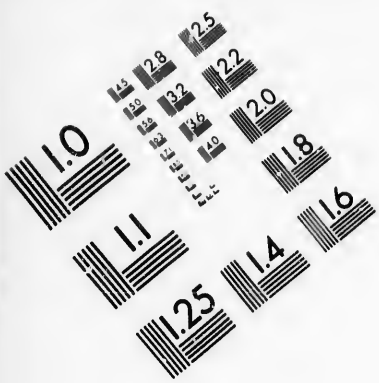

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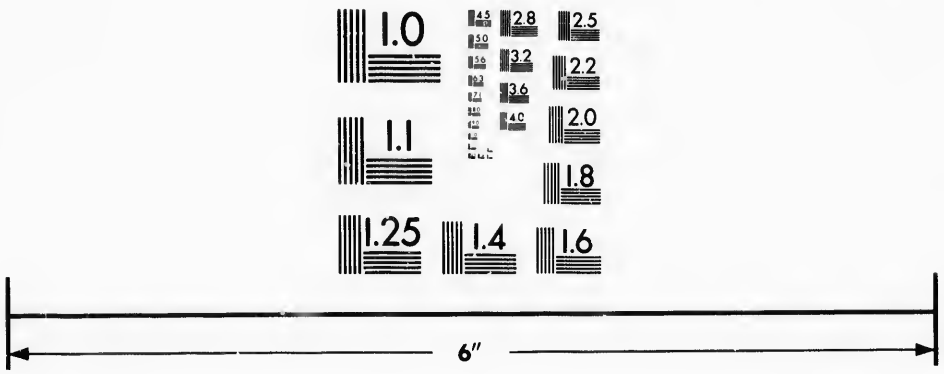

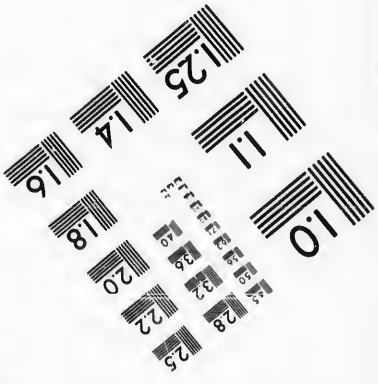

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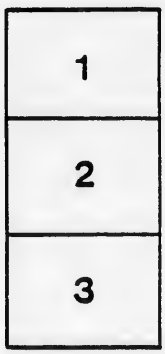

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Peter Redpath Museum,
McGILL UNIVERSITY, MONTREAL.
NOTES ON SPECIMENS—NOVEMBER, 1894

REVISION OF THE

BIVALVE MOLLUSKS

OF THE

COAL-FORMATION

OF

NOVA SCOTIA.

BY

SIR J. WILLIAM DAWSON, LL.D., F.R.S.
F.G.S., &c.

Montreal:
Peter Redpath Museum.
1894

BIVALVE MOLLUSKS

OF THE

COAL FORMATION OF NOVA SCOTIA.

By Sir William Dawson, LL.D., F.R.S.

(*Reprinted from the Canadian Record of Science, October*, 1894.)

The abundant occurrence of shells of bivalve mollusks in the beds associated with coal has long attracted the attention of collectors on both sides of the Atlantic, and various opinions have been entertained as to the affinities of these animals, the nature of their habitat, whether freshwater or marine, and the manner in which they became associated with the coal and its accompanying beds. They occur in extreme abundance in some of the beds of bituminous and carbonaceous shale and in bituminous limestones, and more sparingly in argillaceous and arenaceous shales, throughout the coal-fields of Nova Scotia and Cape Breton, and naturally excited the interest of the writer in his earliest explorations of these beds. It is to be observed also that they not infrequently occur plentifully in the roof-shales of beds of coal.

They were noticed in one of my earliest papers on the coal formation of Nova Scotia in the Journal of the Geo-

logical Society of London in 1853.[1] In this article I figured four species of bivalves from the coal-formation of the South Joggins, but without descriptions. Two of them, one the common *Naiadites* and another a narrow *Anthracomya*, were referred to *Modiola*. Two others were referred to *Unio*. One of these is an *Anthracomya* of Unio-like form. The other appears to be a Carbonicola, perhaps *C. angulata*. I remarked at the time on the vast abundance of these shells and their apparently freshwater habitat. This was the first publication so far as I know of these fossils from the Nova Scotia coal region.

