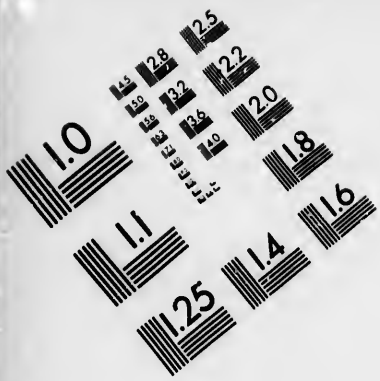

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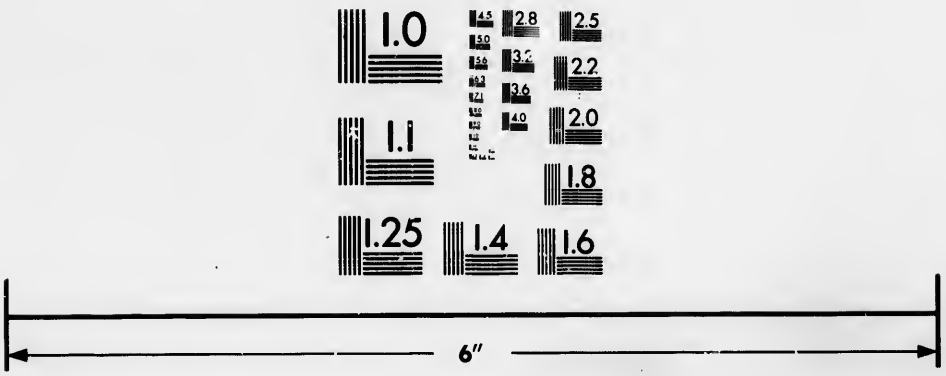

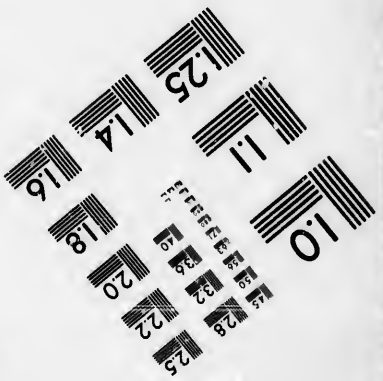

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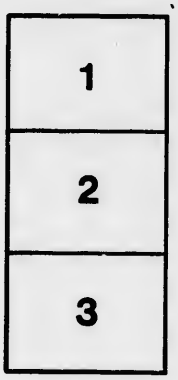
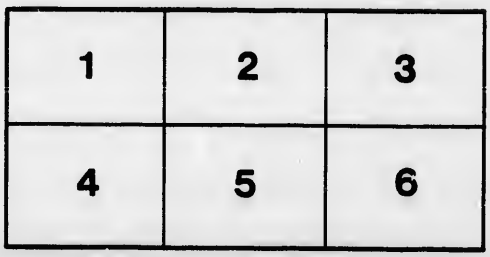




[*From the* Quarterly Journal *of the* Geological Society *for August* 1874.]

On the Upper Coal-formation *of* Eastern Nova Scotia *and* Prince-Edward Island *in its* Relation *to the* Permian.

By J. W. Dawson, LL.D., F.R.S., F.G.S., McGill College, Montreal.

This formation was first distinguished as a separate member of the Carboniferous system in Eastern Nova Scotia by the writer, in a paper published in the first volume of the 'Journal of the Geological Society,' in 1845—and was defined to be an upper or overlying series superimposed on the productive Coal-measures, and distinguished by the absence of thick coal-seams, by the prevalence of red and grey sandstones and red shales, and by a peculiar group of vegetable fossils.

Subsequently, in my paper on the South Joggins* and in my 'Acadian Geology,' this formation was identified with the upper series of the Joggins section, Divisions 1 & 2 of Sir William Logan's sectional list, and with the Upper Barren Measures of the English Coal-fields and the third or upper zone of Geinitz in the Coal-formation of Saxony†.

