

VIII.—GEOLOGICAL NOMENCLATURE IN NOVA SCOTIA.—BY
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THE DEVONIAN.

In the summer of 1876, a great series of metamorphic rocks, cut by masses of granite and trap, was separated in Cape Breton from the overlying Carboniferous conglomerate made up of their detritus. These rocks were then traced from Loch Lomond to St. Peters, through Isle Madame and into Guysboro and Antigonish counties, as recorded in the reports of the Geological Survey between 1877 and 1881.

Localities were described at which the Carboniferous, comparatively unaltered, comes in contact with and contains pebbles of these metamorphic rocks; several sections indicating a thickness of at least 10,000 feet were given in detail and mention was made of carbonized plants, fish remains, ostracods and other fossils found in many of the beds, the plants including forms like *Psilophyton*, a characteristic Devonian genus.

Above them lies a formation, several thousands of feet in thickness, containing marine fossils of the Carboniferous Limestone series of England and characterized everywhere from Newfoundland to the western boundary of New Brunswick, a distance of 450 miles, by the occurrence of thick beds of gypsum; while at their base lie about 3,000 feet of limestones and other beds of marine origin, shown by Dr. Honeyman, in one of the finest pieces of combined stratigraphical and palæontological geology yet done in Nova Scotia, to range at Arasaig from Medina to Lower Helderberg.

Rocks in this position, precisely similar in lithological character, had been called Devonian in New Brunswick, Newfoundland, Gaspé and on Logan's map of the Pictou Coal field, and this name was accordingly applied to them in Cape Breton.

It was subsequently found that the large Pre-carboniferous area, eighteen miles wide at the Strait of Canso and five miles in width at Lochaber, thirty-five miles to the south-west, instead of being Silurian as claimed by Sir William Dawson, contains only these plant-bearing Devonian strata which are divisible into three groups corresponding closely with those into which the Devonian rocks of New Brunswick had already been subdivided. They extend from Lochaber along the East River of St. Mary's and the East River of Pictou to strike the Inter-colonial railway near Glengarry, form the high land south of Truro and pass unconformably beneath the Carboniferous of Stewiacke River; and a small area is found at MacAra Brook, from which come the fish remains and *Pterygotus* subsequently described by A. Smith Woodward as homotaxial with the upper Silurian or lower Devonian of England.

As this grouping affected also rocks referred by Sir William Dawson * on the evidence of their fossil plants "to the lower part of the coal formation or Millstone Grit" and even higher, it was naturally called in question; and in 1885 Mr. T. C. Weston was sent to Nova Scotia, assisted by Mr. J. A. Robert, to collect fossils between Riversdale and the Strait of Canso. They found everywhere *Lepidodendron corrugatum*, *Stigmaria ficoides* and *Cyclopteris acadica*, forms supposed to be characteristic of the Horton series; on the East River of St. Mary's plants which resemble rhizomes of *Psilophyton*; and, near Sunnybrae, *Cordaites* and numerous markings of *Psilophyton* allied to *P. glabrum* and *P. elegans*; at and near Riversdale they obtained *Calamites*, *Sphenopteris*, *Anthracomya elongata* and *A. laevis*, *Lepidodendron corrugatum*, *Stigmaria ficoides*, ferns and erect trees, characteristic again of the Horton series.

These rocks near Truro and on Cobequid Bay and Minas Basin had in the meantime been recognized by Dr. Ells as probably identical with the Devonian of New Brunswick.

* Acadian Geology, pages 435 and 439; Plants of the Lower Carboniferous and Millstone Grit, p. 13.

The Reports of the Geological Survey for 1885 and 1886 were sharply assailed by Sir J. W. Dawson for their disregard of fossils; they were assumed to cast doubt upon the value and accuracy of the work done in Cape Breton. "As to the rocks of the Riversdale section and that at MacKay Head, I have no hesitation in saying that it would be contrary to all analogy, not only in Nova Scotia but everywhere else, that they should be as low as the Horton series. They are unequivocally Millstone Grit and the flora of these sections is so well-known that there can scarcely be any mistake respecting it. The opinion advanced by Dr. Ells that the rocks of MacKay Head are like those of Riversdale is quite correct, they being the same series; but the comparison of them with the St. John Devonian is quite unwarrantable, the fossils being quite distinct."