These shells were further referred to in the first edition of "Acadian Geology" in 1855; and in the supplement to that work issued in 1860, I proposed for them a new generic name, *Naiadites*, and described them in the following terms, which I quote here, as indicating conclusions which have to a large extent been verified by subsequent discoveries.

"The so-called Modiolæ of the coal-measures are still uncertain as to their affinities. They do not come within the characters of the genera Cardinia, Anthracosia, &c., to which fossils occurring in similar situations in the British coal-fields have been referred. They are all thin shells, marked with growth lines, but destitute of other ornamentation, and, so far as can be observed, without teeth. In so far as external form is concerned they may all be referred to the genera Modiola and Anodon. But mere form may be a very fallacious guide, and I shall notice what seem to me to be the distinct specific forms under the provisional name Naiadites, intending thereby to express my belief that they are probably allied to the Unionidæ. They are certainly distinct from any of the shells of the marine carboniferous limestones, and are never associated with marine fossils. It is possible that their nearest living analogue is the *Bysso-anodonta* of D'Orbigny, from the River Parana."

At the same time five species were described, and indications were given as to their local and stratigraphical distribution. A sixth species was subsequently discovered,

[1] Vol. X, p. 39.

and another referred to the same group has since been found to belong to the genus Anthracosia or Carbonicola.

Before the publication of the second edition of "Acadian Geology" in 1868, I had sent specimens to my friend, the late Mr. Salter, of the Geological Survey of Great Britain, who was at the time studying the British species, and he described them with some other fossils from Nova Scotia which I had placed in his hands, in a paper in the Journal of the Geological Society[1] with figures of three of the species, which he referred to his two new genera *Anthracoptera* and *Anthracomya*, then recently established for the British species. He thus dropped my genus "Naiadites" and substituted two other names of later date. I might have objected to this, but I have made it a rule never to raise questions of priority or of mere nomenclature, and I felt quite sure that Salter was not a man to do any injustice, while I fully recognized his superiority as an authority on fossils of this kind. There was, however, a more important point involved, having relation to the whole question of the conditions of accumulation of coal. Salter held the shells to be probably marine, and on this ground my name Naiadites was objectionable to him, while one of his names, Anthracomya, implied the idea of burrowing creatures allied to the Mya or sand clam. Now, throughout the whole thickness of the coal-formation of Nova Scotia, there is an entire absence of the species of marine mollusks found in the underlying marine limestones, while the bivalve shells in question occur almost exclusively in the coal measures and are not found in the admittedly marine beds. The question was an important one with reference to the mode of accumulation of coal, a subject then engaging my attention; for though the occurrence of a few exceptional beds holding marine shells might be explicable as the result of occasional invasions of the sea on beds usually beyond its reach, the association of these shells with the beds of coal was so constant and intimate that if they could be proved to be marine, a similar conclusion might naturally be

[1] Vol. XIX, p. 80, 1863.

reached respecting the coal itself, and even some of the plants associated with it. I therefore submitted to Mr. Salter and published in my new edition the following facts, tending to show that my so-called Naiadites were freshwater or estuarine shells.

1. Under the microscope the thicker shells, even those of the Anthracoptera type which most resemble marine species, present an internal lamellar and subnacreous layer and a thin layer of vertical prismatic fibres, covered with a well developed epidermis in the manner of the shells of the Unionidæ or freshwater mussels.

2. The ligament uniting the valves was external, and there seem to have been no hinge teeth. The shells were closed or very slightly open posteriorly, and in some species there are indications of a byssus or "beard" for attachment. The general aspect is in some species that of mussels, in others that of Unios or Anodons.

3. I know of no instance of the occurrence of these shells in the marine limestones or in association with species known to be marine.

4. The mode of their occurrence precludes the idea that they were burrowers, and favors the supposition that they may have been attached by a byssus to floating timber and to one another.

