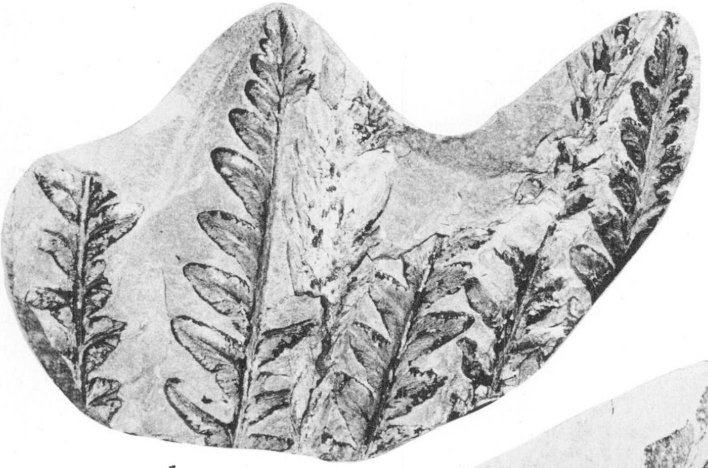
Figure 1. Hypotype, No. 969. Locality 3408.

Mariopteris latifolia (Brongniart). (Page 25.)

Figure 2. Hypotype, No. 874 x2. Locality 1100.

Mariopteris hirsuta Corsin. (Page 27.)

Figure 3. Hypotype, No. 871 x2. Locality 1196.



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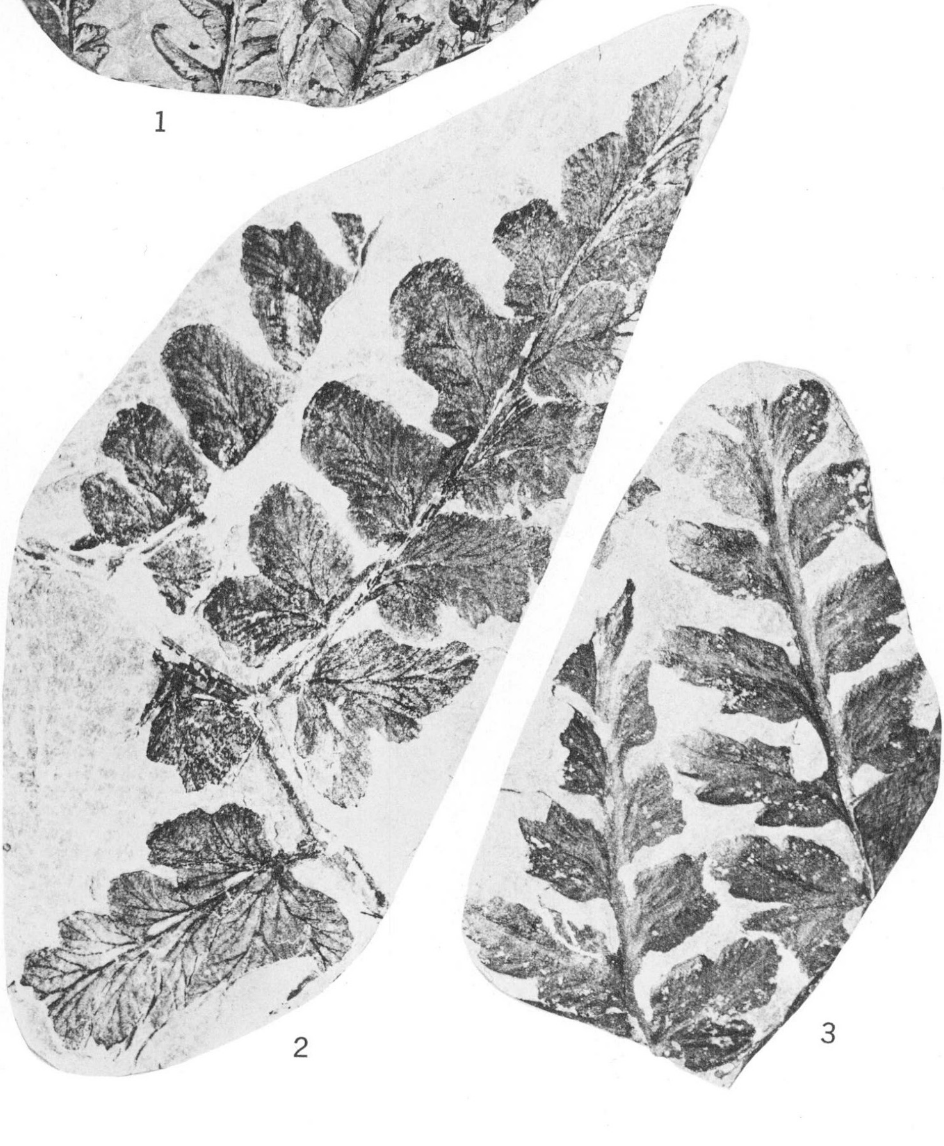

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PLATE XVII

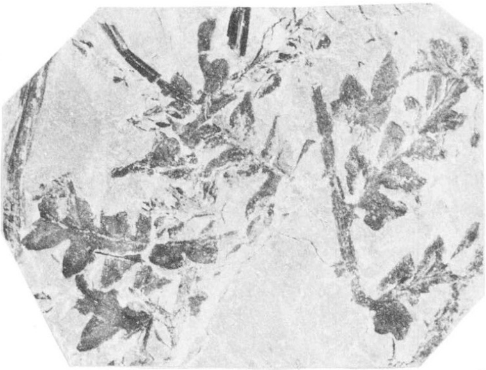
Mariopteris hirta (Stur). (Page 29.)

Figure 1. Hypotype, No. 880 x2. Locality 1020.

PLATE XVIII

Mariopteris hirta (Stur). (Page 29.)

Figure 1.	Hypotype, No. 883. Locality 978.
Figure 2.	Hypotype, No. 881 x3. Locality 978.
Figure 3.	Hypotype, No. 869 x2. Locality 1020.



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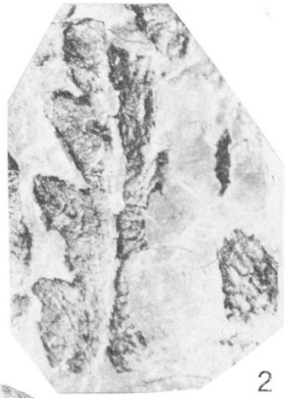

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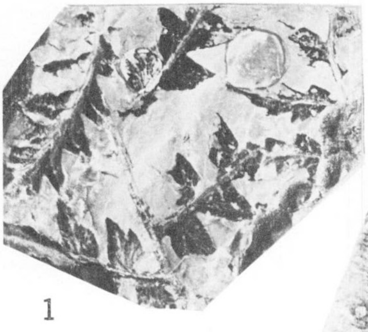
PLATE XIX

Mariopteris hirta (Stur). (Page 29.)

Figure 1. Hypotype, No. 882. Locality 990.
Figure 2. Hypotype, No. 878 x2. Locality 1020.

PLATE XIX



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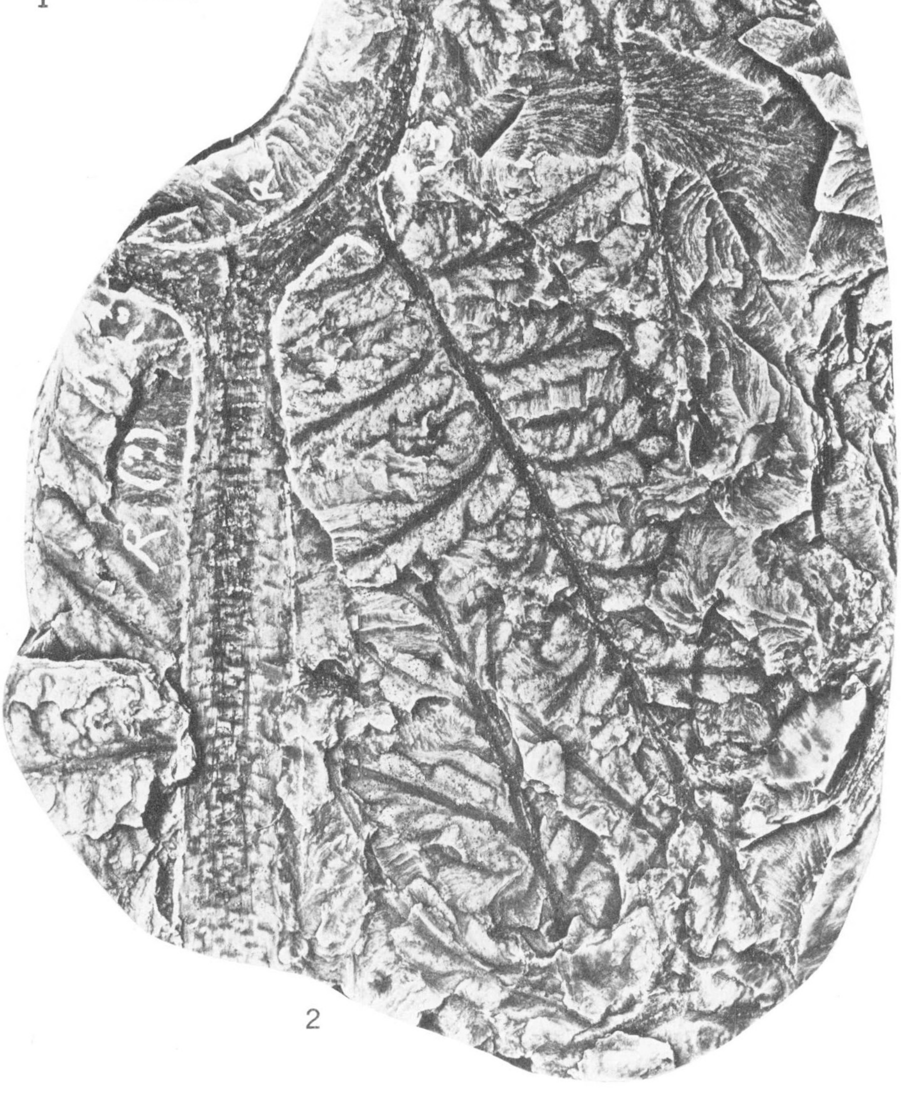

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PLATE XX

Mariopteris carnosa Corsin. (Page 26.)

Figure 1. Hypotype, No. 967. Locality 1171.
Figure 2. Hypotype, No. 868. Locality 1172.

Pecopteris (Asterotheca) miltoni Artis. (Page 30.)

Figure 3. Hypotype, No. 852 x2. Locality 1020.

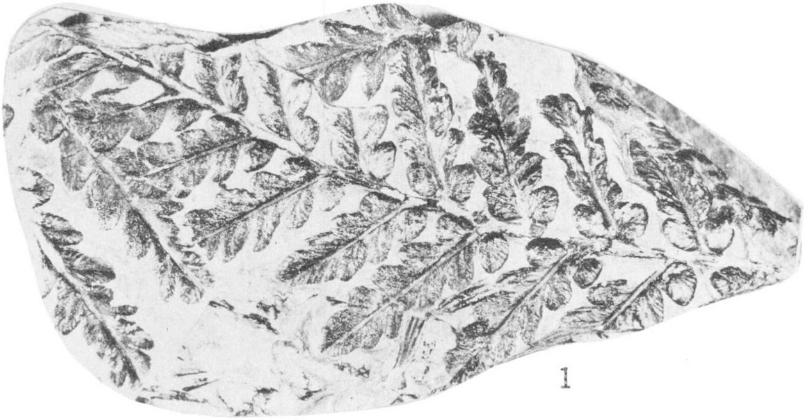

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PLATE XXI

Pecopteris (Asterotheca) miltoni Artis. (Page 30.)

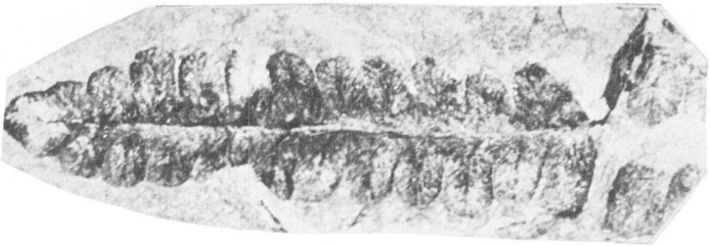
Figure 1. Hypotype, No. 853 (pars) x3. Locality 1144.
Figure 2. Hypotype, No. 853. Locality 1144.