Still more recently, in a 'Report on the Geology of Prince Edward Island,' 1871, I have referred to the upper part of the same formation the lower series of sandstones in Prince-Edward Island, not previously separated from the overlying Trias‡.

In Prince-Edward Island, however, where the highest beds of this series occur, they become nearly horizontal, and are overlain apparently in a conformable manner by the Red Sandstones of the Trias, which differ very little from them in mineral character. It thus happens that, but for the occurrence of some of the characteristic Carboniferous plants in the Lower series and of a few equally characteristic Triassic forms in the Upper, it would be difficult to affirm that we have to deal with two formations so different in age.

In connexion with this, the entire absence of the Permian system, not only here but throughout Eastern America, raises the question which I have already suggested in 'Acadian Geology,' whether the conditions of the Upper Coal-formation may not have continued longer here than in Europe, so that rocks in the former region constituting an upward extension of the Carboniferous may synchronize with part at least of the Permian. On the one hand, there seems to be no stratigraphical break to separate these rocks from the Middle Coal-formation of Nova Scotia; and their fossils are in the main identical. On the other hand, where the beds are so slightly inclined that the Trias seems conformable to the Carboniferous, no very marked break is to be expected; and some of the fossils, as the conifers of the genus *Walchia*, and *Calamites gigas*, have a decided Permian tendency.

* Quart. Journ. Geol. Soc. vol. x. † Acadian Geology, p. 149.

‡ 'Report on the Geological Structure of Prince-Edward Island,' by J. W. Dawson, LL.D. &c., and B. I. Harrington, B.A., Ph.D.

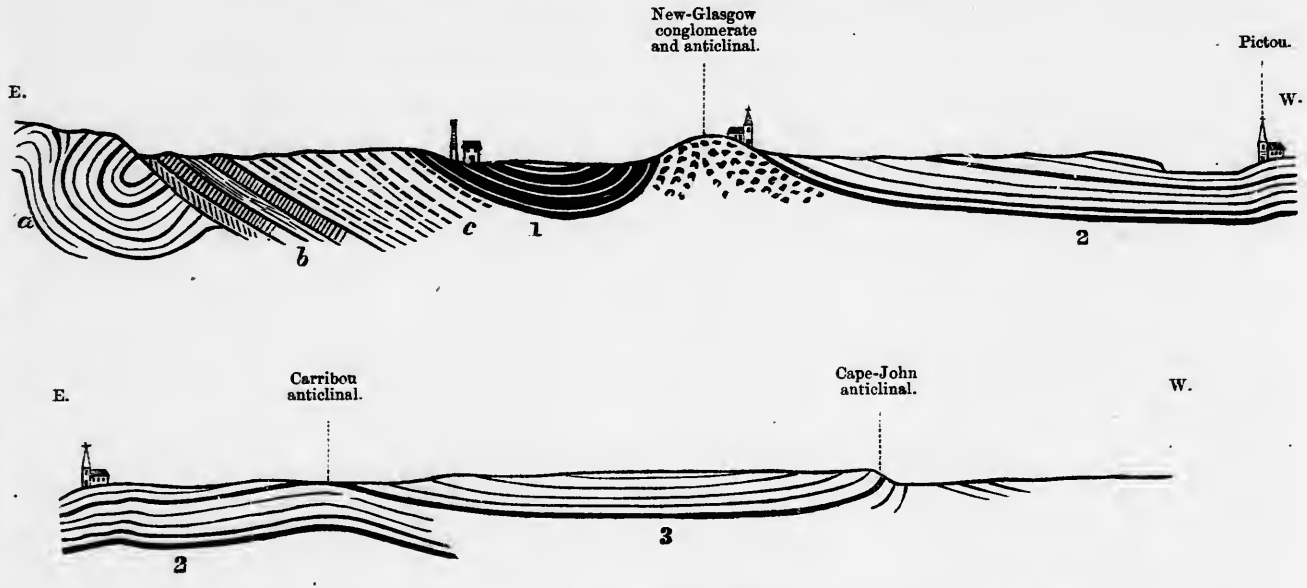
On the whole, in the 'Report' above referred to, I declined to separate the red beds of the Lower Series in Prince Edward Island from the Newer Coal-formation. Prof. Geinitz, however, in noticing my Report*, and also in a private letter, expresses the opinion that the fossils have, as an assemblage, so much of a Permian (or Dyadic) aspect that they may fairly be referred to that formation, more particularly to its lower part, the Lower Rothliegende. Attaching, as every one must, great weight to the judgment of Prof. Geinitz on such a point, I have in recent visits to Nova Scotia reexamined the more instructive sections of the Newer Coal-formation on the eastern coast of that province, with the view of ascertaining whether any stratigraphical or palæontological line can be found to divide the Upper Coal-formation series of my former papers into two members or to separate it from the Middle Coal-formation. The results of this reexamination and their bearing on general geological questions I propose to state shortly as follows :—