5. The attachment of shells of spirorbis to the outer surface of many specimens seems to show that they were free in clear water when living, while the dense piling together of these shells in some beds almost unmixed with other material, and their occasional occurrence in patches associated with fossil wood, points to the same conclusion.

6. They are associated with fine sediments, vegetable debris, the crusts of minute crustaceans and remains of fishes more likely to have been inhabitants of fresh or brackish water than of the sea.

On these grounds, and being unable from the specimens in my possession to make out evidence of generic distinction, I continued to use the name Naiadites; using however, Salter's names as subgeneric, so as to keep our species in harmony with those of England as described by the Geological

Survey. The matter was left in this form in my edition of 1868. It seems, however, that in substituting a figure not perhaps very accurately drawn from a flattened specimen, for the figure which Salter had given from an angular and compressed example, I caused some misunderstanding as to one of the species, leading to the supposition that one of those named by Salter was different from that which I recognized by the same name. The difference was really in state of preservation with some inaccuracy in drawing in both cases. I shall give below copies of these imperfect figures, which however, represent actual appearances which may mislead collectors, along with a figure carefully copied from a young specimen less distorted than usual.

Subsequently to 1868, the pressure of other work prevented me from giving any further attention to these shells, except in collecting such specimens as occurred to me in my visits to the coal-fields of Nova Scotia, and placing these in drawers and collecting-boxes along with the older material. In the autumn of 1892, however, Dr. Wheelton Hind, F.G.S., who had undertaken a thorough revision of the specimens of this kind in English collections, was so kind as to invite me to place in his hands for study and comparison specimens of the species I had described. Unfortunately his letter arrived at a time when I was incapacitated by severe illness from attending to the matter, and was unable to avail myself of his kindness until after the publication of his paper on the British species in 1893. As soon as possible, however, a suite of specimens was sent to him, along with a note on their mode of occurrence and distribution, and the result was a joint paper which appears in the Journal of the Geological Society for August, 1894, on which the following statements are based.

On examination and comparison with British specimens, some of which are much better preserved than ours, Hind concludes that my seven species, excluding one which he believes belongs to the genus *Carbonicola* of McCoy, *Anthracosia* of King, are referable to two genera which may be named *Naiadites* (Anthracoptera of Salter) and *Anthracomya* of Salter. The first may be regarded as a member of the

family Mytilidæ or mussels, the second as allied to Anodons in the family of the Unionidæ or freshwater mussels, as they are sometimes called.

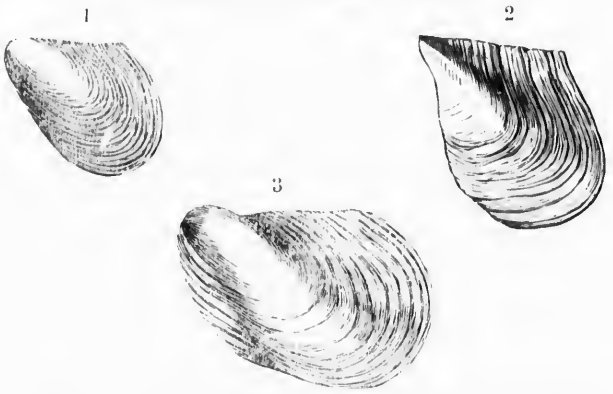
Mr. Wheelton Hind gives the characters of the genera in full. For these characters reference may be made to his paper[1]; but for the benefit of collectors, the following summary of the more important external points may be inserted here.

Genus, NAIADITES, Dawson.

(*Anthracoptera*, Salter.)

Shell Modiola-like, somewhat triangular in form, broad and rounded behind, somewhat pointed in front, beak at anterior extremity, almost terminal, and extending obliquely backward in a more or less pronounced ridge, hinge-line straight, sometimes showing delicate internal striæ, teeth rudimentary; epidermis somewhat wrinkled, surface with concentric lamellæ and lines of growth. A few specimens showing the interior indicate that the hinge-plate was finely striated, and that there was a trifid anterior muscular scar and a larger single posterior one.

1. *Naiadites carbonarius*, Dawson.



