the islanders, fearing that in some storm, the angry sea might overwhelm their island, had erected wooden bulwarks, fixed in the sand, to stem the force of the waves; but one by one these had been washed away until only a few remained. And then came a mighty storm, such as they had not before known. The crested billows, mountains high, dashed against the shore; and as night closed around them, the fear-stricken islanders, saw that the sand banks were undermined, and the last of the buttresses were tumbling into the flood. All through the long night they listened to the howling of the storm, and trembled lest the whole island should be swallowed up. But when morning came, they found that the sea had washed away the sand banks that had accumulated through long centuries, and had exposed a bed of solid granite, that, before unknown to them, had formed the foundation of their island, and against which the angry sea raged in vain. And is not so with religion? have we not reared bulwarks and buttresses, which we, puny mortals, think are necessary for its support? The sea of knowledge ever spreading, sweeps them away, but exposes the eternal rock of truth on which religion is built.

Art. IV.— *On the characteristic Fossils of different Coal seams in Nova Scotia.* By Henry Poole.

[*Read March* 2, 1863.]

At a late meeting of one of the Scientific Societies in England, I noticed that the question had been asked, whether any law governed the position of fossils in the Coal Formations, and if any attempts had been made to classify or tabulate the *loci* or places in which certain fossils were found, above, or below coal seams, so as to guide explorers in their search for workable seams of coal.

In reply, it was regretted that much attention had not been paid to the subject; and, with the exception of the fact observed by Sir William Logan, that the Stigmaria ficoides, when found in an underclay, always indicates a seam of coal, even if only half an inch in thickness, I am not aware of any other general law having been established.

I am inclined to believe that further research will shew that the difference in quality of the different coal fields is owing to the difference of the vegetation that produced them. That this vegetation varied, according to the nature of the subsoil in which it grew; whether arena-

ceous, argillaceous, or calcareous; or whether it grew in fresh water or saline swamps. My observations lead me to infer that almost every—perhaps every—coal seam has some distinct fossil which belongs to its own period; while there are other fossils, particularly ferns, which appear to prevail through a large number of coal seams indiscriminately.

I think it is very important that the fossils of every coal seam should be carefully noted; and particularly the position, whether above or below the seam, or in any parting which may occur throughout the thick seams.

Theory is of little value, unless it can be supported by facts. I have, therefore, collected and grouped together such facts as I am able to extract from my notes on the different Coal Fields in this Province which I have visited, and which are necessarily very imperfect, as they were not taken at the time, with reference to the subject now under discussion.

Albion Mines Coal Field, Pictou,—commencing at Robert Culton's farm on the east river, one and a-half mile to the south of the Fraser Coal Mine District, and which is the lowest place in geological position that I have examined, I found the coal measures situated on the McCulloch brook to dip 22° N. 40° E., by magnet; but a fault has disturbed the measures, which are here in confusion. They consist of bright bitumenous coal, and cannel-like curled oil coal, with bitumenous shales. In the latter is an abundance of fossils. I obtained Lepidodendron, Cordaites, and other markings, like fruits similar to the Cardiocarpon acutum of Mantell; also, a stalk with a head like ryegrass, supposed to be "Antholithes." One band or more of the shales contains innumerable Spirorbis and Cyprides shells, and accompanying them are ganoid fish scales, teeth, and spines. Thick plates or scales are also found on the same slab with the Cardiocarpon, and many of them resemble the figured plates of the Coccosteus cuspidatus.

Proceeding down the McCulloch brook, but following the coal formation in ascending order, there are appearances of "crops" of coal and shales in several places, but they have not been examined. On coming within the boundary of the Fraser Mine there is the crop of a coal seam five feet thick, dipping 21° N. 25° W., of inferior quality, with a band of Calc spar running through it, with Stigmaria, Sigillaria and Cordaites, in the soft crumbly coal. Overlying this coal at about 200 feet of section, is a thin seam of coal dipping 16° N. 65° W.; and 30 feet above it is a band of oil coal dipping 13° N. 67° W., which is very rich, and varying from 2 to 20 inches in thickness; and from the free way in which it burns, throwing off stars or sparks of light, it has been named Stellar Coal to distinguish it.