Pecopteris (Asterotheca) hemitelioides Brongniart. (Page 34.)

Figure 3. Hypotype, No. 939 x5½. Locality 1434.

Mariopteris hirsuta Corsin. (Page 27.)

Figure 4. Hypotype, No. 870. Locality 1196.



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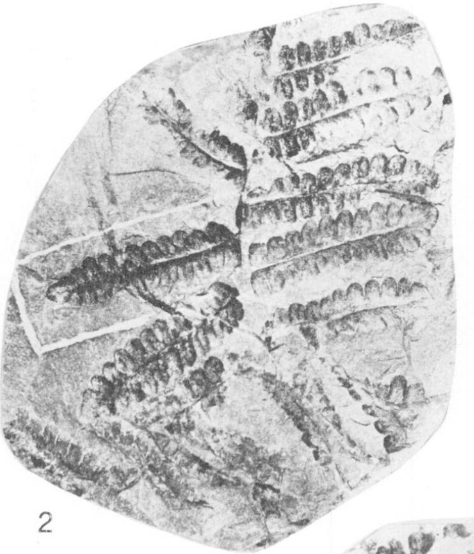

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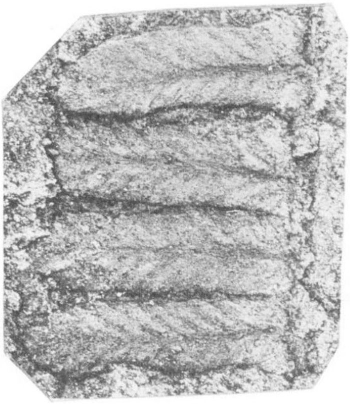

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Plate XXII

Pecopteris (Asterotheca) miltoni Artis. (Page 30.)

Figure 1. Hypotype, No. 849 (*see* Pl. XXIII). Locality 945.
Figure 2. Hypotype, No. 854. Locality 1019.
Figure 3. Hypotype, No. 851 x2. Locality 1172.

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PLATE XXIII

Pecopteris (Asterotheca) miltoni Artis. (Page 30.)

Figure 1. Hypotype, No. 849 x 2¼ (*see* Pl. XXII, fig. 1). Locality 945.

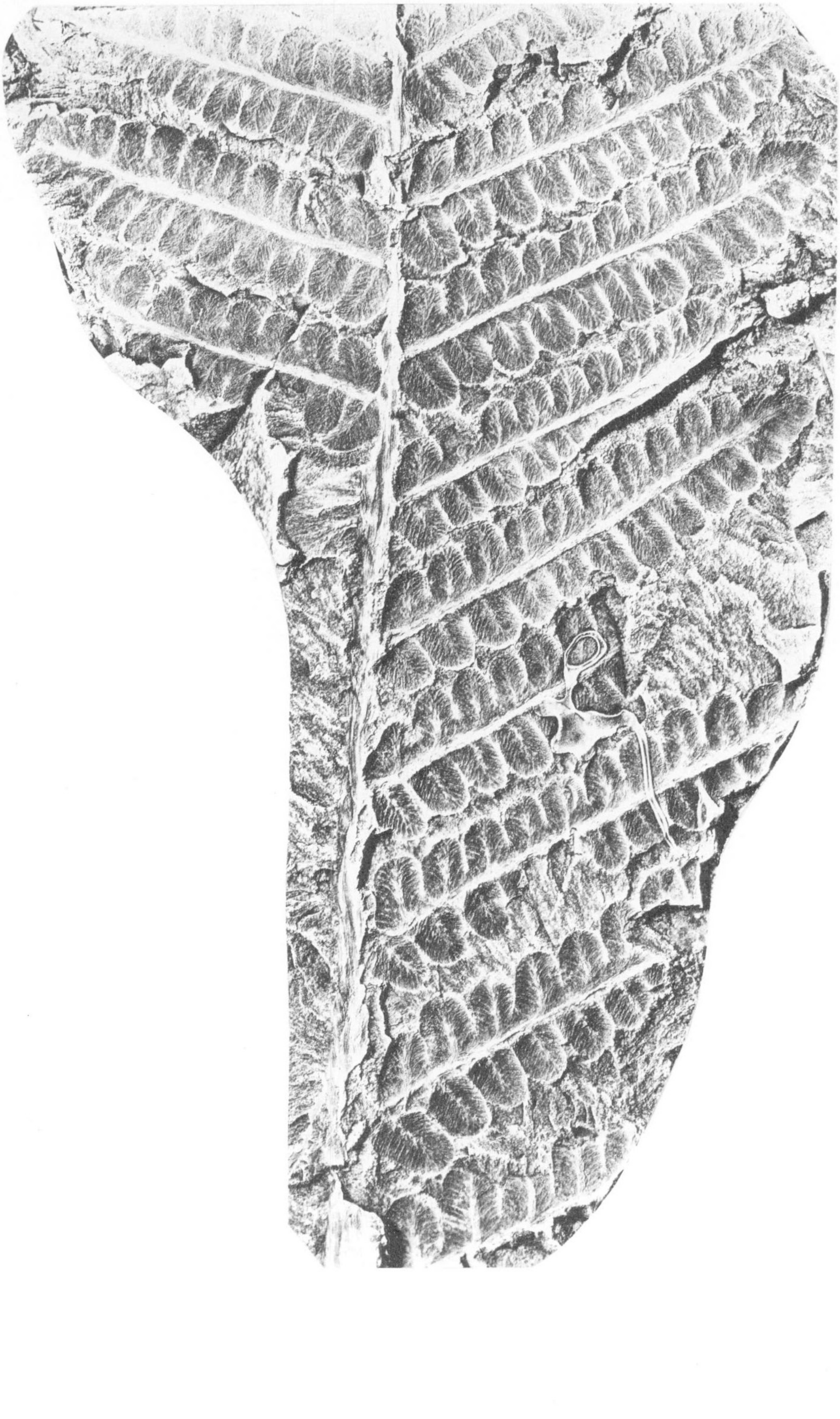


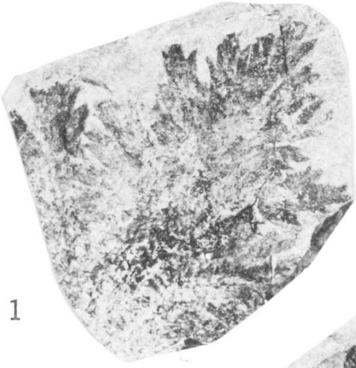
PLATE XXIV

Aphlebia sp. A. (Page 35.)

Figure 1. Specimen No. 976. Locality 945.

Pecopteris (Asterotheca) miltoni Artis. (Page 30.)

Figure 2. Hypotype, No. 850 x2. Locality 978.



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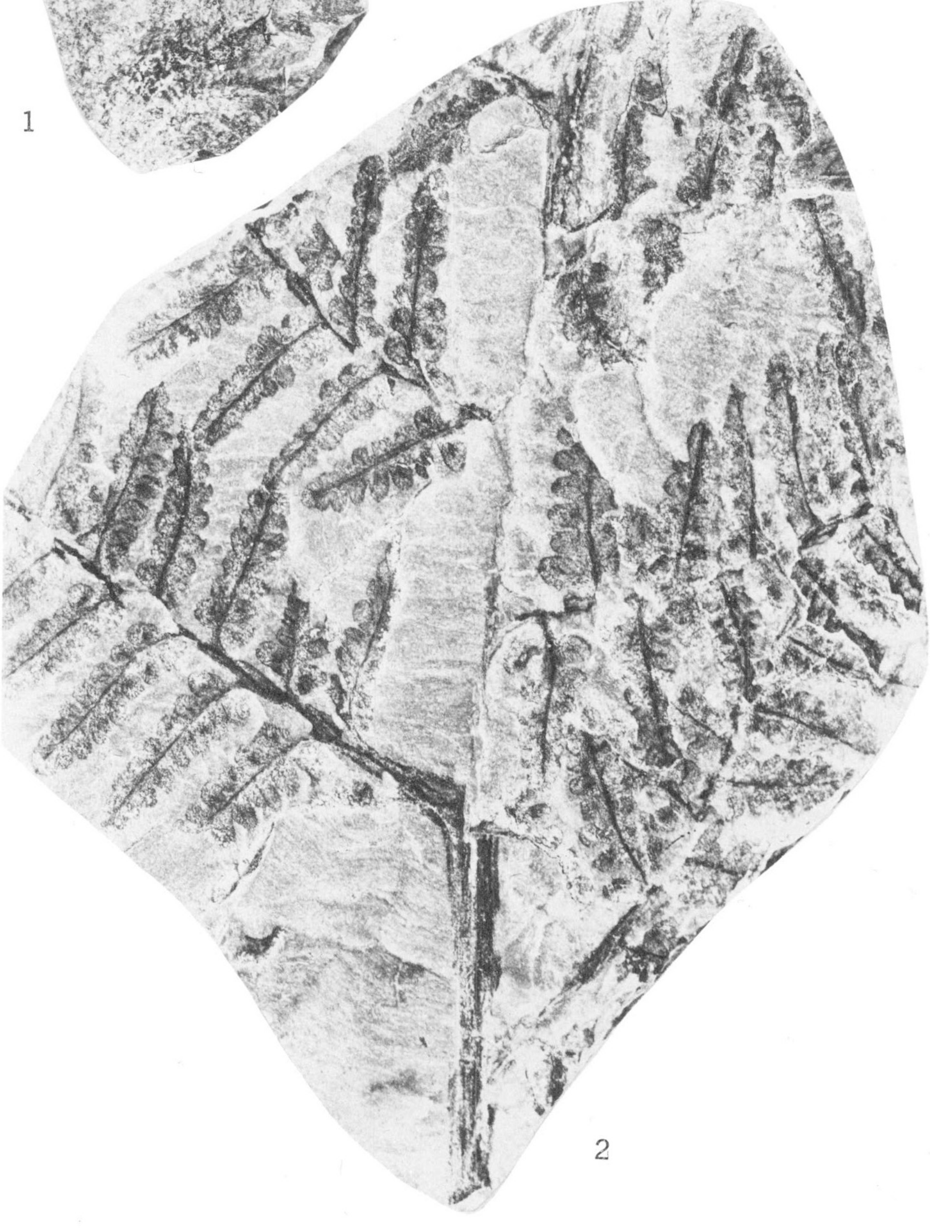

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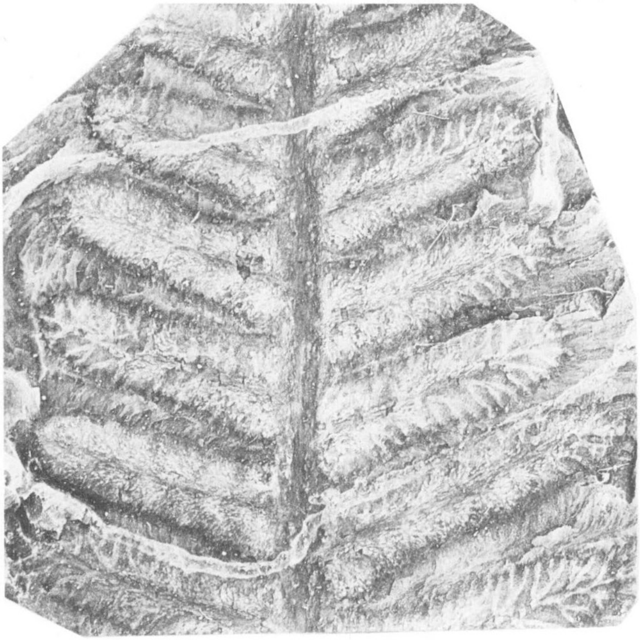
PLATE XXV

Pecopteris (Asterotheca) acadica n. sp. (Page 32.)

Figure 1. Paratype, No. 848 (pars) x5. Locality 1076.
Figure 2. Paratype, No. 848. Locality 963.
Figure 3. Holotype, No. 847 (*see* Pl. LVI, fig. 7). Locality 963.



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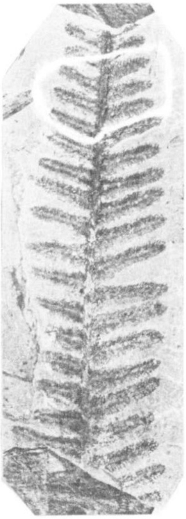

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PLATE XXVI

Aphlebia sp. B. (Page 35.)

Figure 1. Specimen No. 977 x3. Locality 5095.

Pecopteris (Senftenbergia) pennaeformis Brongniart. (Page 35.)