Figures 1 to 3.—*Naiadites carbonarius*, Middle Coal-formation, S. Joggins. 1 and 2.—Original figures from imperfect specimens, 3.—More perfect specimen, enlarged x 2.

[1] Journal of Geological Society, May, 1893.

Journal of Geological Society, Vol. X, 1853; Supplement to Acadian Geology, 1860, p. 43; Salter, Journal of Geological Society (Anthracoptera). Vol. XIX, 1863, p. 79; Acadian Geology, 2nd Edition, 1868, p. 204; Wheelton Hind, Journal of Geological Society, Vol. L, 1894.

This is the most common species of the genus, and is very abundant in some shales and bituminous limestones of the coal-formation. So much is this the case, that some thin beds may be said to be made up of these shells, which though somewhat strong, are often much compressed and distorted, so that it is often very difficult to obtain perfect examples. In beds where they are less plentiful they are usually much flattened, by which the general outline of the shell is greatly modified. Owing to these circumstances and also to the fact that the shell is rounder when young and becomes more angular and elongated with age, it is difficult to select typical specimens—hence the published figures are dissimilar. When perfect it may be described as somewhat quadrate, beak anterior, obtusely pointed, hinge line straight, two-thirds the length of shell, ventral margin with slight sinus, posterior margin broadly rounded, umbonal ridge prominent.
my paper of 1853 in "Acadian Geology" second edition, in Salter's paper of 1863, and in Wheelton Hind's paper of 1894, or figures 1, 2 and 3 of this paper).

This shell is very near in form to *Naiadites modiolaris* (*Avicula modiolaris* of Sowerby), and also to some forms of *N. tumida* Etheridge, resembling them in some respects so closely that it is difficult to distinguish some of the Nova Scotian specimens from these English forms. It is also near to *N.* (*Modiola*) *Wyomingensis* Lea, of the Pennsylvania coal measures. These forms may certainly be regarded as representative species.

It is not improbable that some of the shells from the Carboniferous of Illinois and Ohio, which have been referred to the genus *Myalina*, belong to this genus, as suggested by Dr. Hind. Meek and Worthen have also referred a species from the Keokuk group (Lower Carboniferous) to the genus Anthracoptera (Naiadites)—*A. fragilis* M. and W.[1] White has described *N. Polita* (*Anthracoptera polita*) from the coal measures of the West.[2]

[1] Chicago Academy, 1880.

[2] U. S. Geological Survey, XII, 1880, p. 166.

There can be little doubt, from internal markings and external form as well as from mode of occurrence, that these shells were anchored by a byssus to floating timber and to one another, often in great masses, just as the common mussel is found attached to floating logs in the estuaries of modern Canadian rivers. Mr. Etheridge has noticed a group from the coal-formation of Scotland, apparently attached to a stem of a calamite, and Dr. Hind has noticed the same fact. The specimen is in the collection of the English Geological Survey.

The specimens in my collections in the Peter Redpath Museum, are principally from the South Joggins, where myriads of these shells occur in some of the shales as thickly packed together as possible. Other specimens are from Pictou and from Mabou in Cape Breton. They are confined for the most part to the middle portion of the coal-formation of which they are very characteristic, whereas the shells of the next genus range in great abundance from the millstone grit to the newer coal-formation inclusive.

2. *Naiadites longus.* S. N.

4

Fig. 4.—*Naiadites longus*, S. N. Middle Coal-formation, S. Joggins, enlarged, × 2.

Wheelton Hind, (long variety of *N. carbonarius*), Journal of Geological Society, Vol. L, 1894, p. 440, Pl. XX, Fig. 1.

This shell, which occurs rarely in beds associated with those holding the typical *N. carbonarius*, is regarded by Dr. Wheelton Hind as a variety of the preceding. It differs however, very much in form, and there do not appear to be intermediate specimens, while it is rare and solitary, and

would either seem to have been less gregarious in its habits, or to be represented by mere stragglers from its proper locality. It may therefore, be not unreasonably regarded as a distinct species. Most of the specimens in our collections are from the South Joggins, but there are some from Cape Breton. Compare *N. triangularis*, Sby.

3. *Naiadites mytiloides*, s. n.