The Carboniferous district of Pictou county, extending for about 45 miles along the shores of Northumberland Strait, exposes in that distance in coast- and river-sections the whole thickness of the Carboniferous system, arranged in three *synclinal forms* (see Section, fig. 1). The first or eastern synclinal (No. 1 in the Section), extending from the older metamorphic rocks on the eastward and southward to a line running nearly east and west through the town of New Glasgow, consists entirely of the Lower Carboniferous, Millstone Grit, and Middle Coal-formation, and contains all the known workable Coal-measures of the county. Its northern boundary, the New-Glasgow anticlinal, brings up a bed not recognized in the other Nova-Scotia Coal-fields—the New-Glasgow Conglomerate, an immense mass, believed in some parts to be 1600 feet in thickness†, and containing boulders 3 feet in diameter, with pebbles of all sizes, many of its largest stones being composed of the hard brown or purplish sandstones of the Lower Carboniferous. Its stratigraphical position is that of the upper part of the Millstone Grit or lower part of the Middle Coal-formation ; and it is evidently an exceptional bed, representing an immense bar or beach of gravel and stones stretching from the eastern end of the metamorphic chain of the Cobequid Mountains across the Pictou Coal-field, and protecting those deep swamps in which the Pictou main coal, 36 feet thick, and its black shale roof, more than 1000 feet thick, were deposited. The theory of this remarkable deposit, one of the most singular connected with any Coal-field, is fully discussed in the second edition of my 'Acadian Geology.' I may merely remark that, facing as this bed does the open sea stretching to the northward in the Coal-formation period, it is not unreasonable to suppose that it indicates the action of heavy ice grounding on the shores behind which grew the *Sigillaria*-forests of the Coal-swamps. The arrangement of the beds in

* Neues Jahrbuch, 1872.

† This is Sir W. Logan's estimate, and is warranted by the breadth which the bed occupies in the Section; but there are indications that it thins rapidly toward the dip.

Fig. 1.—*General Section of the Carboniferous rocks of Pictou, Nova Scotia.*



a. Silurian.
1. Middle Coal-formation.
b. Lower Carboniferous.
2 & 3. Upper Coal-formation and Permo-Carboniferous.
c. Millstone Grit.

the first synclinal, which is that of the great Pictou coal-beds, has recently been worked out in much detail by Sir W. E. Logan and the late Mr. E. Hartley.

The second or middle synclinal (No. 2 in the Section) extends from New Glasgow to Carribou Harbour, and centres in the deep indentation of Pictou Harbour. On its southern side it contains, north of New Glasgow, the depauperated equivalent of the Middle Coal-formation; and the remainder of it is occupied by the Newer Coal-formation, whose newest beds, however, are not represented in this trough. The low anticlinal which separates it from the third trough brings up nothing older than the lower part of the Newer Coal-formation.

The third synclinal (No. 3 in the Section) extends from Carribou Harbour to Cape John, and, stretching westward through the Cumberland Coal-field, shows in its centre the newest beds of the Upper Coal-formation.