Figure 2. Hypotype, No. 981 x2. Locality 3859.

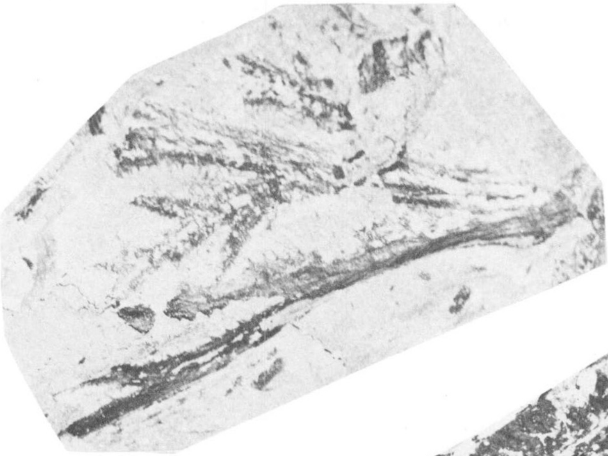

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PLATE XXVII

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb. (Page 39.)

Figure 1. Hypotype, No. 889 x4/5 approx. Locality 990.

PLATE XXVII

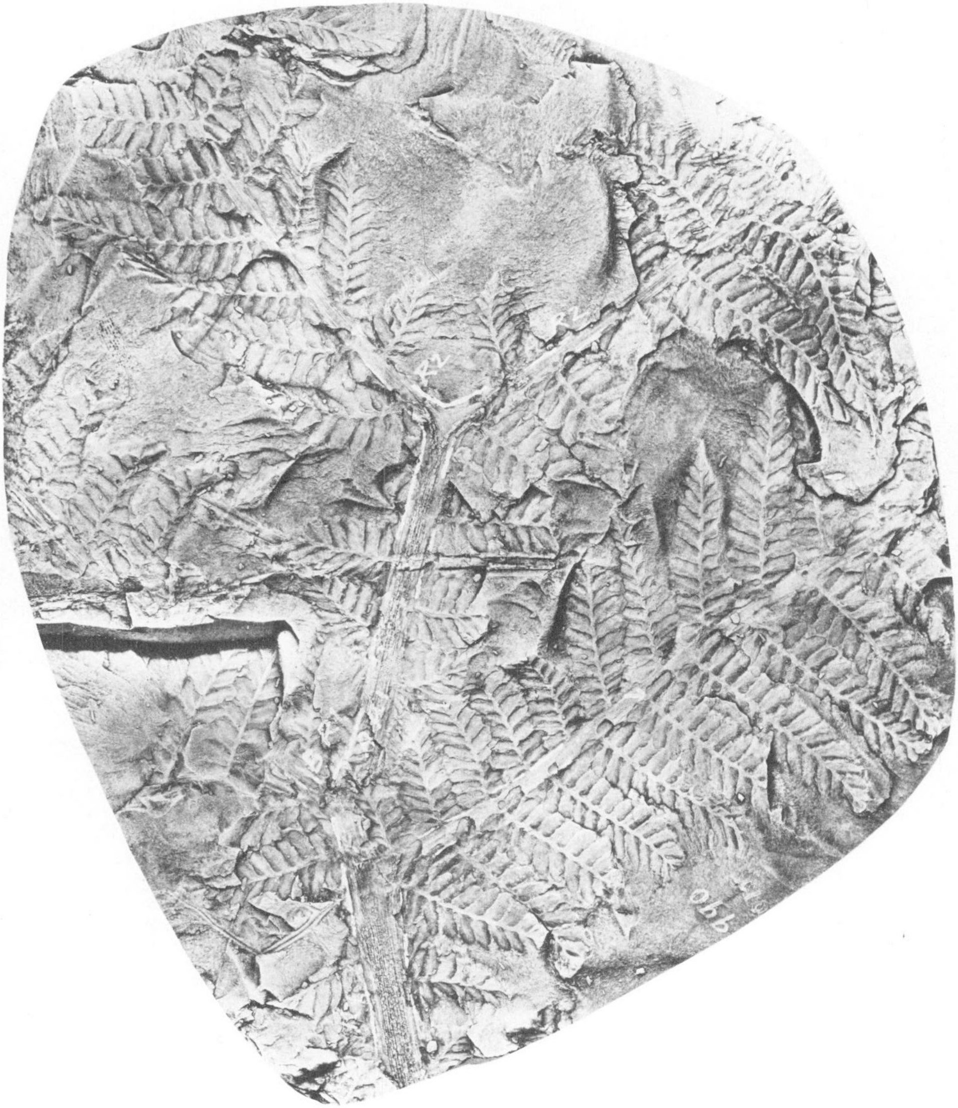

PLATE XXVIII

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb. (Page 39.)

Figure 1. Hypotype, No. 890. Locality 1037.
Figure 2. Hypotype, No. 893. Locality 945.
Figure 3. Hypotype, No. 892 x3. Locality 1020.
Figure 4. Hypotype, No. 898 x3. Locality 1020.

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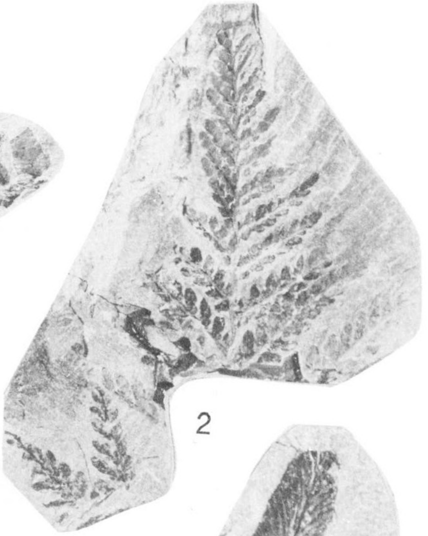

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PLATE XXIX

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb. (Page 39.)

Figure 1. Hypotype, No. 899 x2 approx. (*see* Pl. XXXI, fig. 1). Locality 5090

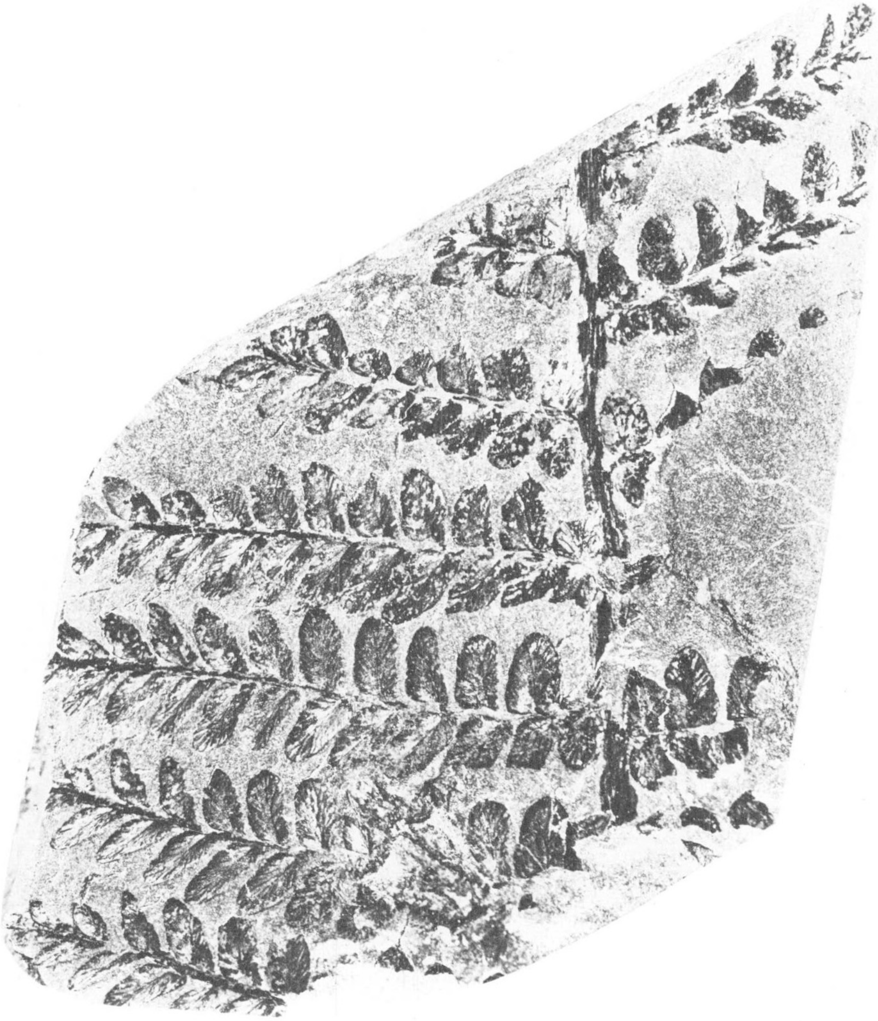


PLATE XXX

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb. (Page 39.)

Figure 1. Hypotype, No. 894 x2. Locality 1054.

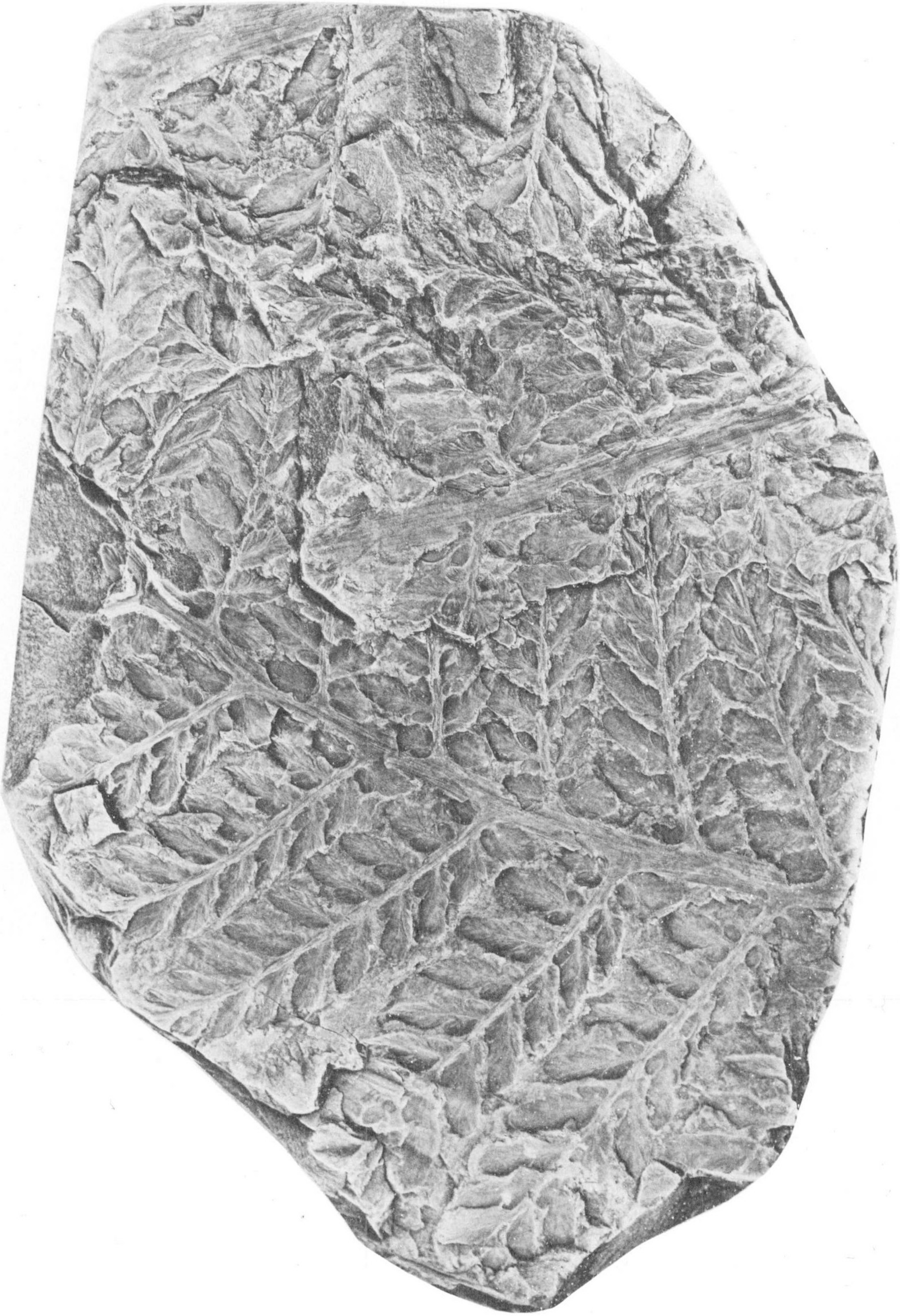
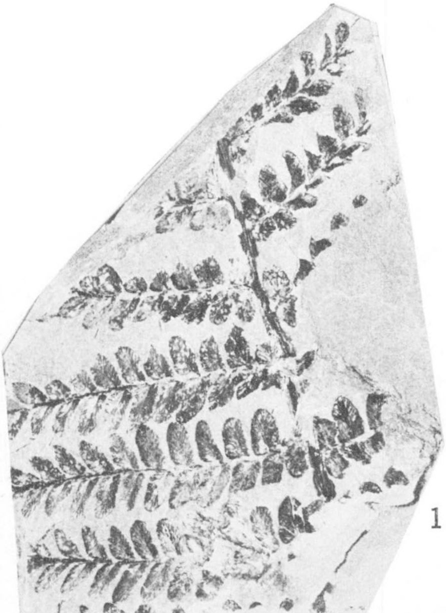


PLATE XXXI

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb. (Page 39.)