This strong dissent induced Dr. Selwyn in 1892 to visit the region and see for himself the position of these strata. His view of their relations was emphatically expressed in the Summary Report for that year. In the conclusions arrived at by Mr. Fletcher he fully agreed. In 1895, Dr. Selwyn was succeeded as director of the Geological Survey by Dr. G. M. Dawson. Maps of Pictou and Colchester counties were then being engraved. The compilation of Sheets 43 to 48 was completed and that of Sheets 56 to 65, 76, 83, 100 and 101 well advanced. In the same year Dr. Ami was sent to Nova Scotia to obtain palæontological evidence of the age of the rocks in question; in the following seasons he was accompanied by the director, and in one season by Dr. Ells.

But in 1898 "certain points connected with the geological structure of that region remained still critical," although it was hoped that the special investigations of that year might render it possible to complete the information for several of the above sheets, which in that event would be promptly issued. At this time, Dr. Ami was protesting against the publication of a report in which he was represented as advocating the Carboniferous age of these rocks. On the contrary, he believed the evidence to show "that the strata of Union and Riversdale may be

regarded as equivalent to those in Lancaster township, New Brunswick, described and held to be of Devonian age," adding that several typical Horton fossils, such as *Lepidodendron corrugatum* and *Cyclopteris acadica* are common to the Riversdale and Union rocks and to the Devonian of New Brunswick.

In the following year, however, he states that so far as the faunas are concerned they clearly indicate a Carboniferous facies for the New Brunswick Devonian, the rocks of Harrington River, Parrsboro, Riversdale, Union and Horton Bluff. The only proof adduced for this radical change, and the addition of 15,000 feet of strata beneath the Limestone to the already enormously developed Carboniferous of Nova Scotia, is that of certain fossils, assumed to have a definite range, in regard to some of which he is surely mistaken. For "the protolimuloid crustacean, usually referred to the Carboniferous system" is on the contrary* also found associated with such characteristic Lower Devonian forms as *Pterygotus*, *Coccosteus*, *Pterichthys* and *Glyptolepis*; *Estheria* is not "all the world over recognized as Carboniferous" any more than *Pterinea* is peculiar to the Devonian; *Leaia* occurs in Pennsylvania in rocks regarded by most geologists as Devonian; and Professor Marsh has described, from the Devonian, amphibians as highly developed as the *Dendrerpeton* found by Sir William Logan at Horton Bluff in 1841 and by Dr. Ami, at Parrsboro in 1898, the affinities of which the latter regards as Permian.

Collections of fossil plants from these rocks in Nova Scotia and New Brunswick were examined by Mr. David White of the United States Geological Survey in 1898, and by Mr. R. Kidston of Stirling, Scotland, in 1899, who came to almost the same conclusions on perfectly independent grounds. Their views are given at length by Dr. Whiteaves in his "Address on the Devonian System in Canada," and may be thus summarized: (1) The Horton series is nearly contemporaneous with the Pocono formation of the eastern United States and the lower

* Ottawa Naturalist for January, 1900, Vol. VIII, No. 10, p. 256.

Carboniferous of England. (2) The Riversdale and Harrington River series are assuredly newer than the Horton and have a most pronounced Upper Carboniferous facies. (3) The plant-bearing beds near St. John, N. B. are not Middle Devonian but Carboniferous and are the exact equivalents of the Riversdale series.

Dr. Whiteaves adds: "Our knowledge of the organic remains of the Devonian of Nova Scotia is still in its infancy, and it would seem that the plant-bearing beds near St. John, N. B., which have so long been regarded as Devonian, may possibly be Carboniferous."

Admitting apparently that "a classification by faunas alone is one-sided and that the physical history of the strata should also be considered," Dr. Ami, in 1899, set aside the authority of the palæontologists mentioned above and accepted the order of superposition* given by "the two geologists on the Canadian Survey staff, who have studied the question from a stratigraphical and lithological point of view," but, as a sort of compromise, for their name Devonian he substituted "Eo-Carboniferous," just as he had previously employed the word "Eo-Devonian" for the so-called Lower Oriskany of Nictaux. This stratigraphical sequence has indeed been admitted by all geologists who have examined it in the field. Richard Brown, Campbell, Gesner, Lyell, Honeyman, Logan, Poole, Ells, Fletcher, Selwyn and others in Nova Scotia; Gesner, Hartt, Matthew, Bailey and Ells in New Brunswick; Murray in Newfoundland; Ells and Whiteaves in Gaspé—all place these rocks beneath the Carboniferous Limestone, near the debatable line between Carboniferous and Devonian, in many indisputable sections where no thrust-faults, outliers, overturned fossil trees or other agency of theoretical biologists are available to make part Devonian, part Coal Measures.