5

Fig. 5.—*Naiadites mytiloides*, s. n., Chimney Corner, Cape Breton, enlarged × 2.

This small and pretty species has more the aspect of modern mytili than the others, but its internal markings are unknown. It is narrow in front, with the hinge-line slightly curved and the shell widening to the rounded posterior end, where it is regularly curved. The ventral margin is slightly incurved and flattened in the best preserved specimens; but most of the specimens are more or less crushed. The epidermis is not preserved, and the surface shows only a few concentric growth-lines.

These shells occur abundantly, but for the most part broken or crushed, in shale from the coal-formation of Chimney Corner, Cape Breton, collected by a former student of McGill, Mr. Neighswander. They are nearly uniform in size, about half an inch in length. This shell is from one of the more northern parts of the Cape Breton coal-fields. It may be compared with *Myalina meliniformis*, M. & W. from Illinois, also with *N. Carinata*, Sby., England.

Genus ANTHRACOMYA, Salter.

Shell transverse; slightly inequivalve inequilateral, the anterior end being small and rounded, the posterior end rounded and wider. Umbones usually near the anterior end. Hinge-line straight without teeth; ligament external; indications of a byssal furrow in front in some species; surface marked with concentric lamellæ and ridges of growth.

Epidermis thick and sometimes wrinkled, especially in flattened specimens, shell substance usually very thin.

Shells of this genus are more widely distributed, both locally and in time, in the coal-formation of Nova Scotia, than those of the previous genus. Shale surfaces are sometimes crowded with them, though they do not so much enter into the composition of beds of some thickness. There are several species, varying a good deal in form, some being nearly circular, while others are much elongated. There are also two types, one more attenuated and gibbous in front and therefore assuming a more mytiloid aspect, (*e.g. A. elongata*), the other more regularly oval and Unio-like in form (*e.g. A. arenacea*). The first type is in some degree a passage, so far as form is concerned, to the genus Naiadites. The internal surface is not known.

It is noteworthy that while several of the species range from the Lower Carboniferous or the millstone grit to the upper coal measures, the individuals are usually smaller and more depauperated in the lower beds.

1. *Anthracomya elongata*, Dawson.

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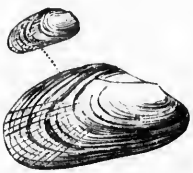

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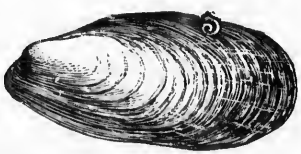

Figs. 6, 7, 8.—*Anthracomya elongata*, Middle Coal-formation, S. Joggins and Mabou, C. Breton. Fig. 6.—Small specimen, natural size and enlarged. Fig. 7.—Large specimen, natural size. Fig. 8.—Medium specimen with spirorbis attached and anterior end slightly crushed in. Enlarged × 1½.

Supplement to Acadian Geology, 1860, p. 43 (as Naiadites); Salter, Journal of Geological Society, Vol. XIX, 1863, p. 79; Acadian Geology, second edition, 1868, p. 20[illegible]; Wheelton Hind, Journal of Geological Society, Vol. L, 1894.

This species is characterized by an obliquely ovate form in typical specimens, the length being about double the breadth. The umbones are somewhat elevated and near the narrower anterior end. The straight hinge-line is somewhat oblique and a little more than one-third of the length of the shell. The front margin is slightly sinuated, the posterior margin regularly rounded. The surface is smooth and shining, with concentric lines of growth.

This is by much the most abundant species, and is very variable in form and size. When aged, it is more elongated than when immature, and the hinge-line is relatively shorter and less elevated. It often has shells of spirorbis attached, and occurs in patches in beds holding vegetable fragments, in a manner to suggest that it may have been attached to these.

The collection in the Peter Redpath Museum contains specimens from various members of the Carboniferous system, and from the South Joggins, Pictou, Sydney, Glace Bay, Mabou, Riversdale, Swan Creek and Parrsboro. The shells from the three latter places are from beds low down in the system, and are of small size. In general form this shell resembles *A. Williamsoni*, W. Hind, of the English coal measures, but is less elongate.