Figure 1.	Hypotype, No. 899 (*see* Pl. XXIX). Locality 5090.
Figure 2.	Hypotype, No. 895. Locality 5090.
Figure 3.	Hypotype, No. 896. Locality 990.



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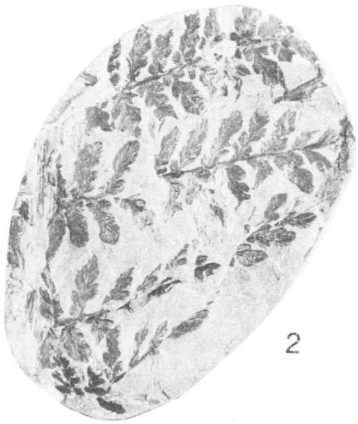

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PLATE XXXII

Neuropteris rarinervis Bunbury. (Page 43.)

Figure 1.	Hypotype, No. 925 x2. Locality 963.
Figure 2.	Hypotype, No. 906. Locality 963.

Cyclopteris sp. (Page 44.)

Figure 3.	Specimen No. 973. Locality 948.
Figure 4.	Specimen No. 974. Locality 1130.

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb. (Page 39.)

Figure 5.	Hypotype, No. 901. Locality 1061.

PLATE XXXII


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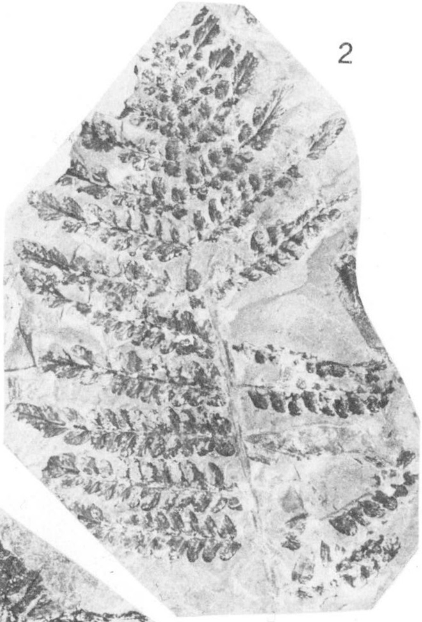
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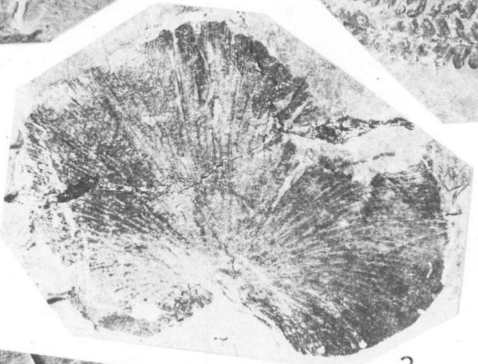
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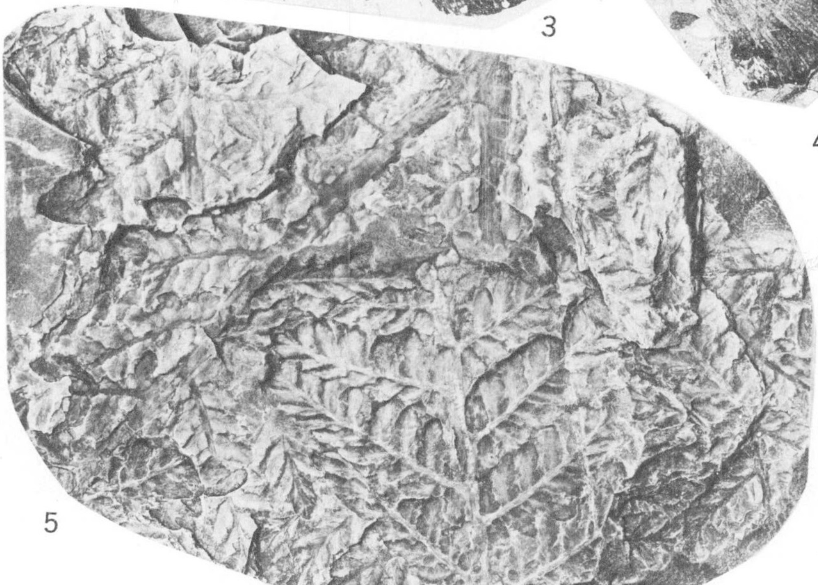
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PLATE XXXIII

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb. (Page 39.)

Figure 1. Hypotype, No. 900. Locality 990.

Neuropteris heterophylla Brongniart. (Page 43.)

Figure 2. Hypotype, No. 911 (*see* Pl. XXXIV, fig. 1). Locality 5431.

Neuropteris (Bellopteris) corsini (Radforth and Walton) n. comb. (Page 39.)

Figure 3. Hypotype, No. 902. Locality 1061.
Figure 4. Hypotype, No. 891 x3. Locality 1042.

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PLATE XXXIV

Neuropteris heterophylla Brongniart. (Page 43.)

Figure 1. Hypotype, No. 911 x3 (*see* Pl. XXXIII, fig. 2). Locality 5431.

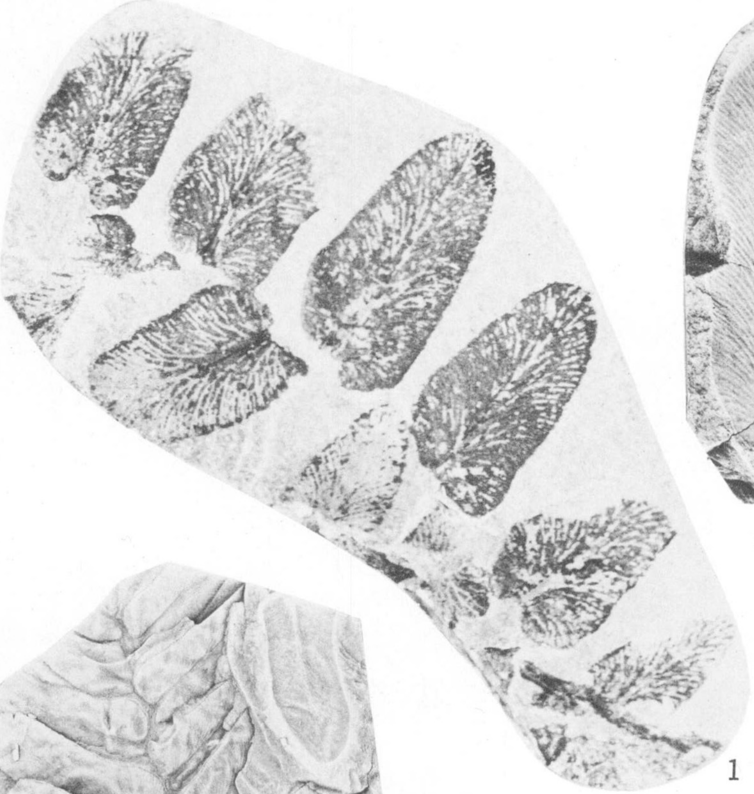
Neuropteris (Mixoneura) flexuosa Sternberg. (Page 42.)

Figure 2. Hypotype, No. 910 x3. Locality 5431.

Neuropteris tenuifolia (Schlotheim). (Page 42.)

Figure 3. Hypotype, No. 972. Locality 3859.
Figure 4. Hypotype, No. 904 (*see* Pl. XXXVI, fig. 2). Locality 1130.

PLATE XXXIV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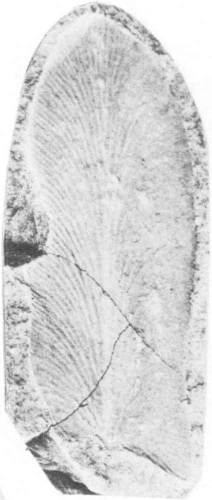
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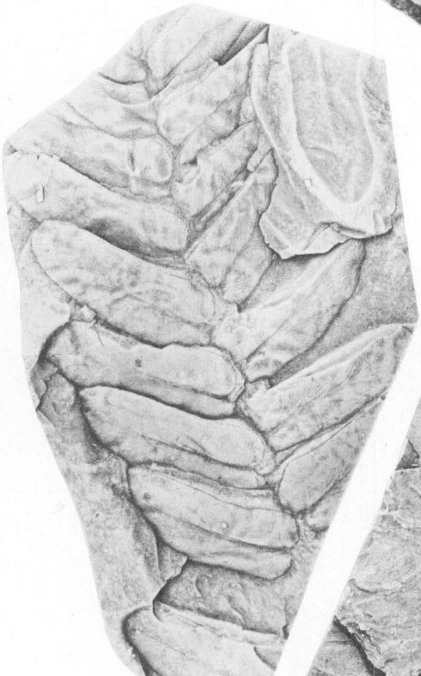
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PLATE XXXV

Neuropteris rarinervis Bunbury. (Page 43)

Figure 1. Hypotype, No. 903 x2. Locality 963.

PLATE XXXVI

Neuropteris rarinervis Bunbury. (Page 43.)

Figure 1. Hypotype, No. 4588 (*see* fig. 3). Locality 1172.

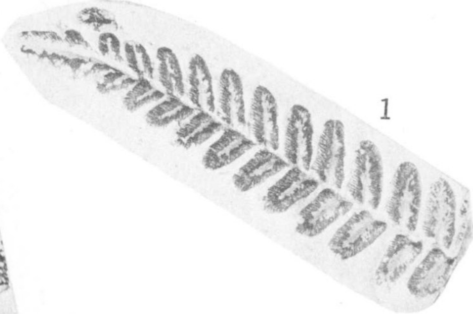
Neuropteris tenuifolia (Schlotheim). (Page 42.)

Figure 2. Hypotype, No. 904 x3 (*see* Pl. XXXIV, fig. 4). Locality 1130.

Neuropteris rarinervis Bunbury. (Page 43.)

Figure 3. Hypotype, No. 4588 x2 (*see* fig. 1). Locality 1172.

PLATE XXXVI



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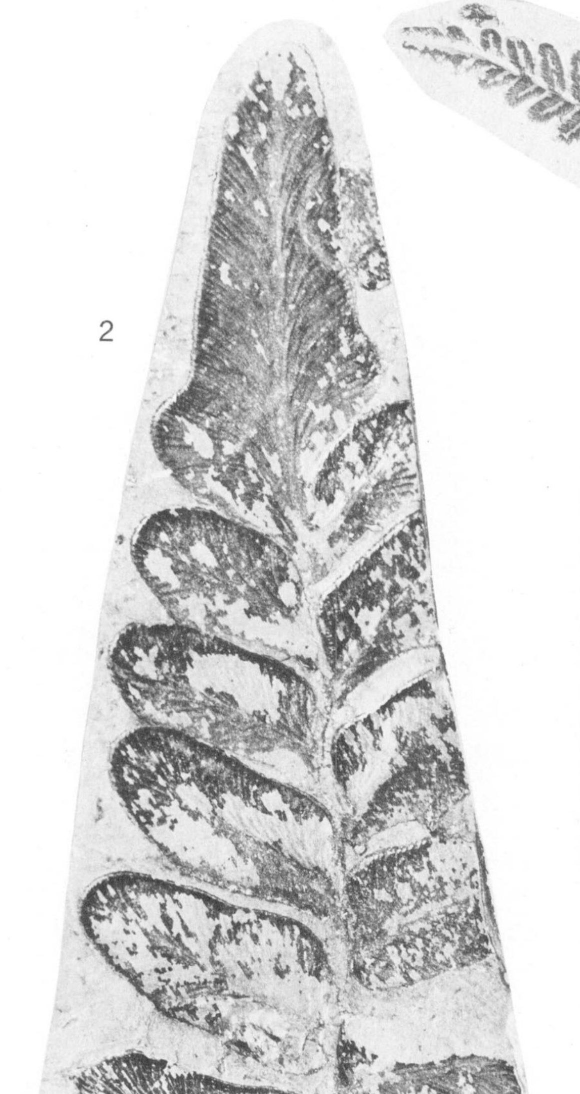

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PLATE XXXVII

Neuropteris scheuchzeri Hoffmann, forma *angustifolia*. (Page 44.)