There is a black friable clay above the oil coal with ironstone balls in the shale above the clay. Lepidodendron and Stigmaria have been found in the coaly bands; and Cordaites in small fragments, with one Cardiocarpon (similar to those found on Robort Cutton's farm) have been found in the clay ironstone; also a few ganoid scales and nodules full of soft ochreous matter of no decided character. In a trial pit sunk at 200 feet above the oil coal, a large bifurcated Stigmaria rootlet was found in an underclay, 3 feet in length, 12 inches in diameter of the main root; and about 6 inches across on either fork. About 250 feet of section above the stellar is the crop of a seam of bitumenous coal in the brook,—thickness not known, with a band of shale full of Cypris shells dipping N. 20° W.

A short distance further north, in ascending order, some bands of sandstone crop out dipping 15° N. 22° E.; a 5 feet seam of good coal was next observed dipping 7½° N. 26° E, but no fossils obtained in this pit. About 100 feet further north, a seam of coal 19 feet 5 inches, dipping 12° N. 40° E., was sunk through, and Lepidodendron found in the band about 3 feet from the bottom. This seam is thought to be a continuation of the deep seam, but the land is here much disturbed by faults. One hundred and fifty feet above the deep coal seam on section, is another coal seam dipping N., which extends for 40 yards across the brook, so corresponds with the main coal,—Stigmaria were got in the underclay of this seam. A trial pit sunk in advance on the crop of this seam, outside of the General Mining Associatiou's bounds, struck the coal at 32 feet down. At 40 feet the bore rods dropped 3 feet, and the water went away, but returned again. While sinking, the miners plugged this hole, but the water made them abandon the sinking. Sixty yards to the north another pit was sunk 15½ feet in arenaceous shales dipping 18° N. 45° E., containing many impressions of Calamites, Poacites, Neuropteris, and Lepidodendron. Beyond this point on the McCulloch brook, one quarter mile from the General Mining Association's No. 4 corner, where the Garloch road bridge crosses the brook, a sandstone quarry was opened dipping 25° N. 40° E., containing fucoid markings, but nothing well defined.

In a trial pit near Wm. Porter's wood road, Poacites and Cypris shells were found in the shales, but the hole had caved in, so I could not obtain the dip.

Below the middle river road, half a mile on the McCulloch brook, is a sandstone bluff about 30 feet high, which shows a dip of 14° S. 25° E., or reversed to the previous measures; therefore I conceive it has been affected by the ridge of conglomerate which rises up further to the north; and extends across between the east and middle rivers.

Turning to the section of the coal brook on the East River, the deepest underlying measures observed are some bands of sandstone, and a thin seam of coal containing Stigmaria about 30 feet below the Fraser oil coal.

The Fraser Oil Coal is a very peculiar and valuable product, and therefore I think it deserving of a minute description. It is found at a vertical depth of 528 feet below the Albion Mines' deep seam. The roof of this deposit consists of soft, friable shales, with bands of Ironstone nodules, Stigmaria, Sigillaria, and detached Neuropteris leaves, then 14 inches of inferior bituminous coal, directly above the oil coal, which varies in thickness from 4 inches up to 20 inches, and has a smooth, regular parting, both above from the bituminous coal, and below from the oil shale. Throughout its entire thickness, it has a curled and twisted structure. Many of the fractures look like the casts of shells, and the sharp edges are polished and slickersided. No fossils have hitherto been found in this curly oil coal, but scales of calcareous spar are often met with in the joints.

The oil shale next below is about 2 feet thick, and contains ganoid fish scales; also, two or three varieties of Lepidodendron, beautifully preserved; also, leaves of Cordaites of various lengths and breadths, which have undergone so little change, that pieces 4 to 6 inches long, when first removed from their slabs, preserved their elasticity. In the argillaceous shales below are innumerable Cypris and Spirorbis shells. Stigmaria roots are found in some of the overlying ironstone bands.