2. *Anthracomya laevis*, Dawson.

9

Fig. 9.—*Anthracomya laevis*, Middle Coal-formation, S. Joggins, natural size, and enlarged.

Supplement to Acadian Geology, last edition, (as Naiadites) Salter, Journal of Geological Society, last edition; Acadian Geology, second edition, p. 205; Wheelton Hind, Journal of Geological Society, l. c.

This is small, broad-ovate, the small umbo about one-third of the distance from the anterior end of the straight hinge-line. To the naked eye the younger shells seem almost circular. The shell is very thin and the epidermis smooth and shining, and much wrinkled in flattened specimens. This little shell has been found in only one bed, a black shale in the lower part of the Joggins coal-measures near the upper part of the millstone grit. It resembles *A. Scotica* of Great Britain.

3. *Anthracomya arenacea*, Dawson.

10

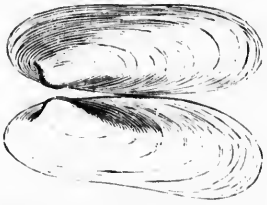

Fig. 10.—*Anthracomya arenacea*, Upper Coal-formation, Pictou, enlarged × 2.

Supplement to Acadian Geology, last edition; Salter, Journal of Geological Society, second edition, p. 205; Wheelton Hind, Journal of Geological Society, l. c.

Shell elliptical, smooth or with very fine concentric lines. Epidermis thin, in many specimens absent. More than twice as long as wide. Anterior margin narrowed in front of beak. Beaks about one-sixth of the length from the anterior end. Posterior end somewhat narrowed at extremity.

This species is usually found in gray arenaceous beds of the upper coal-formation and the millstone grit. It is comparatively rare in the middle coal-formation.

All our museum specimens are from Pictou and Sydney. The species may be compared with *A. lanceolata* of Great Britain.

4. *Anthracomya ovalis*, Dawson.

11

Fig. 11.—*Anthracomya ovalis*, Lower Carboniferous, Parrsboro, enlarged × 2.

Supplement to Acadian Geology, 1860; Salter, Journal of Geological Society, l. c., 1863; Acadian Geology, second edition, p. 205; Wheelton Hind, Journal of Geological Society, l. c.

This species has the general form of the smaller specimens of *elongata*, but is broader behind and more tumid in front, so as to be at once distinguishable by the eye. It occurs sparingly in beds from the millstone grit and lower Carboniferous to the middle coal-formation.

Our specimens are from the South Joggins, Riversdale and Parrsboro. It may be compared with *A. dolabrata* of England, but is always much smaller.

5. *Anthracomya obtenta*, Dawson.

12

Fig. 12,—*Anthracomya obtenta*, Middle Coal-formation, Mabou, Cape Breton, natural size.

Acadian Geology, second edition, p. 205, (as *A. obtusa*, a name which I find was pre-occupied for a species now included in this genus.)

13

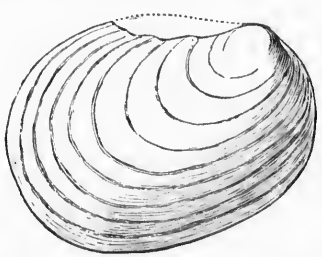

Fig. 13.—*Anthracomya obtenta*, Coal-formation, Pictou, restoration of a flattened and imperfect specimen, enlarged × 2.

General form rounded, and probably when not changed by pressure tumid. Anterior end broad and abruptly rounded; hinge line straight. Beaks raised and somewhat near the front; lower and posterior margins broadly rounded, shell thin, wrinkled when flattened, strongly marked with growth-lines.

This species resembles somewhat *A. Adamsii* var. *expansa*, England. It is rare. Our only specimens are from McLellan's Brook, Pictou, and Mabou, in Cape Breton, and are mostly flattened, except some very young examples from the latter place.