Figure 1. Hypotype, No. 908. Locality 3859.
Figure 2 Hypotype, No. 909 x2. Locality 3859.

Neuropteris (Mixoneura) flexuosa Sternberg. (Page 42.)

Figure 3. Hypotype, No. 905 x3. Locality 5431.

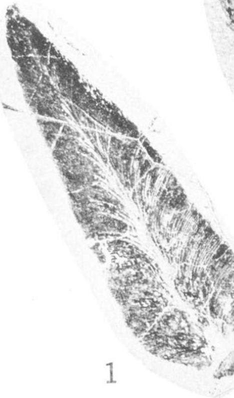
Linopteris muensteri (Eichwald). (Page 45.)

Figure 4. Hypotype, No. 877 x3. Locality 5095.

Neuropteris scheuchzeri Hoffmann, forma *angustifolia*. (Page 44.)

Figure 5. Hypotype, No. 907. Locality 3859.

PLATE XXXVII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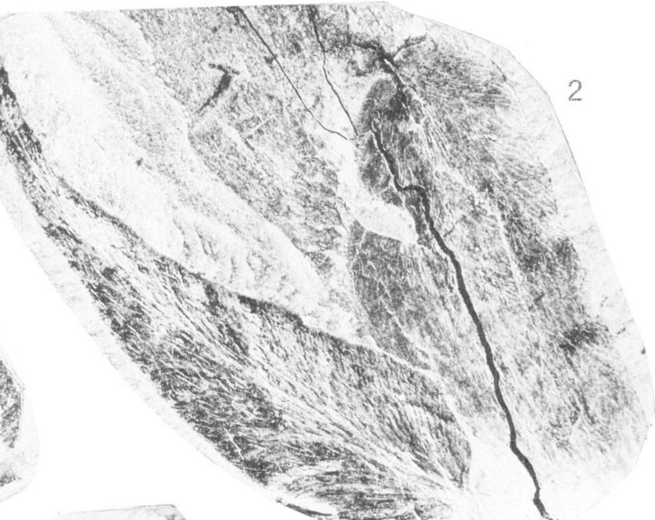
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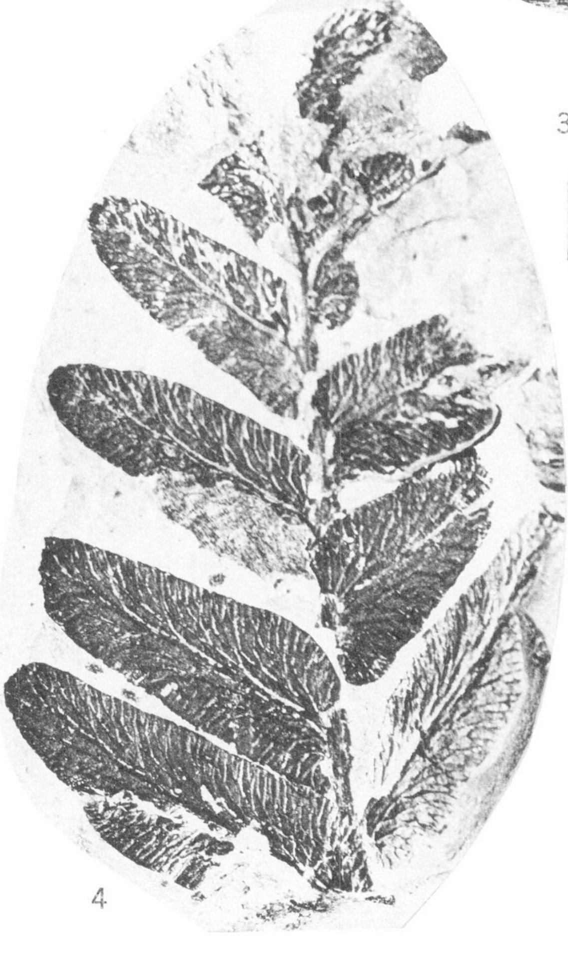
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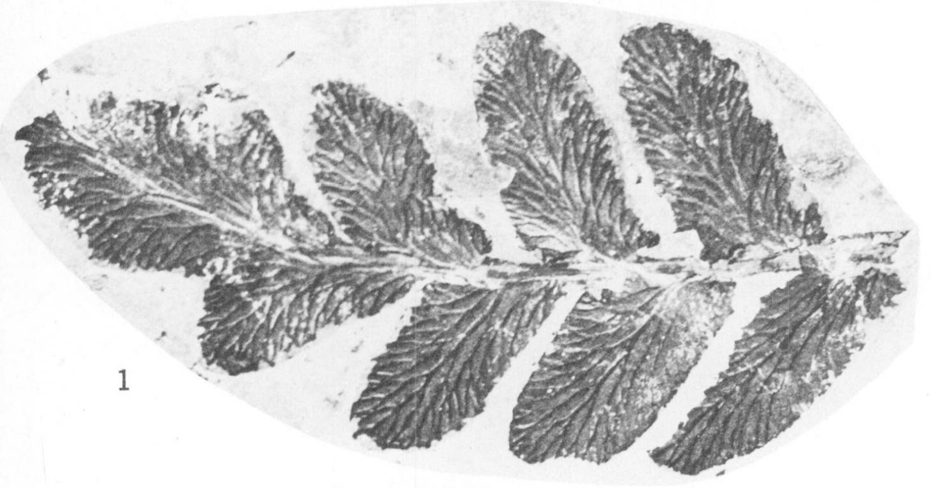
PLATE XXXVIII

Linopteris muensteri (Eichwald). (Page 45.)

Figure 1. Hypotype, No. 888 x3. Locality 3859.
Figure 2. Hypotype, No. 887. Locality 1079.
Figure 3. Hypotype, No. 876 x2. Locality 5095.

PLATE XXXVIII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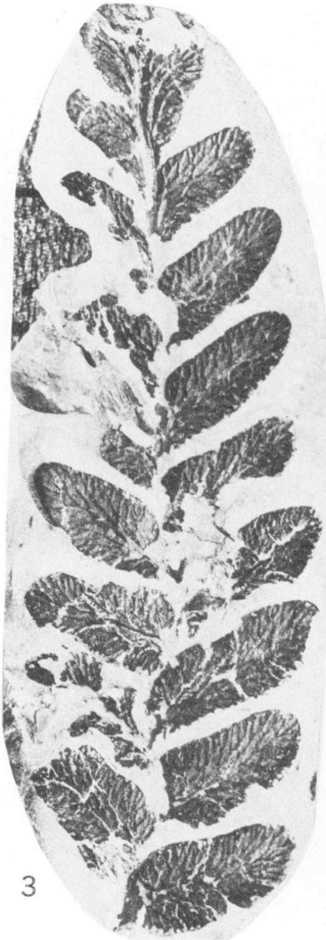
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PLATE XXXIX

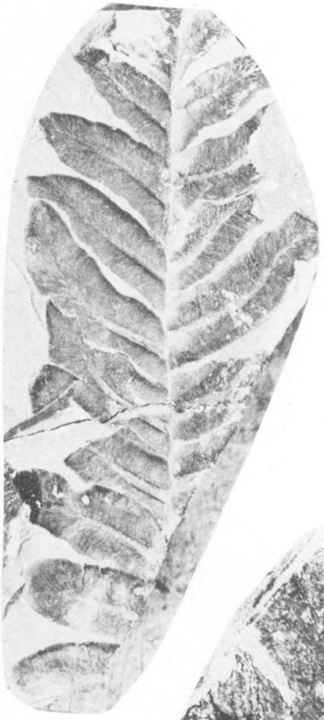
Alethopteris serli (Brongniart). (Page 36.)

Figure 1. Hypotype, No. 856 x¾. Locality 945

PLATE XL

Pecopteridium sullivanti (Lesquereux). (Page 37.)

Figure 1. Hypotype, No. 864. Locality 1076.
Figure 2. Hypotype, No. 941. Locality 963.
Figure 3. Hypotype, No. 863. Locality 963.
Figure 4. Hypotype, No. 862 x3. Locality 963.
Figure 5. Hypotype, No. 865. Locality 1076.



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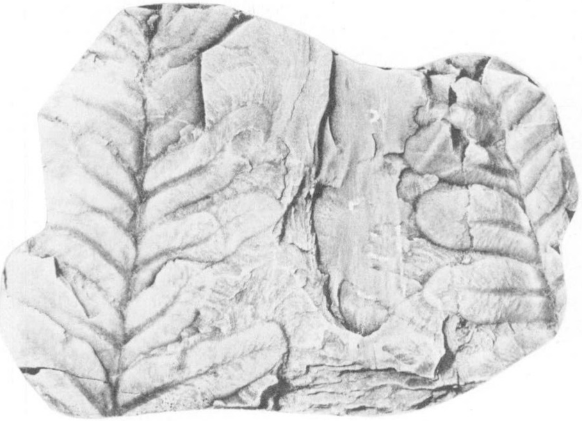

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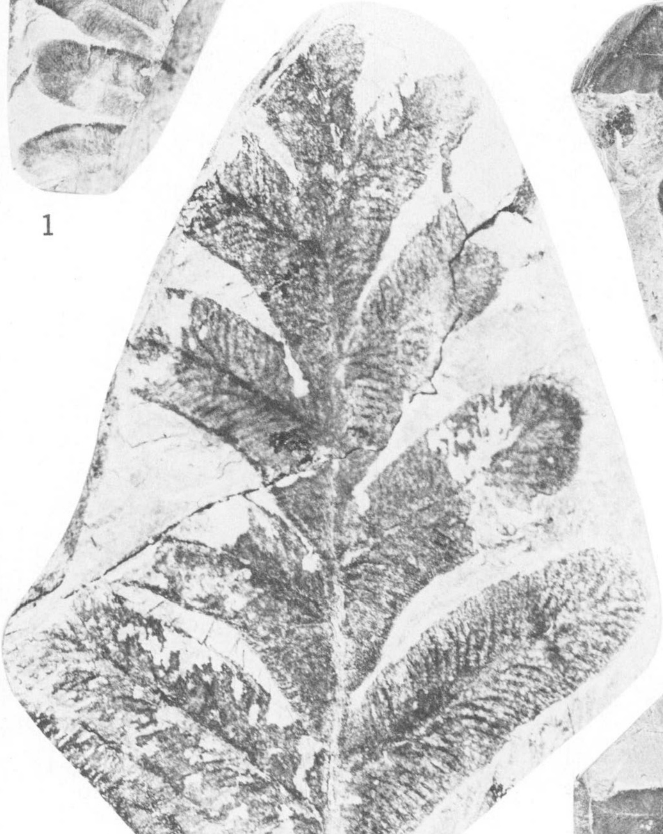

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PLATE XLI

Alethopteris davreuxi (Brongniart). (Page 37.)

Figure 1.	Hypotype, No. 859. Locality 1076.
Figure 2.	Hypotype, No. 860 x2. Locality 1076.

Pecopteridium sullivanti (Lesquereux). (Page 37.)

Figure 3.	Hypotype, No. 940. Locality 963.

Alethopteris serli (Brongniart). (Page 36.)

Figure 4.	Hypotype, No. 857. Locality 1196.

Pecopteridium sullivanti (Lesquereux). (Page 37.)

Figure 5.	Hypotype, No. 942 x2. Locality 963.