In sinking a shaft 150 feet deep to the Dr. McGregor coal seam, an upright Sigillaria stem was found, which measured 21 inches across the one way, and 16 inches in the opposite direction, with a coaly bark surrounding it; but the miners, unfortunately, could not take it out in a good state of preservation. Neuropteris leaves were also obtained, and one large leaf, supposed to be a Cordiates, which had apparently undergone very little change. This is, I believe, the first instance of an upright stem having been found in the Albion coal measures; and was not to have been expected in a thick coal seam, according to Dr. Dawson's reasoning in the Acadian Geology—page 246.

Borings and trial pits down the coal brook have shewn some small veins of coal, with shales and sandstone, but no fossils have been collected in them, or in the ironstone bands, of which the exact position of the fossils has been particularly recorded. I therefore pass on to the deep seam, which, in sinking the engine pit, was found to be 24 feet 9 inches. In the roof was found a thin band of fish teeth, much decayed; also, Coprolites; but, as they have not been observed in the roof of the deep seam

elsewhere, it would appear to be a partial deposit. I have no record of any other fossils found in the trial pits sunk on the crop of this seam.

The Main Coal is one of the thickest known bituminous coal seams, and measured 39 feet 11 inches in the engine shaft sunk through it to reach the deep seam 157½ feet below. It is overlaid by an extraordinary thickness of shales and ironstone bands, without any intervening sandstones or limestones. In sinking the engine shaft, 450 feet of shales were passed through, but the only fossils observed were Cordaites. Some of them were several inches broad, and from a foot to 18 inches long, found in the shales when cutting the inclined railroad to the Dalhousie pits. In the sample sent to the New York Exhibition, vegetable remains and Spirorbis were found in the top 3 inches. In the "holing stone," about 6 feet from the roof, are found remains of large fishes and Coprolites; also, Spirorbis, attached to much decayed plants,—in the same way as we find their living representatives at the present time attached to the sea-weed growing on our shores,—large scales of ganoid fishes, and fragments of the large, bony spines with which those fish were armed. It was also in this bed that Dr. Dawson found the upper part of a skull 7 inches in breadth and 5 inches in width, and armed with strong, conical teeth. This fossil was described by Professor Owen under the name of "Baphetes Planiceps." Alluding to its supposed amphibious habits, and the flatness of its skull, Professor Owen believed the creature to which it belonged to have been a gigantic batrachian, or frog-like reptile. From the same band at the Dalhousie pit, a bone was obtained 4 inches in length, broken at each end, and about quarter of an inch in diameter, with a hole through it similar to a tobacco pipe. There was an enlargement at one end, but nothing sufficiently distinct to prove satisfactorily what it was. It was given to Sir Charles Lyell; and Sir Philip Egerton and Professor Owen differed as to whether it belonged to a fish or a reptile; and it is to be regretted that no more bones were discovered. There is also a fine species of Diplodus tooth found in this band, which Dr. Dawson considers to be new, and has named it *Diplodus Acenaces*.

In the next ironstone band 16 feet from the roof, prostrate trunks with coaly layers are found of Lepidodendron, Ulodendron, Sigillaria, Stigmaria, &c. In the coal band, from 20 to 24 feet down, many minute species of fish are found throughout the coal. At 35 feet a fossil trunk in pyrites was observed; but very little is known about the lower part of the main seam, as only an occasional cross-cut is made into that part of the seam. All these seams on the coal brook dip pretty uniformly,—about 18° N. 40° E.; or about one foot to three. In sinking the furnace shaft for the

Dalhousie pits, down on to the main coal, they found, a little above the coal roof, a band of concretionary clay iron-stones,—which many people called fossil oysters: they were nearly round, about 3 inches in diameter, and about 1½ inch in thickness. I could never find any fossil nucleus in them; and I have thought they have been formed by the decomposition of jelly fish.