It becomes, then, a question of the transference across this line not of a few feet of strata but of a system of 10,000 to 15,000 feet of beds cut off from a marine formation both above

* Ottawa Naturalist, Vol. XIII, No. 9, p. 207.

and below by great unconformities and intrusions of granitic rocks. The only evidence brought against the name Devonian is that of certain fossils assumed to have a definite range in geological time. Were such a means of classification possible in the present state of our knowledge, and we were to understand that, for example, rocks must not be called Devonian above the horizon of the appearance of amphibians, or Silurian above that of fishes, such a classification would be quite satisfactory. Palæontology is not, however, one of the mathematical or exact sciences, but has its limitations even in the countries in which it has been most diligently studied; consequently, uncertainty exists both in Europe and America regarding the proper limits of this and other formations. We have heard, for example, the work of the Second Geological Survey of Pennsylvania, a most important and thorough industrial investigation, described as conducted on the plan that correlations can best be made by lithological means. "Frequently one meets with expressions of lack of confidence in the evidence offered by fossils." And in a recent report on the Devonian and Carboniferous* "the whole subject of the value of fossil plants as means of correlation" is said to be "under consideration."

It is only necessary to read this report to realize the difficulty met with in attempting to group these rocks by their fossils in Pennsylvania, Ohio, Virginia, Illinois, Michigan and other states†—a difficulty well stated in a report of the American committee of the International Congress of Geologists‡ as follows: (1) "Shall we include the Catskill rocks (and, when no marine faunas occur, up to the base of the Olean conglomerate and equivalents) in the Devonian? (2) Shall the Chemung marine fauna be taken as the uppermost fauna of the Devonian? Or shall a part or the whole of the marine faunas between the middle Devonian and the conglomerate which introduces the Coal Measures be called Devonian? If an arbitrary line is to

* Bulletin of the U. S. Geol. Survey, No. 80, pp. 123, 208 and 228.

† Cf. also "Science" for 26th Jan. 1900, p. 140.

‡ Rep. Geol. Congress, 1888, A. pp. 102, 144; B. pp. 144, 153, 154, 156.

be drawn faunally it should be between the Chemung and the Waverley. The difficulties are not less serious in England, and the Pilton and Baggy beds hold faunas which it is as difficult to settle on the Devonian or Carboniferous side as it has been with the Waverley, Kinderhook or Marshall." Professor J. S. Newberry then proposes a classification in which he includes in the Carboniferous system all strata from the Permian to the Chemung, both inclusive; whereas Professor Hall adopts the first alternative suggested above and restricts the term Catskill group to the beds known as X and XI of the Pennsylvania survey (Pocono and Mauch Chunk); and others speak of the latter as distinct from and overlying the Catskill. Adopting Professor Hall's grouping it would seem that the Mauch Chunk and Pocono may represent respectively the Union and Riversdale series of the Nova Scotian Devonian; and that, unless the littoral and estuarine sediments of Pennsylvania represent the pelagic rocks of the east, there must be a great unconformity by which the gypsiferous formation, traced, as above stated, from Newfoundland to the Aroostook, is lost. It has been found that in working up from the lower Palæozoic, the fossils seem to carry the Catskill to XI of the Pennsylvania classification, in working downward from the upper Palæozoic, the fossils seem to carry the Permian to VIII (Venango).

The International Congress proposes to place the upper limit of the Devonian at the base of the Carboniferous Limestone and to include in the former the Catskill and the so-called Lower Carboniferous or Tweedian group of Scotland. The Tweedian has been also correlated with the Condruz beds of Belgium, from which one of the subdivisions of the Devonian (Condrusian) in the classification of the Congress takes its name.