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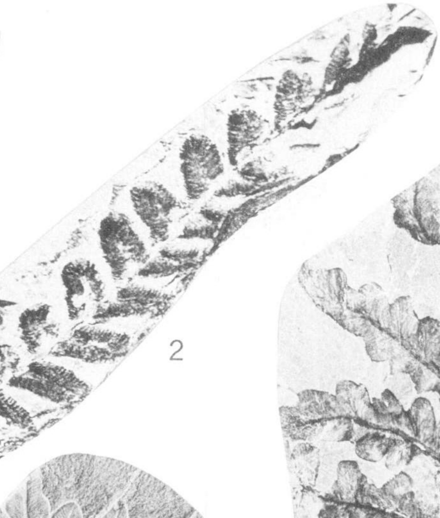

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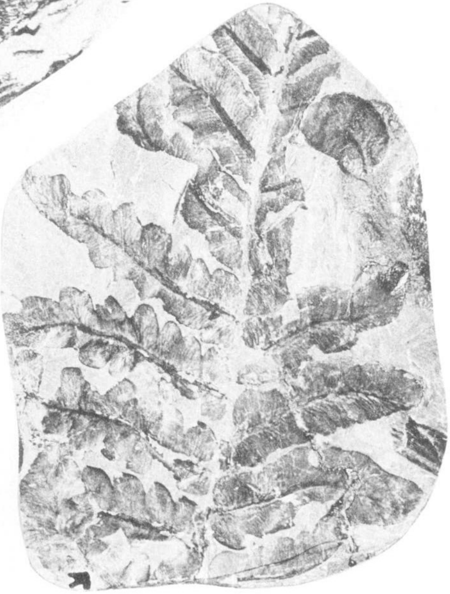

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PLATE XLII

Alethopteris serli (Brongniart). (Page 36.)

Figure 1. Hypotype, No. 966. Locality 945.

Sphenophyllum myriophyllum Crépin. (Page 47.)

Figure 2. Hypotype, No. 984. Locality 948.

Sphenophyllum myriophyllum Crépin. (Page 47.)

Figure 3. Hypotype, No. 829. Locality 945.

Alethopteris lonchitica (Schlotheim). (Page 36.)

Figure 4. Hypotype, No. 858. Locality 945.

Sphenophyllum trichomatosum Stur. (Page 47.)

Figure 5. Hypotype, No. 828 x4. Locality 948.

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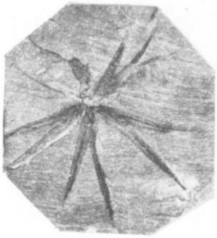

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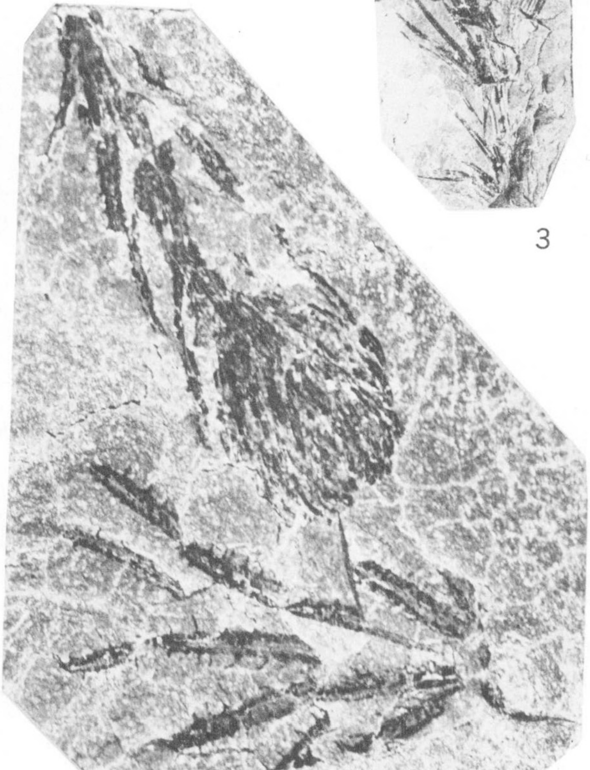

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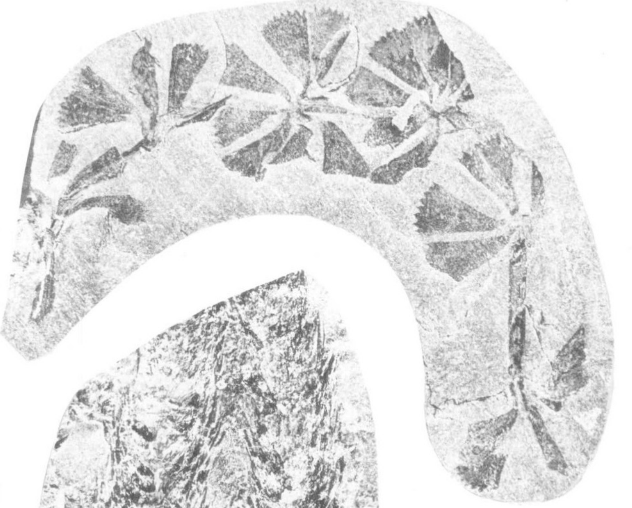
PLATE XLIII

Sphenophyllum cuneifolium (Sternberg). (Page 45.)

Figure 1. Hypotype, No. 826 x2. Locality 945.
Figure 2. Cone. Hypotype, 823 x2. Locality 990.
Figure 3. Cones. Hypotype, No. 822. Locality 948.
Figure 4. Hypotype, No. 825 x4. Locality 945.
Figure 5. Cone. Hypotype, No. 824 x3. Locality 1020.

PLATE XLIII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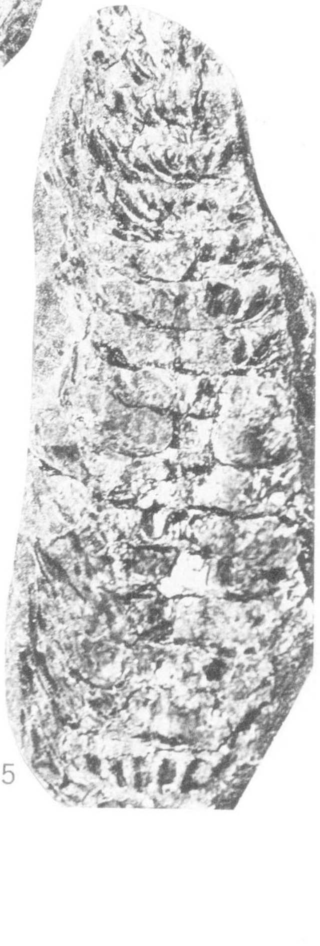
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Plate XLIV

Sphenophyllum emarginatum Brongniart. (Page 46.)

Figure 1. Hypotype, No. 831 x3. Locality 1172.
Figure 2. Hypotype, No. 834. Locality 963.
Figure 3. Hypotype. No. 963 (pars) x3 (*see* Pl. LVI, fig. 1). Locality 5353.
Figure 4. Hypotype, No. 963 (pars) x3. Locality 5353.

Calamites ramosus Artis. (Page 49.)

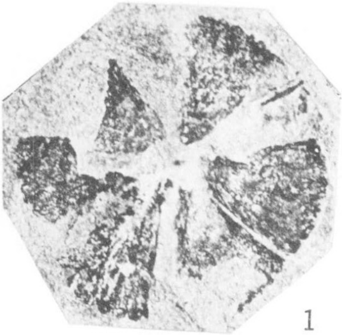
Figure 5. Hypotype, No. 965. Locality 5353.

Calamites suckowi Brongniart. (Page 48.)

Figure 6. Hypotype, No. 957. Locality 990.

Annularia sphenophylloides (Zenker). (Page 51.)

Figure 7. Hypotype, No. 840 x6. Locality 1020.



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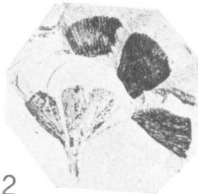

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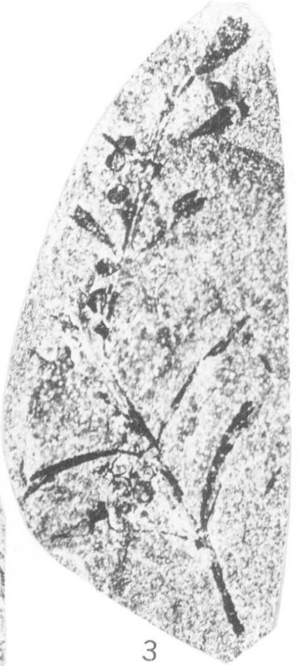

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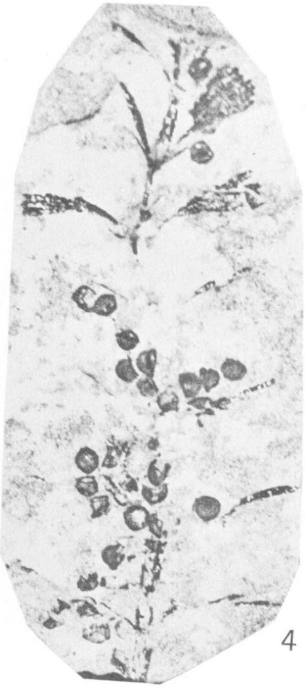

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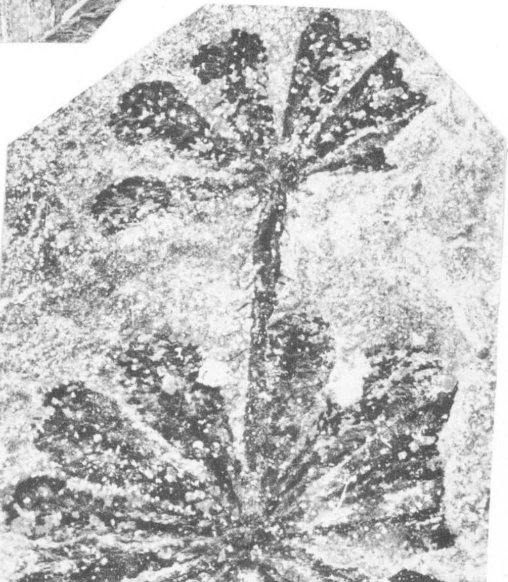

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PLATE XLV

Asterophyllites longifolius (Sternberg). (Page 49.)

Figure 1. Hypotype, No. 839. Locality 856.

Annularia pseudostellata Potonié. (Page 50.)

Figure 2. Hypotype, No. 837. Locality 1000.

Asterophyllites grandis (Sternberg). (Page 49.)

Figure 3. Hypotype, No. 937 x3. Locality 5430.

Macrostachya sp. (Page 51.)

Figure 4. Specimen No. 833. Locality 1172.

Annularia pseudostellata Potonié. (Page 50.)

Figure 5. Hypotype, No. 835 x2. Locality 1019.

Calamites ramosus Artis. (Page 49.)

Figure 6. Hypotype, No. 841. Locality 990.

PLATE XLV


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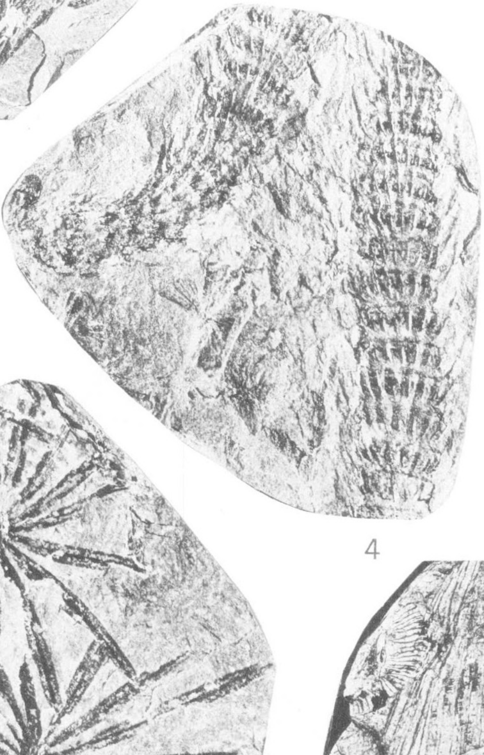
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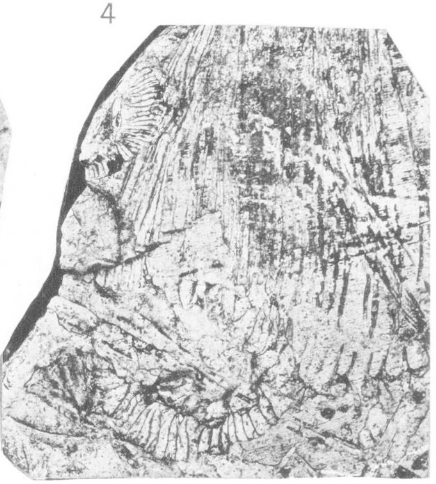
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PLATE XLVI

Lepidodendron pictoense Dawson. (Page 52.)