Going westward from the Dalhousie pits, a band of sandstones crops out, which has been extensively quarried for the use of the works. A great many fucoid and other fossil markings are found through this sandstone, which is not conformable to the main coal measures, but dips to the north. In a trial pit sunk through this sandstone, a fossil fruit was found resembling an olive. This sandstone is overlaid by small seams of coal, of a similar character to the Sydney coals, alternating with shales and sandstones. One seam of coal I traced for upwards of half a mile between two brooks, by observing the change in the forest trees from birch to spruce,—the former growing on the slates overlying the coal, and the spruce growing on the sandstones. In one of these shale bands I obtained a fine fossil Lepidostrobus, which looked like a head of bearded barley, and which is supposed to be the seed-bearing head of the Lepidodendron; but fossils were not often found in these measures, which were much disturbed and broken up by faults, as we went to the north, or towards the New Glasgow Conglomerate. About one quarter mile to the north of the main engine pit, on the west bank of the East River, and at the mouth of the coal brook, the measures shew a dip to the S. E.; and at the mouth of a small brook half a mile further north, near Pensioner Calder's house, a fault shows dipping S. E., with Cypris shells in the shales; and Stigmaria and Calamites in the sandstone dipping 63° S. 20° E. Proceeding further north, near the Gondola wharf, the sandstones dip 36° S. 20° E.; with ripple marks and worm tracks, and shales dip 50° S. 43° E.

Two small seams of coal were found years ago, where Blackwood's mill was erected, dipping at a high angle to the S. E., and near them a trial pit was sunk for oil coal to some depth, but unsuccessfully, and filled up again. On the quarry road, oil coal was found dipping 26° S. 45° E.; and a few yards further east, a pit was sunk 15 feet down, and one foot of good oil coal obtained; dip 50° S. 20° W., but it soon thinned out to a mere thread; it is close upon the back of the conglomerate ridge; and about 50 yards to the east of this pit, red sandstone dips 64° N. 80° E. There is, therefore, upwards of a mile of the coal measures which dip to the S. E., or nearly in an opposite direction to the workable coal seams.

The Conglomerate ridge dips about 54° N. 10° E., where it shews in

the bank near New Glasgow bridge, and is upwards of 200 yards in breadth. It consists of many bands of coarse conglomerate, and red sandstone of irregular thickness and false stratification; and at least one distinct line of a fault through it. Continuing down the west bank of the East River, there are the remains of a freestone quarry, where good building stone was obtained, and of which I have understood the Province Building was constructed. I have not got the exact dip of these measures to refer to, but they dip moderately to the N. E., and Stigmaria roots, upwards of three feet long, have been found in the lower bands.

At the Deacon's Cove, upwards of a mile below New Glasgow, several trial holes were made in the shales near the mill dam in search of oil coals. One seam was 14 inches thick, dipping 5° a little to the east of north; an inch of coal shews about 15 feet above this seam, containing fish remains. In other trial holes the oil shale was poor, dipped 16° due N., contained Diplodus teeth, a fin, Calamites, and other markings. A pit was sunk in the bank above the dam through light blue arenaceous clayslate, containing an abundance of fossil stems, Neuropteris and Sphenopteris leaves; but all very friable, and hard to preserve. At 23 feet down this pit, was a band containing well preserved Unio shells. At 26 feet down the oil shale was found of a good quality, but only 6½ inches thick, so would not pay to work. There was a hard band full of fish remains just above the oil shale, containing scales, plates, teeth, and spines, but all mixed up in confusion together; also, a band with Cypris shells, but its exact position was not ascertained.

One conical tooth Dr. Dawson thought was probably a Rhizodus, but a new species. Broad, flat scales were punctured, and lined after the manner of the Osteoplax, of McCoy; others marked with fine, wavy lines, as in Holoptychius, or Rhizodus. The flat, sabre-like spines resemble in form those of the Devonian Machœracanthi.

Proceeding down the river towards the north, the land is low, and does not shew any rock sections. At Skinner's and Dunbar's Points are thick gravel banks, which have been cut through in making the railroad.