It is to be observed that in these synclinals the north-west sides have steeper dips than the south-east sides, and consequently occupy a less breadth on the map. The south-east sides also show the best and most continuous sections; and for this reason I shall select the section from New Glasgow to Pictou Harbour, and that from Carribou Harbour towards Cape John, as typical of the lower and upper parts of the Upper Coal-formation.

1. *Section on the East River of Pictou.*

1. On the river-section, below New-Glasgow bridge, the conglomerate is succeeded in ascending order by a grey concretionary limestone 20 feet thick, associated with sandstone and shale, and containing in some layers great numbers of the *Spirorbis* which I have described as *S. arietinus**, and whose habits of life were probably not dissimilar to those of *S. carbonarius*, so abundant in the Coal-measures. This limestone does not appear in the immediate river-section, but on the flank of the conglomerate east of New Glasgow.

2. Above this is a series of black shales and underclays with grey sandstones and some reddish and purple shales, and thin seams of bituminous shale and coal. These beds contain *Stigmariæ*, *Lepidodendra*, Entomostracans and fish-remains, the fossils and the mineral character of the beds alike corresponding with those seen in the upper part of the Coal-measures south of the conglomerate. The thickness of these beds is about 400 feet.

3. This series is succeeded by a thick grey sandstone holding *Calamites*, *Calamodendron*, trunks with aerial roots (*Psaronius*), &c., 30 to 50 feet thick. This appears at the mouth of Smelt Brook and in several quarries to the eastward of that place.

4. Above this is a second series of dark shales and under-clays,

* 'Report of Geol. Survey of Canada.' This limestone may be compared with the "*Spirorbis*-limestone" of the Shrewsbury, Lancashire, and Warwickshire Coal-fields in England. See Hull 'Coal-fields of Great Britain.'

and bituminous shales associated with grey sand-stones and containing fossils similar to those of the series below. It especially abounds in fish-scales and *Cythere*; and several of the fishes are specifically identical with those of the upper part of the Middle Coal-measures as seen in the southern trough, south of New Glasgow. These beds are about 200 feet thick. Mr. H. Poole has described them in the 'Canadian Naturalist' for August 1860.

5. The beds up to this point may be considered the equivalents of the Middle Coal-measures or of the upper part of them, and are now succeeded in ascending order by thick grey and reddish sandstones and reddish and grey shales, including, however, thin coaly bed and underclays, and clays with nodular limestone. These may be regarded as belonging to the Upper Coal-formation; and their aggregate thickness as far as Pictou Harbour may be 2000 feet. They contain *Calamites*, trunks of *Dadoxylon materiarium*, *Lepidodendron*, *Pecopteris arborescens*? and *Neuropteris*.

The dip of the Conglomerate is high; and that this is not altogether due to false stratification is shown by the fact that to the eastward of New Glasgow the limestone and the Coal-measure beds rest on the Conglomerate at an angle of 45°; but this rapidly diminishes to 20°, and in the greater part of the section it is only from 8° to 6°.

The line of demarcation between the Middle and Upper Coal-formations is not marked here by any great physical break, but merely by the cessation of the characteristic beds of the Middle Coal-formation and the change to sandstones associated with red shales.

At first sight it might appear that as the beds north of the Conglomerate dip uniformly to the north, and mostly at slight angles, and those south of its outcrop are much more disturbed, there might be evidence of unconformability. This, however, is due to a line of fault extending along the outcrop of the Conglomerate, and to the greater relative disturbance of the beds of the southern synclinal.

2. *Section west of Carribou Harbour.*

This Section exposes the south side of the third or northern synclinal, and may be supposed to begin not far above the base of the Upper Coal-formation. It extends in ascending order obliquely across the synclinal for about ten miles along a coast in which the beds are on the whole well exposed, with uniform dips of about N. 30° E. magnetic, or nearly true north, and at an angle of about 10°; and no break or evidence of unconformability exists throughout the series, which amounts here in thickness to about 2500 feet.