The annexed tabular view of various classifications proposed for these rocks will show at once their radical inconsistency and the indefinite range of the fossils:—

1	2	3	4
CANADIAN GEOLOGICAL SURVEY.	ELLS & FLETCHER.	DAWSON IN NEW BRUNSW'K.	DAWSON IN NOVA SCOTIA.
CARBONIFEROUS SYSTEM.			
Permian.	Permian, or Upper Carboniferous.	Upper Carboniferous.	
Coal Measures.	Coal Measures.	Coal Measures.	Union or Salmon River.
Millstone Grit.	Millstone Grit.	Millstone Grit.	Riversdale.
Carboniferous Limestone.	Carboniferous Limestone.	Windsor Series.	Windsor Series (Upper Carboniferous of Schuchert.)
Carboniferous Conglomerate.	Carboniferous Conglomerate.	Horton Series or *Albert Shales.	Horton Tweedian of Scotland.†
DEVONIAN SYSTEM.			
Catskill.		Perry.	
Chemung.	Union, including rocks of MacAra Brook, Lochaber and Economy.	Mispec.	Logan's Devonian of Middle River of Pictou. Rocks of Brookfield.
Hamilton.	Riversdale, Harrington River (4000 ft), MacKay Head and Horton.†	Cordaite Shales Dadoxylon Sandstone.	
Corniferous.	Basal Conglomerate.	Bloomsbury.	
Oriskany.			
SILURIAN SYSTEM.		Dr. G. F. Matthew suggests placing the Cordaite Shales in the Silurian.	

* An unconformable series beneath the lower carboniferous limestone and conglomerate.

† The relation of the Horton to the beds immediately overlying the Silurian has not yet been worked out.

5 R. KIDSTON.	6 DAVID WHITE.	7 PENNSYLVANIA.	8 JAMES HALL.	9 J. S. NEWBERRY.
Union ?				Permian.
Riversdale, Harrington River, and Cordaite Shales (St. John Devonian).	Union			Coal Measures.
	Riversdale and Cordaite Shales (Devonian of St. John, N. B.)	Pottsville XII (Olean.)		Millstone Grit.
		Mauch Chunk XI.		Carboniferous Limestone.
Horton — (Lower Carboniferous of England). †	Horton (Pocono of Pennsylvania, Waverly. Newer than Kiltorcan).	Pocono X (White Catskill of Lesley).		Waverley.
		Catskill IX.	Mauch Chunk XI. Pocono X.	Catskill.
		Chemung VIII (Venango).		Chemung. DEVONIAN SYSTEM.
				Hamilton.
				Corniferous.
				Oriskany.
				SILURIAN SYSTEM.

† Referred by the International Congress of Geologists to the Devonian. (Condrusian).

Only the knowledge that palæontologists sometimes "give more consideration to the results of theoretic biologic studies than to the already established stratigraphic succession of the faunas" can explain the foregoing table, which offers the alternative of correlating with the Nova Scotian productive coal measures, lying thousands of feet above the Riversdale, either the Coal Measures of England or the Cretaceous coal-bearing rocks of the Pacific coast.

The Horton cannot be at the same time above and below and on the same horizon as the Riversdale; and Dr. Ami has perhaps acted wisely in omitting it from his classification, its prominence in the others being due to its being easily accessible and first examined. At Horton Bluff it contains only 287 feet of strata well exposed on one side of a syncline, and 459 feet, not so well exposed, on the other; whereas the section at Harrington River shows nearly 4000 feet of black and gray beds; that near Union station 6468 feet of red beds of the upper * group alone (of which 684 feet, containing fish remains throughout, were remeasured at MacAra Brook); while a great thickness of the lower gray and black beds is exposed along the railway from Riversdale to West River and in every brook flowing south from the Cobequid Hills, these exposures being sometimes almost continuous for several miles, as recorded in the reports of the Geological Survey.

It will be readily understood that fossils thus studied and applied, having fixed no definite horizon higher than the Lower Helderberg, have hindered not helped in mapping the comparatively simple geological structure of these formations, while most satisfactory progress has been made by Mr. Fairbault in an investigation of 27,000 feet of more complicated, non-fossiliferous rocks comprising the gold-bearing series of the province.

* Geol. Survey Report for 1886, Part P, page 65.