Opposite to the Loading Ground, on Matheson's farm, a thin vein of coal, 1 foot 3 inches thick, was obtained, in a pit sunk near his house, at a depth of 19½ feet. It was overlaid by a band of soft, blue sandy clay-slate, dipping 5° N. 25° E., and containing many Pecopteris, Neuropteris, Lepidostrobus, and Calamites, with sandstone bands below the coal, through which a borehole was put down for 70 feet, but no coal obtained. At 50 feet, a heavy spring of water was tapped, which will be a valuable discovery to the farm.

On Forbes's Point, a borehole was put down 75 feet, but nothing obtained but red and white sandstones, in thick bands. At low water mark, on the extreme point called Skinner's Point, an inch of coal and fireclay is seen to crop out, but no other coal has been observed along the shore of the Middle River.

The overlying sandstones on the point dip 7° N. 74° E. Thick measures of disturbed conglomerate underlie the coal and fireclay near the Little Gut on the north side.

Returning towards the head of the McLellan brook, which is to the eastward of the Albion Mines, and flows into the East River above New Glasgow, the coal measures have been much disturbed, and none of the thick seams of coal have been discovered in the sections exposed upon its banks; while its coal seams and shales do not correspond with any of the sections of the East River. On McLean's brook, which is the point furthest south that I have examined, and about a mile up from the road, are thick bands of conglomerate and slate; then a coaly band said to be 4 feet thick; then sandstones in thick bands with Calamites and Stigmaria dipping 20° N. 70° W. with slate below dipping 50° N. 35° W. This appears to be the lowest part of the coal measures, as the limestone shews a little further up the brook.

A small coal seam, about 2 feet, has been slightly worked, which crops out in the bank on the side of McPherson Fraser's mill dam; and another seam is seen in the brook a short distance below the mill. Water prevented me from getting their exact thicknesses, or bearings, but the latter appeared to be to the N. E.

At Andrew Patrick's mine, the shales, bituminous shales and sandstones which are in ascending geological order, dip 16° N. 38° E. A slope has been driven down 70 feet. There was 1 foot thick of bituminous shale at the crop; 7½ feet thick at the face; curly at the roof, and yielding over 60 gallons of oil to the ton; slickersided at the floor, in which I found a Lepidodendron at the face of the slope; the shale dipped 30° N. 45° E. A second seam about 4 inches thick, and of richer quality, (and at a distance of 44 yards on the surface,) above the worked seam dipped 29° N. 20° E. These works soon came to an end, for the measures reversed about 150 yards down the stream to the north, and dipped 25° S. 20° E.

Lower down the stream, on Turnbull's farm, the measures dip 17° S. 15° E.; and on McDonald's farm, the shales dip 21° S. 15° E., where I got Lepidodendrons and a few Neuropteris leaves in the shales; also ganoid scales, and some peculiar flat wrinkled fossils; which Professor

Agassiz named Holoptychius scales, but which Dr. Dawson has pronounced to be shells, and named them *Naiadites obtusa.*

Following down the windings of the McLellan brook, thick bands of sandstone are seen dipping 16° S. 58° E., and 19° S. 35° E.; also a seam of coal one foot in thickness with a dip of 7° S. 77° E. At S. Black's burnt mill dam, a fault or disturbance has caused the measures to be thrown out of their position; bands of rippled marked and curled sandstone dip 8° S. 20° E. By the bridge thick bands of shales dip 6° S. 25° E.; and one band about 14 inches is bituminous, and yields about 30 gallons of coal oil to the ton. At Rock point, on the opposite side of Geo. Fraser's intervale, are thick beds of shale which have been cut through by the river, and dip 9° S. 70° E., and contain Cyprides, fish scales, and spines, and leaf markings.

Going west, and crossing the underlying measures—as shewn in the brook at 100 yards from the east side boundary line of the General Mining Association,—are bands of cannel coal dipping 10° S. 70° E. The best quality at top is 10 inches; then shaly 2.6; bottom best, 1 foot; total thickness 4.4; abundance of Cypris shells are found in the shales below.