The lowest beds seen in this section at the mouth of Carribou River are red and grey shales, and grey, red, and brown sandstones, including a small bed of coal 5 inches thick, with *Stigmaria*-rootlets in the underclay; and at Carribou Island, nearly in the line of strike, there is a somewhat thicker bed of coal. The overlying series may be described as consisting of indefinite alternations of shales, mostly deep red, with sandstones, grey, red, and brown, the latter sometimes

coarse and pebbly, and occasionally in thick massive beds. Several of the beds of shale contain concretions of limestone, in one case forming a nearly continuous bed, and with no fossils except a few casts of a *Cythere*. In one of the lower beds of sandstone seen on Carribou River there are concretions of grey copper, and fossil trunks of trees penetrated by this mineral; and some of the fossil trees found in the sandstones on the coast are partly mineralized with sulphate of baryta.

The only material difference in mineral character is that red beds become more prevalent toward the upper part of the section, where the general character of the beds is precisely that of the supposed Upper Coal-formation rocks at Miminigash, Governor's Island, and Gallas Point in Prince-Edward Island, and on the coast of New Brunswick at Cape Jourimain*.

The following statements, reduced from my sectional lists, will serve to illustrate these points of mineral character.

In the whole section the sandstones, including the argillaceous sandstones, are to the shales in the proportion of about two to one in vertical thickness, and the grey and buff sandstones are about equal to those which are brown and red, while the red and mottled shales greatly preponderate over those which are grey.

In the lower half of the section, extending to the mouth of Toney River, the grey sandstone, red sandstone, and shales (mostly red) are in the proportions of $4\frac{1}{2}$, 3, $6\frac{1}{2}$. In the upper half of the section they are in the proportions of $4\frac{1}{2}$, $5\frac{1}{2}$, 3; so that red sandstones become decidedly more prevalent in the upper part, where there is also a greater proportion of coarse pebbly sandstones and of light-red shale with greenish stains.

If we compare this with the upper part of the Joggins section as given in Sir William Logan's lists, we find a thickness of 2267 feet; and if we regard the Ragged-Reef Sandstones as equivalent to the heavy sandstones at the base of the Pictou section, it is possible that the upper part of the latter is not represented at the Joggins. Taking the proportions of sandstones and shales at the latter place, we find them to be grey sandstone 12, red and brown sandstone 1, shale 10; so that here the proportions of sandstones to shales are not very dissimilar to those in the lower part of the Pictou series, but the grey sandstones are greatly more prevalent. Like those in the upper part at Pictou, some of the upper beds at the Joggins are coarse and pebbly, a character not observed, in either Coal-field, in the sandstones of the Middle Coal-formation.

If, on the other hand, we turn to Prince-Edward Island, the geological relations, and especially the fact that the outcrops on Prince-Edward Island correspond with the extension of two of the New-Brunswick Carboniferous anticlinals, would lead us to believe that the upper Coal-formation beds seen at Gallas Point, and amounting to about 800 feet in vertical thickness, must belong to the upper part of the Pictou series, or may even reach some way above its summit. Accordingly we find the proportions of the

* Report on Prince-Edward Island.

several rocks to be grey sandstone 2, red and brown sandstone 4, shales 2, or a still greater proportion of red sandstone as compared with Pictou. All this accords with the idea of a gradual increase of red beds in approaching the summit of the formation, so that the upper Coal-formation passes in its upper part into beds having more the aspect of some parts of the Lower Dyas or Permian. No true dolomite is present in these beds; but Dr. Harrington's analyses show that some of the thin beds of concretionary limestone are highly magnesian, and the sandstones contain concretions of sulphate of copper, while the fossil trees which abound in them are often mineralized with sulphates of copper and iron, and sulphate of baryta.

Fossils of the Upper Coal-formation.