Figure 1. Hypotype, No. 804 x3. Locality 1172.

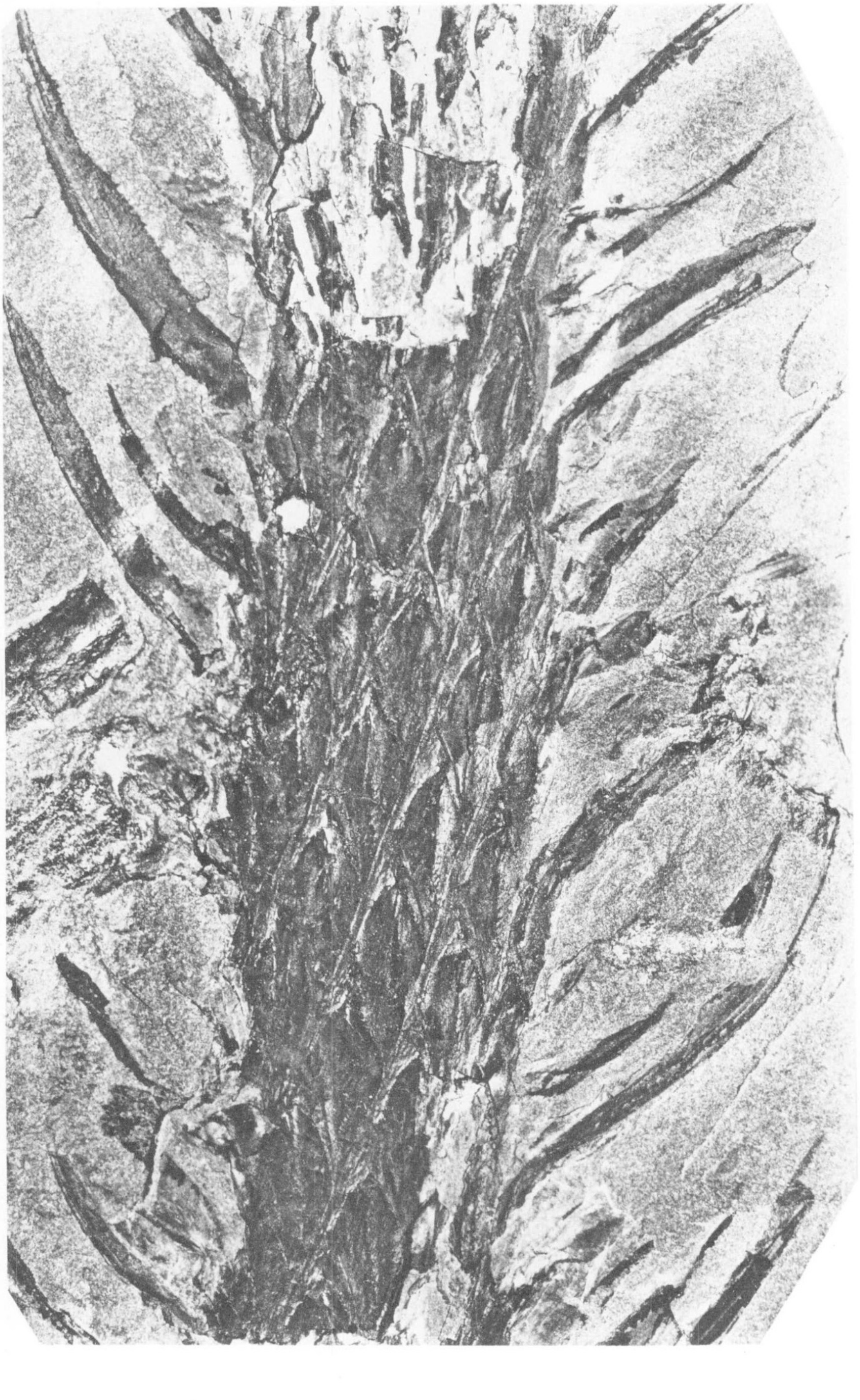

PLATE XLVII

Macrostachya sp. (Page 51.)

Figure 1. Specimen No. 832. Locality 1172.

Annularia pseudostellata Potonié. (Page 50.)

Figure 2. Hypotype, No. 836. Locality 990.
Figure 3. Hypotype, No. 838. Locality 1019.

Asterophyllites grandis (Sternberg). (Page 49.)

Figure 4. Hypotype, No. 938 x3. Locality 5430.

Lepidodendron bretonense Bell. (Page 53.)

Figure 5. Hypotype, No. 809 x3. Locality 977.
Figure 6. Hypotype, No. 810. Locality 948.


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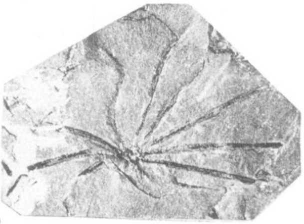
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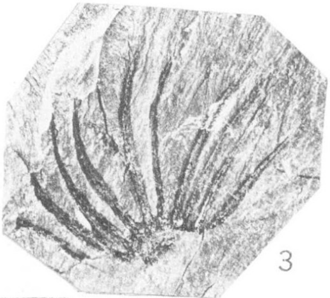
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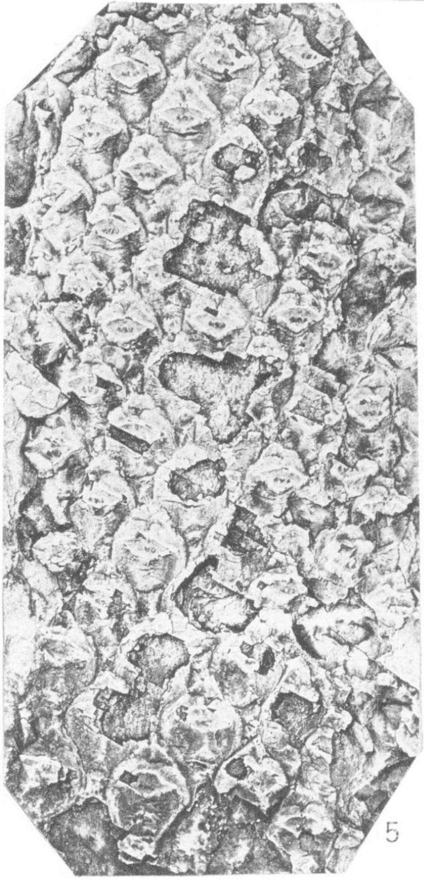
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PLATE XLVIII

Asolanus camptotaenia Wood. (Page 56.)

Figure 1. Hypotype, No. 978. Locality 3859.
Figure 2. Hypotype, No. 797 (pars) x4. Locality 1076.
Figure 3. Hypotype, No. 802 (pars) x4. Locality 1076.

Lepidodendron bretonense Bell. (Page 53.)

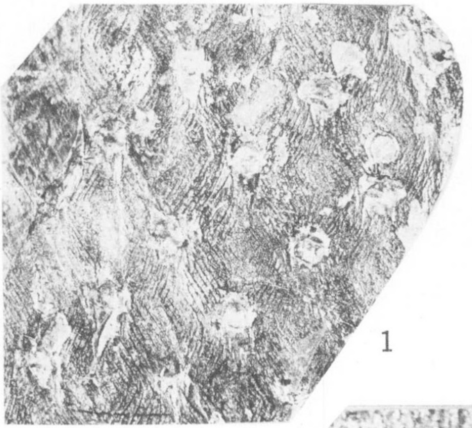
Figure 4. Hypotype, No. 812. Locality 1079.

Lepidostrobophyllum majus (Brongniart). (Page 55.)

Figure 5. Hypotype, No. 956. Locality 1100.

Lepidodendron bretonense Bell. (Page 53.)

Figure 6. Hypotype, No. 811. Locality 990.



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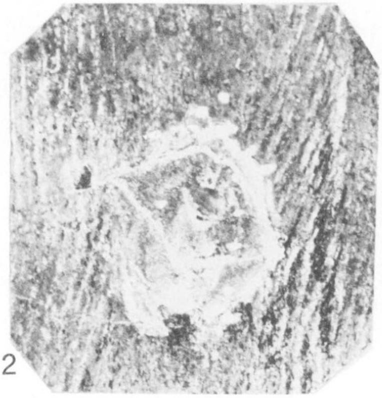

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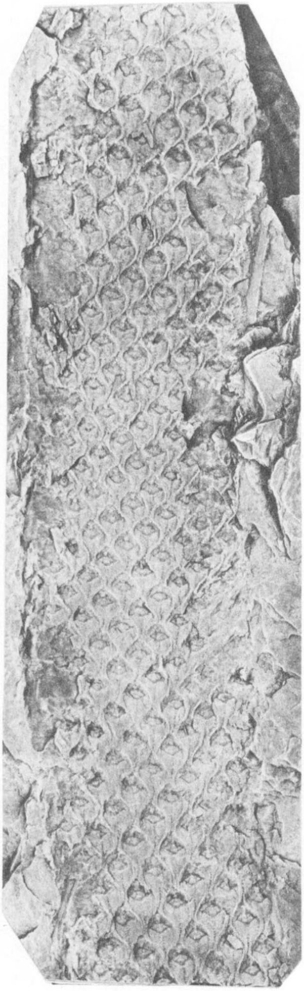

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PLATE XLIX

Lepidodendron pictoense Dawson. (Page 52.)

Figure 1. Hypotype, No. 805. Locality 1172.

Lepidodendron bretonense Bell. (Page 53.)

Figure 2. Hypotype, No. 803 x2. Locality 1172.

Lepidodendron pictoense Dawson. (Page 52.)

Figure 3. Hypotype, No. 807. Locality 1172.

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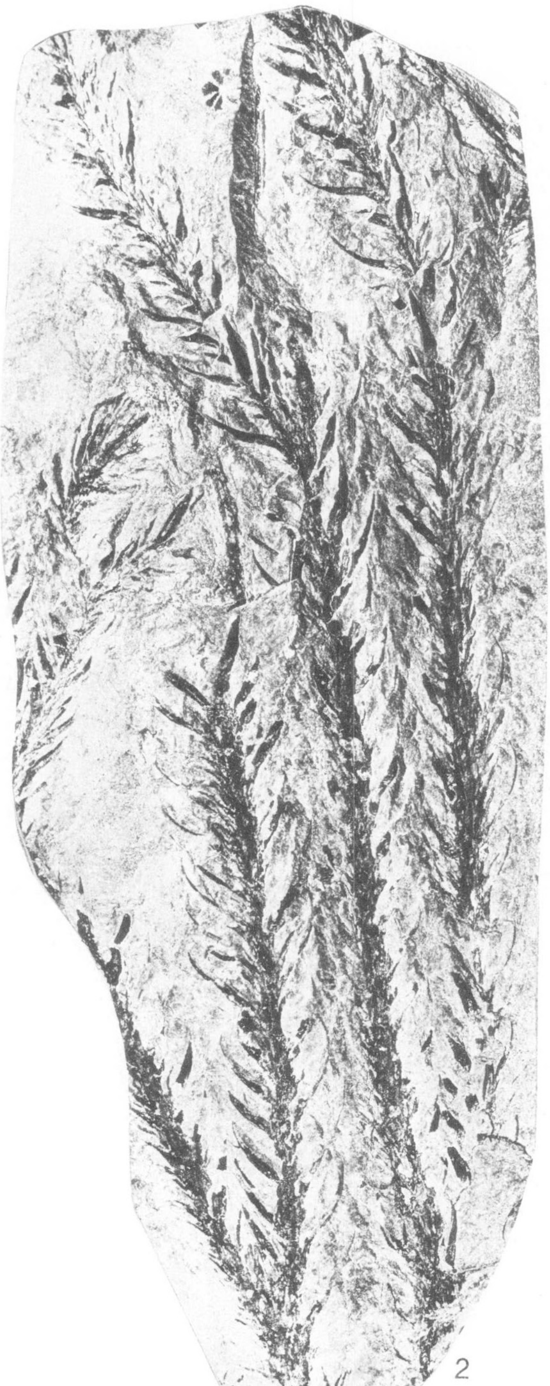

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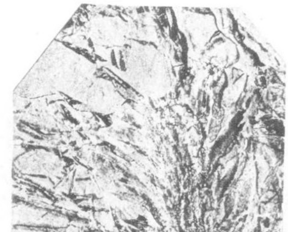
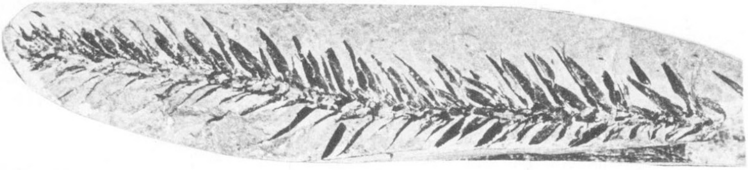


3

PLATE L

Lepidodendron pictoense Dawson. (Page 52.)