In addition to fragments of plants and comminuted debris of vegetable matter, the beds holding Naiadites, contain a number of other animal remains, constituting a peculiar fauna altogether different from that of the lower carboniferous marine limestone, and also in many respects distinct from that of the sandstones of the millstone grit and upper coal formation. This fauna, though not that which we would expect in fresh-water lakes or streams under ordinary conditions, seems of such a nature as to be appropriate to bodies of shallow, fresh or brackish water loaded with vegetable matter, or to wide and sluggish creeks traversing the great swamps of the period, and occasionally widening into lagoons, receiving much fresh water from the land, and having but little communication with the open sea. The beds supposed to be thus deposited are carbonaceous or bituminous shales and laminated, impure limestones full of earthy matter, and blackened with bituminous and carbonaceous debris. In addition to the bivalve shells in question, they contain vast numbers of minute bivalve crustaceans. (Bairdia and Carbonia)[1] Species of *Eurypterus, Diplostylus and Anthropalaemon*, representing crustaceans of higher types. Great numbers of the little *Spirorbis carbonarius* are also attached to many of the plants and other fossils. Numerous scales and teeth of ganoid fishes of the genera *Palæoniscus, Rhizodus*, &c.,

[1] Rupert Jones, London Geological Magazine, August, 1894, p. 269, and June, 1889, p. 356.

also occur, and teeth of dipnoid fishes (*Ctenodus*), also various species of sharks (*Ctenoptychius, Psammodus, Diplodus*, &c). Some of these sharks must have attained to a considerable size, and they no doubt found access to the inland waters by the outlets communicating with the sea, and were attracted to visit these comparatively impure lagoons by the abundance of food which they afforded.[1] Very rarely there have been found in these beds bones of amphibians and shells of pulmonate snails, (*Pupa vetusta*, &c.). Animals of these kinds no doubt haunted the margins of the lagoons or creeks; but only occasionally left their remains in deposits accumulating in these places.

We perhaps obtain a glimpse of purer inland waters, similar to those of modern Canadian lakes, by means of a remarkable shell, discovered by Mr. Weston, of the Geological Survey, at the South Joggins in 1893, and which has been described by Mr. Whiteaves, F.G.S., under the name *Asthenodonta Westoni*.[2] It resembles in general form the large pearl-mussel of our modern lakes. (*Margaritana margaritifera* L.) and some specimens are no less than nine inches in length, and of somewhat massive thickness anteriorly. It was found in a sandstone with drift trunks of trees, and may have come from some distance inland. Such a shell could scarcely have been a companion of our little Naiadites or Anthrocomyæ, and points to more favorable conditions for fresh-water molluscan life in lakes or large streams in the interior of the continent.

Conditions favourable to such mollusks were probably, as I have elsewhere suggested, more prevalent in the later Erian or Devonian than in the Carboniferous. Hence the occurrence of such large Anodon-like shells as *Amnigenia Cattskillensis*, Hall in New York, and *Anodon Jukesii* in the Kiltorcan beds in Ireland. The above discovery however now gives reason to believe in similar conditions as existing in higher grounds contemporaneously with the great coal swamps of the low plains of the carboniferous period.

[1] Notices of this fauna will be found in Acadian geology, pp. 202 et seq., and supplements.

[2] Trans. Royal Society of Canada, Section iv, 1893

The picture presented by the wide swamps and dark ponds and sluggish streams of the coal-formation period, with the creatures of low organization by which they were inhabited, is not an attractive one; but these conditions, which spread so widely over our continents in the carboniferous period, were those suitable to the accumulation of the great deposits of coal so essential to us in the present condition of the world. The animals which form the subject of the present paper, though of little value or interest in themselves, give much information as to the conditions of accumulation of coal, and it is a source of gratification to the writer of this paper to find that as interpreted by their latest investigator, Dr. Wheelton Hind, they tend to establish more firmly the conclusions as to the manner of the production of coal-beds for which he has contended for so many years, and which are so well illustrated by the admirable sections of the coal-bearing rocks seen in the coast-cliffs of Nova Scotia and Cape Breton.