Fossils are by no means so abundant in the Upper as in the Middle Coal-formation, and they are chiefly vegetable. One of the most characteristic plants is *Dadoxylon materiarium*, a species with simple medullary rays, drifted trunks of which abound in a calcified or silicified condition in the sandstones. The fine specimens of the *Sternbergia* pith of this species which I described in 1857 * and 1871 † are from this formation. In the upper beds leafy branches of the genus *Walchia* are common fossils, probably belonging to trees of the genus *Dadoxylon*, the only pines which accompany them. Calamites are also abundant, especially *C. Suckovii* and *C. Cistii*; and *Calamodendron approximatum* is not uncommon, while *Calamites gigas* occurs rarely in the upper part. *Annularia sphenophylloides* is a characteristic plant in the lower part, and *Cordaïtes simplex* is very abundant in some beds. *Lepidodendra* are rare, and represented principally by a species which is identical with, or very near to *L. pictoense*. Among ferns the most abundant species are *Pecopteris arborescens* and a variety of *Alethopteris nervosa*. *Stigmariæ* and *Sigillariæ* are much less frequent even in the lower part than in the Middle Coal-formation, and have not yet been recognized in the upper part.

The following tabular view may serve as a summary of the flora of the Upper Coal-formation as at present known. The first two columns represent the upper and lower parts of the Upper Coal-formation in Nova Scotia; and the third column represents that of Prince-Edward Island. Of the species all but about ten, or more than three fourths, have been found in the Middle Coal-formation also. It will be observed that the number of species, which in all is much smaller than that in the Middle Coal-formation, becomes rapidly reduced in the upper part, and that there is a considerable similarity between the upper series in Nova Scotia and that in Prince-Edward Island. This is further noticeable in the great prevalence of specimens of *Dadoxylon materiarium*, *Walchia*, *Cordaïtes simplex*, and *Pecopteris arborescens* in this part of the formation in both districts.

* Proc. Amer. Association, 1857, Canad. Nat. vol. ii.
† Report on Prince-Edward Island.

Species.	Upper Coal-formation.		
	Nova Scotia.		Prince-Edward Island.
	Lower part.	Upper part.	
1. Dadoxylon materiarium, *Daws.*	*	*	*
2. Walchia (Araucarites) gracilis, *Daws.*	.....	*	*
3. —— (——) robusta, *Daws.*	.....	.....	*
4. Sigillaria scutellata, *Brongn.*	*		
5. Stigmaria ficoides, *Brongn.*	*		
6. Calamites Suckovii, *Brongn.*	*	*	*
7. —— Cistii, *Brongn.*	*	*	*
8. —— gigas, *Brongn.*	.....	.....	*
9. —— arenaceus? *Jäger*	.....	.....	*
10. Calamodendron approximatum, *Brongn.*	*		
11. Annularia sphenophylloides, *Zenker*	*	*	
12. —— longifolia, *Brongn.*	*	*	
13. Sphenophyllum emarginatum, *Brongn.*	*		
14. —— longifolium, *Geinitz*	*		
15. Cyclopteris oblongifolia? *Göpp.*	*		
16. —— heterophylla, *Göpp.*	*		
17. —— fimbriata, *Lesq.*	*		
18. Neuropteris flexuosa, *Brongn.*	*	*	
19. —— cordata, *Brongn.*	*	*	
20. —— heterophylla, *Brongn.*	*		
21. —— rarinervis, *Bunbury*	*	*	*
22. —— auriculata, *Brongn.*	*	*	
23. —— angustifolia?, *Brongn.*	*		
24. Odontopteris Schlotheimii, *Brongn.*	*		
25. Sphenopteris latior, *Daws.*	*		
26. —— alata?, *Brongn.*	*		
27. Alethopteris nervosa, *Brongn.*	*	*	*
28. —— Serlii, *Brongn.*	*		
29. —— acuta, *Brongn.*	*		
30. Pecopteris arborescens, *Brongn.*	*	*	*
31. —— abbreviata, *Brongn.*	*		
32. —— unita, *Brongn.*	*		
33. —— rigida, *Daws.*	.....	*	*
34. —— oreopteroides, *Brongn.*	*	*	*
35. —— Bucklandi?, *Brongn.*, or ? Massilionis, *Lesq.*	.....	.....	*
36. Beinertia Gœpperti, *Daws.*	*		
37. Palæopteris acadica, *Daws.*	*		
38. Cordaïtes simplex, *Daws.*	*	*	*
39. Lepidodendron pictoense, *Daws.*	*	*	
40. —— undulatum, *Sternb.*	*		
41. Lepidophloios parvus, *Daws.*	*		
42. Lepidophyllum, (various sp.)	*		
43. Pinnularia	*	*	
44. Trigonocarpum Nœggerathii, *Brongn.*	*		
45. ——, sp.	.....	.....	*
46. Rhabdocarpus insignis, *Daws.*	*		
47. Antholithes squamosus, *Daws.*	*		