Figure 1.	Hypotype, No. 806. Locality 1172.
Figure 2.	Hypotype, No. 808. Locality 1172.
Figure 3.	Hypotype, No. 804 (*see* Pl. XLVI). Locality 1172.



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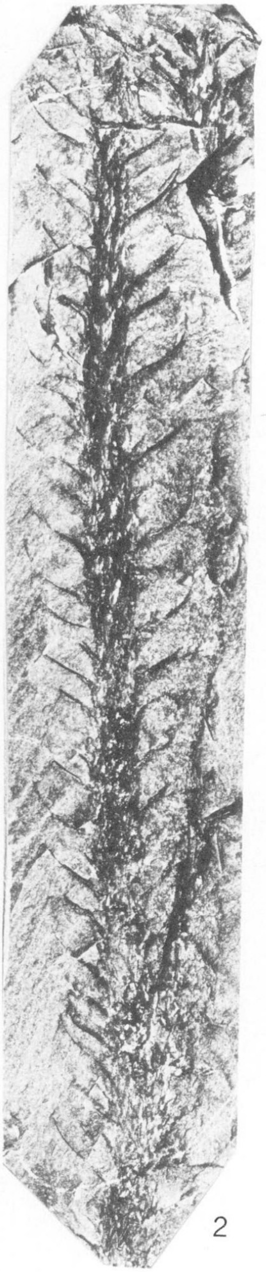

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PLATE LI

Trigonocarpus? sp. (Page 61.)

Figure 1. Specimen Nos. 952 (right), 953 (left). Locality 977.

Gymnostrobus wilsoni n. sp. (Page 57.)

Figure 2. Paratype, No. 934 x2. Locality 5353.

Samaropsis bisecta (Dawson). (Page 61.)

Figure 3. Hypotype, No. 971. Locality 945.

Sigillaria tessellata (Steinhauer). (Page 55.)

Figure 4. Hypotype, No. 795. Locality 977.

1

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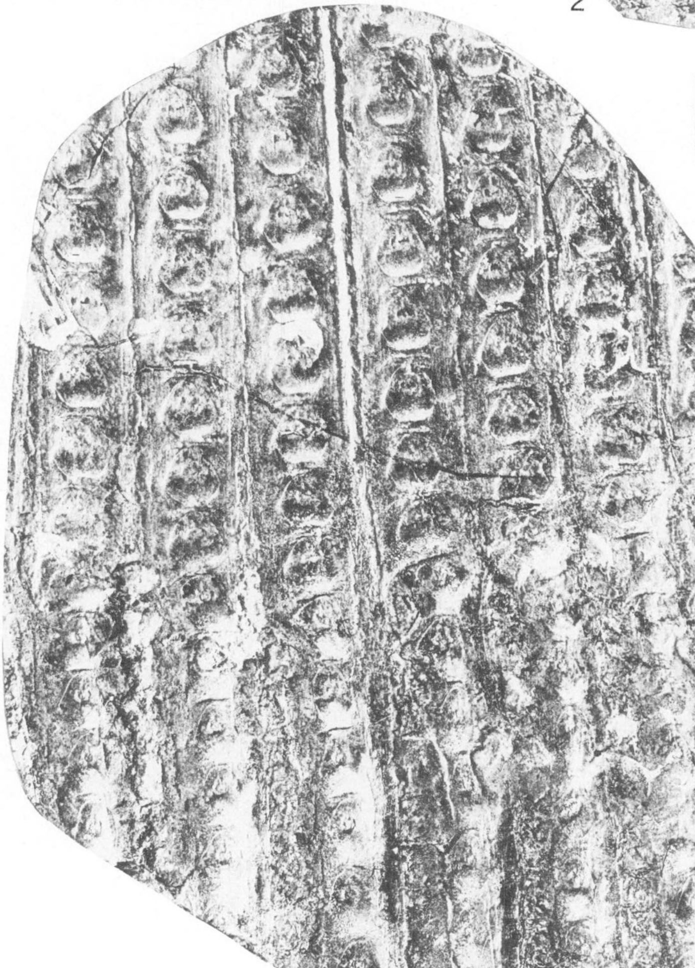


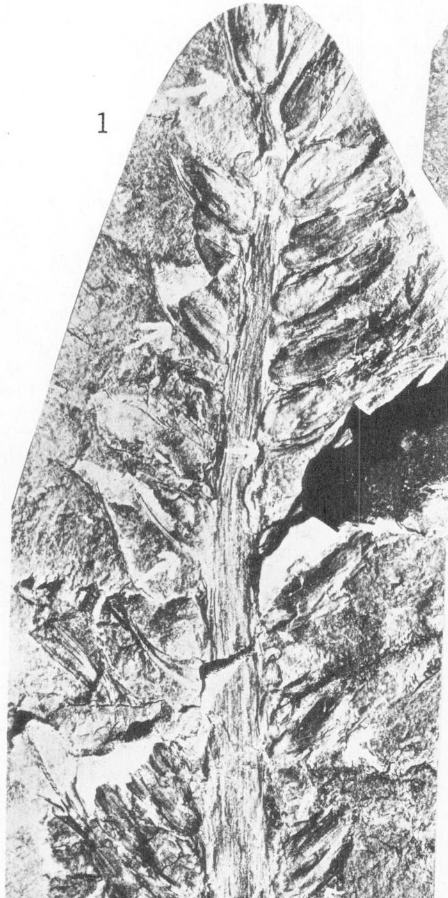
4

PLATE LII

Cordaitanthus rhabdocarpi (Dawson) n. comb. (Page 59.)

Figure 1. Hypotype, No. 946. Locality 990.
Figure 2. Bract. Hypotype, No. 949 x2. Locality 1130.
Figure 3. Hypotype, No. 948. Locality 1020.

PLATE LII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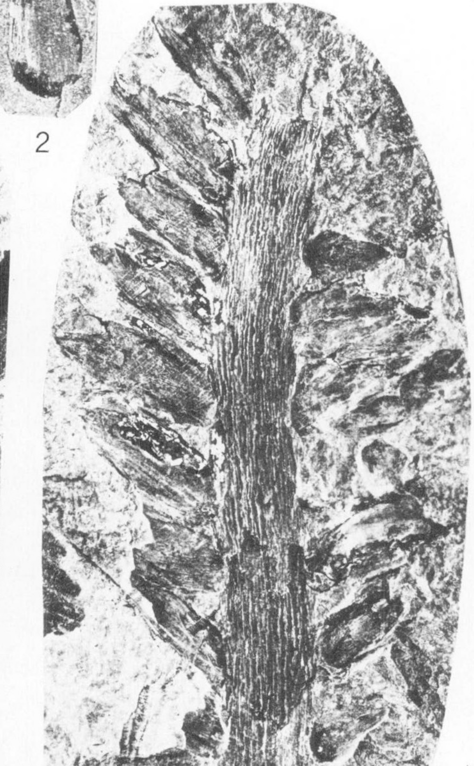
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PLATE LIII

Cordaitanthus rhabdocarpi (Dawson) n. comb. (Page 59.)

Figure 1. Hypotype, No. 945 (*see* Pl. LIV). Locality 5074.

Radiospermum? sp. (Page 62.)

Figure 2. Specimen Nos. 954, 955 (*see* fig. 4). Locality 5025.

Gymnostrobus wilsoni n. sp. (Page 57.)

Figure 3. Holotype, No. 796. Locality 1076.

Radiospermum? sp. (Page 62.)

Figure 4. Specimen Nos. 954, 955 x3 (*see* fig. 2).

PLATE LIII

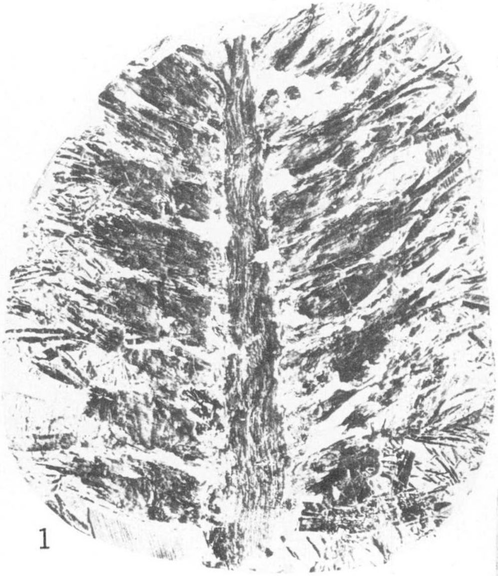
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Plate LIV

Cordaitanthus rhabdocarpi (Dawson) n. comb. (Page 59.)

Figure 1. Hypotype, No. 945 x2 (*see* Pl. LIII, fig. 1). Locality 5074.

PLATE LIV

PLATE LV

Saportaea dispar (Dawson) n. comb. (Page 58.)

Figure 1. Holotype, No. 4427. Locality 1152.

Cordaites principalis (Germar). (Page 59.)

Figure 2. Hypotype, No. 979. Locality 3859.

Gymnostrobus wilsoni n. sp. (Page 57.)

Figure 3. Paratype, No. 799. Locality 1076.
Figure 4. Paratype, No. 801 x2. Locality 1076.
Figure 5. Paratype, No. 800. Locality 5353.

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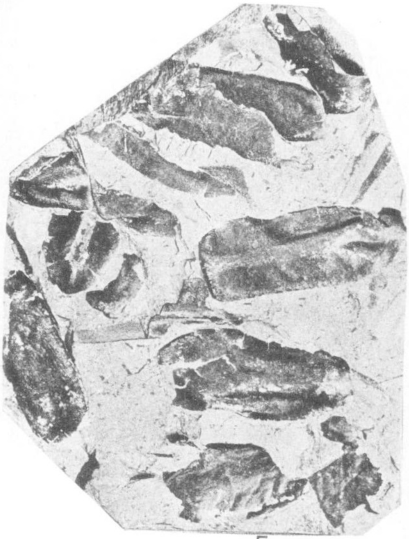

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PLATE LVI

Sphenophyllum emarginatum Brongniart, fertile? (Page 46.)

Figure 1. Hypotype, No. 963 (branch of). Locality 5353.

Mariopteris hirta (Stur). (Page 29.)

Figure 2. Hypotype, No. 879 x3. Locality 1020.

Samaropsis cornuta (Dawson). (Page 60.)

Figure 3. Hypotype, No. 951 x3. Locality 1130.

Samaropsis cornuta (Dawson), among bracts of *Cordaitanthus rhabdocarpi* (Dawson). (Page 60.)

Figure 4. Hypotype, No. 950 x3. Locality 1130.

Samaropsis bisecta (Dawson). (Page 61.)

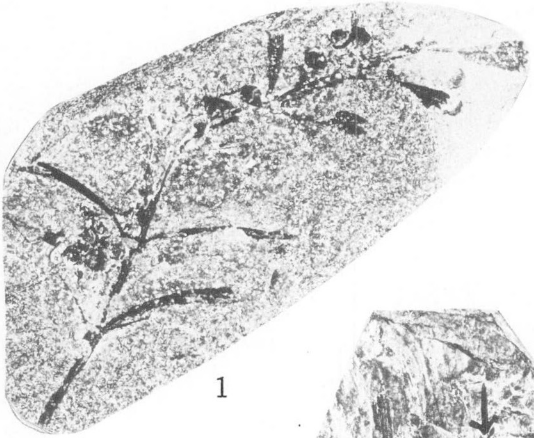
Figure 5. Hypotype, No. 971 x2. Locality 945.

Myriotheca desaillyi Zeiller. (Page 19.)

Figure 6. Hypotype, No. 867 x5 (*see* Pl. VIII, fig. 2). Locality 3859.

Pecopteris (Asterotheca) acadica n. sp. (Page 32.)

Figure 7. Holotype, No. 847 (pars) x5. Locality 963.



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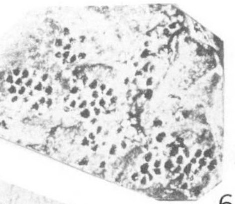

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INDEX TO FOSSILS

*Numbers in **bold**-face type indicate where species are described*