Throughout the thousands of feet of such rocks, constituting the productive coal-measures as exposed in these sections, I have shown [1] that there is an entire absence of properly marine or oceanic remains; and the accumulations of sediment and organic matter, and the animal and vegetable fossils so abundantly present, all point to the existence of wide swampy flats, traversed by ditch-like creeks, and with shallow lakes or lagoons, supporting an exuberant plant-life, and from time to time inundated. In this way the beds of coal, underlaid as they are by underclays with roots, and overlaid by clays and sands containing prostrate and drift plants, and associated with beds holding a fauna appropriate to such conditions, were accumulated by growth *in situ* in the manner of modern bogs. The accumulation of successive beds with intervening shales and sandstones, is due to the gradual or intermittent subsidence of the areas of deposition under the weight of the sediments laid down upon them, as we see at the present day in the deltas of great rivers.

[1] Acadian geology, chap. XI.

Such were undoubtedly the conditions of coal accumulation; but we must be prepared to admit many exceptional cases. Vast areas of bog imply great tracts of water-soaked and inundated ground, filling up with drifted vegetable muck. They also necessitate such casualities as bursting of bogs and the floatage of their semi-fluid contents over large areas, as we find now occasionally occurring in Ireland and in Florida. To such causes we may attribute beds of earthy bitumen and of cannel coal, and possibly the coal containing fish scales which I have described in the Joggins section [1] or the celebrated Jarrow coal in Ireland, recently so well described by Mr. Bolton [2] in which fossil fishes and batrachians occur imbedded entire in the coal itself, as if they had been overwhelmed and buried in a torrent of vegetable mud. The Jarrow coal is also, over a large part of its area, destitute of an underclay or "seating" as it is called in Ireland, and it thins out in different directions, as if it had been formed in a limited depression of the surface. Such beds constitute the exception which illustrates if it does not prove the rule, by showing how different our ordinary coal beds must have been had they been formed in such special and peculiar ways.

It is further to be observed that while in many places the coal-formation swamps have been elevated into uplands and mountains, in other regions they have been depressed beneath the sea. The island of Cape Breton affords an excellent example of this. It consists of two broad ridges of old Palæozoic and Pre-Cambrian rocks with a carboniferous depression in the middle, and belts and patches of coal-formation beds around its sides, dipping towards the sea. The soundings show that these coal-formation areas are continuous under the sea with those of Nova Scotia proper on the South and Newfoundland on the North, and that they extend to great distances under the Atlantic to the East and the Gulf of St. Lawrence to the West. Thus we can imagine Cape Breton in the coal-formation period

[1] Acadian Geology, pp. 164, 199.

[2] Manchester Transactions, Vol. XXII, Part 16, 1894.

to have consisted of an elevated nucleus of older rocks, perhaps with interior lakes, while around it stretched a great level expanse of bogs and lagoons now in great part submerged. There might thus be a very marked distinction between the hills, thinly covered perhaps with Ferns and Pines, with clear fresh-water lakes, and the vast swamps densely clothed with Sigillariæ, Lepidodendra, Calamites and Cordaites, and with dark bodies of impure water full of vegetable matter. The faunæ of these districts might be equally different. We know little as yet of the upland fauna; but may hope for more discoveries in this direction, especially in countries like Nova Scotia and Cape Breton, where there were elevated districts in the midst of the areas of coal accumulation.

Appendix.

Note on Genus *Carbonicola*, McCoy. (*Anthracosia*, King.)

This genus, which occurs abundantly in the Coal Formation of Great Britain, is represented, so far as known, in Nova Scotia by only two small species, both from the lower part of the Coal Formation, or possibly from the Lower Carboniferous. One of these is *C. angulata* (*Naiadites angulata*, Acadian Geology, p. 204, fig. 46.) It is from Parrsboro, from beds holding fossil plants and, so far as known, no marine shells. The other, *C. Bradorica* (*Anthracosia Bradorica*, Ac. Geol., p. 314, fig. 133 b) is from a shale supposed to be Lower Carboniferous, at Baddeck, Cape Breton. The affinities of these shells are at present uncertain, but will probably be discussed by Dr. Wheelton Hind in a forthcoming paper. Its associations would seem to indicate that the *habitat* of some of the species was similar to that of the genus *Anthracomya*, which at Parrsboro are found in neighboring beds. The figure of *C. Bradorica* is reproduced here to show the characteristic form.

Carbonicola Bradorica.