There is unfortunately no recognized Permian in Eastern America wherewith to compare the fossils of the upper member of the Newer Coal-formation; but inasmuch as the Coal-formation of Nova

Scotia is, as I have elsewhere shown, more nearly allied in its fossils to that of Europe than to that of the interior of North America; and as the Permian flora consists to a great extent of survivors from the Coal-formation, it will not be unfair to compare the above list with the species in Geinitz's and Göppert's Memoirs on the European Permian.

The very abundant *Dadoxylon materiarium* is a tree of the same type with several species found in the European Permian, as for instance *D. saxonicum*, Reich., and *D. Schrollianum*, Göpp. *Walchia* is also regarded as characteristic of the European Dyas; but as it is not improbable that it represents merely leafy branches of *Dadoxylon*, it belongs to the Carboniferous as well. One of our species, however, is very near to *W. piniformis* of the Dyas. *Calamites arenaceus*, whether or not an internal axis of *Equisetites*, is Dyadic in Europe; and some of my specimens may well belong to *C. leioderma* of the European Permian. *C. gigas* is a decidedly and peculiarly Permian species. *C. Suckovii* and *C. Cistii* are Permian as well as Carboniferous in Europe, as is also *Calamodendron approximatum*. *Annularia longifolia* is Permian as well as Carboniferous. *Neuropteris rarinervis* is peculiarly American and very widely distributed; but it is questionable if some of its larger-leaved varieties are not identical with European forms known by other names. *Neuropteris flexuosa*, *N. cordata*, and *N. auriculata*, as well as *Pecopteris* (*Cyatheites*) *arborescens*, *P. oreopteroides*, and *P. abbreviata* are both Carboniferous and Permian; and the species which I have compared doubtfully with *P. Bucklandi*, and with *P. Massilionis* of Lesquereux, has strong points of affinity with *P. densifolius* of Göppert. *Cordaïtes simplex* is a peculiar American species, but nearly allied, according to Geinitz, to his *C. Rœsslerianus* from the Lower Dyas. Finally Geinitz thinks the *Trigonocarpum* from Prince-Edward Island to be the same with his *Rhabdocarpus dyadicus*.

We thus have an undoubted palæontological resemblance between the upward extension of the Carboniferous in Nova Scotia and Prince-Edward Island and the Permian of Europe, though in the former regions no stratigraphical break enables us to establish on that ground any well-marked line of division. Taking into consideration the great thickness of the Carboniferous in Nova Scotia and the large development of this Upper Permo-Carboniferous member, it would not be surprising that in this last we may have a chronological equivalent of part at least of the European Permian.

We have no evidence as to age derivable from marine shells. The highest marine limestone known to me, a bed near Wallace Harbour, which I described many years ago in the Journal of this Society *, belongs to the base of the Newer Coal-formation, and contains *Productus cora*, *P. semireticulatus*, and *Aviculopecten simplex*, all characteristic Lower Carboniferous forms.

In Prince-Edward Island the Upper Carboniferous and the Trias are appparently conformable, and may almost be said to pass into

* See also 'Acadian Geology,' p. 214, 2nd edition.

each other, though in Nova Scotia the Trias rests unconformably on the Carboniferous. I believe, however, that this apparent conformity in Prince-Edward Island, and the resemblance of the two series in mineral characters, arises from the almost horizontal position of the Carboniferous beds, and from the circumstance that the Trias has been in part formed from their waste. The Triassic fossils, though few, are of species quite distinct from those of the Carboniferous. Further details as to the relations of these formations in Prince-Edward Island will be found in my Report on that island.

To sum up, it may be said that the beds which overlie the Coal-field of Pictou and extend into Prince-Edward Island, and which constitute the upper part of the Upper Coal-formation, have such strong points of resemblance to the lower part of the European Permian, both in their mineral character and organic remains, that they may fairly be named Permo-Carboniferous, a name already applied to certain marine limestones in the West, in which the Carboniferous graduates upward into the Permian. They may also be held to some extent to bridge over the gap which in Eastern America separates the Carboniferous from the Trias.

I may add that in Nova Scotia the Lower Carboniferous beds are usually more hardened and altered than those of the Middle Coal-formation, and the latter more than those of the Upper Coal-formation. Moreover there are instances in Nova Scotia of local unconformability of the Lower Carboniferous beds; and the New-Glasgow conglomerate affords evidence of extensive denudation of the Lower Carboniferous before the deposition of the productive Coal-measures. These facts indicate the long duration of the Carboniferous period and the extent of the physical changes which it included; and it is evident that, had unconformability or extensive local denudation occurred somewhat higher in the system, it might have been regarded as forming the base of an overlying Permian series.

I have discussed somewhat fully the relations of the flora of the Lower Carboniferous to those of the Devonian on the one hand, and of the Upper Members of the Carboniferous on the other, in a 'Report on the Fossil Plants of the Lower Carboniferous and Millstone Grit,' recently published by the Geological Survey of Canada*. I hope that I may be able at some future time to describe and illustrate fully the plants of the Upper Coal-formation in the same manner.

Discussion.

Prof. Ramsay agreed with the author in thinking that these Upper Carboniferous rocks represented the Permian, and that there is a gradual passage from the Carboniferous to the Permian. In North Staffordshire there is some evidence of this passage, but not in other parts of England. Mr. Binney had argued that the Permian is the uppermost part of the Carboniferous series; but this is not true in the English area, although it is true if we consider the

* Montreal, 1873.

globe in general. The Coal-measures are grey, black, and blue; but in the upper portion they sometimes change to a red tint. During the Coal-period we have evidence of estuarine conditions; but subsequently the access of the sea was cut off, and the Permian rocks were formed in vast inland lakes.

Prof. Hughes remarked that the group referred to by Principal Dawson under the head of Permo-Carboniferous could not be considered as in any way proving a passage from Carboniferous to Permian, seeing that the Permian was altogether wanting in Eastern America, unless the fossils approached those of undoubted Permian in Europe. But he pointed out that many large portions of the so-called Permian of Europe had been already proved to be only stained Carboniferous. The fossil lists were founded on a wrong classification of the rocks, which had not yet been set right. Believing, therefore, that the Permian system must be broken up and part given back to the Lower New Red and Magnesian Limestone series, previously so well established, and part to the Upper Carboniferous, he was inclined to refer the Permo-Carboniferous of Principal Dawson to the latter, the difference in the plants being only such as might reasonably be expected between the newer and older portions of a series representing immense lapse of time and changing conditions. Principal Dawson had shown that the beds in question were similar in almost all but colour, and conformable to the underlying undoubted Carboniferous. If, therefore, they were higher than any Carboniferous beds of England, they must be synchronous with the lower part of the unrepresented time between the Carboniferous and so-called Permian; but being more closely connectod with the lower rocks, he saw no necessity in the present state of our knowledge for such a term as Permo-Carboniferous.

Prof. Ramsay could not agree with Prof. Hughes in his opinion as to the value of the term Permian. The staining of rocks occurs in two ways—namely, by infiltration from above through overlying beds, and by direct deposition. Silurian rocks are often stained in the former manner.

Mr. Evans remarked that this paper had given rise to an interesting discussion. The fact of the two deposits being conformable in one place and unconformable in another, did not, in his opinion, necessarily convert them into one system. He thought there were symptoms that the Permian would eventually be regarded as Upper Carboniferous. He believed that there was a third mode in which rocks were stained—namely, by the oxidation of iron already existing in the beds.