Near McLellan's house on the road side, the shales dip 22° N. 60° W., and in the brook 19° due east.

Going towards New Glasgow, a coal seam crops out in Potter's brook, dipping N. W.; also a seam 3 6 of coal at the back of New Glasgow, worked by John McKay, dips 13° N. 60° W. A coaly shale band directly above this coal, contains innumerable scales and plates of fish, named Rhizodus by Dr. Dawson. Teeth of *Diplodus penetrans*—a small and pretty species of shark-like fish of the Hybodont family; also, teeth supposed to belong to the Ctenoptychius, another shark. In one slab, 4 by 6 inches on the surface, I counted 15 teeth of a larger kind of Diplodus: they averaged half an inch in diameter. No underclay but a band of limestone lies just below this coal. At Wright's adit, not 100 yards higher up the brook, the coal seam is worked 4.7 high, and dips 18° N. 10° E, and has the same kind of roof, with fish scales and teeth, and a pavement of limestone 22 inches thick. The measures dip steeper at the face of the level driven in 100 yards; but as this coal is near the Conglomerate ridge and dips towards it, it is not likely that it will hold good very far.

The Conglomerate ridge on the New Glasgow side of the East River is much higher (upwards of 200 feet), and apparently wider than on the western side, and as the surface is covered with gravel, the dip is not visible.

About half a mile below New Glasgow, a trial pit was sunk 31½ feet at Sinclair's cove, looking for oil coal. They passed through 16 feet of drift; 9 feet of shales; 1 foot 2 inches of black bat and ironstone; then 10 inches of good curly oil bat dipping 10° N. 20° E.; then 9 inches of inferior quality which would burn; then 6 inches of curled fireclay which would not burn, succeeded by a mottled limestone 3 inches thick, dipping 8o N. 25o E.; fireclay below, 2 feet thick.

This limestone is also visible on the top of New Glasgow hill, about two miles off on the line of strike. I could not find any fossils in this pit.

Continuing down the bank side of the East River, near to the junction of the Smelt brook, were indications of the crop of sandstone bands; then a band of 4 inches thick of concretionary limestone, with the lime weathered out. The sample sent to Dr. Dawson contained a fish scale, marked like Gyrolopis. This was overlaid by a thick band of coarse sandstone, full of hard, red, flattened concretionary balls, and ripple marked.

At the point of junction, on the north side, between the Smelt brook and East River, quantities of pieces of bituminous shales were lying on the shore, similar to band No. 1, described hereafter, and which I was not certain whether they had fallen out of the bank above, which was much decomposed, or if they had been washed down the Smelt brook, from where the No. 1 band crosses that stream to the eastward. I am inclined to think the former, as the shales are of too friable a nature to travel far. Then succeed sandstones, with Stigmaria roots and Calamites, and above them soft, yellow, sandy shales, containing Unio shells; then a half-inch vein of coal, with fireclay above and below it, which is succeeded by a sandstone 1 foot 6 inches thick, in which is an "Upthrow Fault," to the north or rise of the measures of several feet, which was not accurately ascertained from the bank being covered with debris. Above this sandstone is 4 feet of arenaceous shale, then 10 inches of oil shale (3rd band of section), in the roof of which were Poacites and Lepidodendrons; also, fish jaws of a Lepidoid fish, perhaps Palæoniscus; teeth were like the Diplopterus; ganoid scales and spines, sabre-shaped, like the Machœracanthus, of Devonian age. Coprolites were also found. Then came 1 foot 6 inches of shale above, then 6 inches of sandstone, then 4 feet of shale, succeeded by No. 2 oil shale, one foot thick, the richest in quality, and containing fish scales, then 1 foot 6 inches of sandy shale, overlaid by No. 1 oil shale, 6 inches thick, containing Corprolites and Diplodus teeth, buckler-shaped scales, resembling the Coccosteus. The whole of these measures dip 10° N. 30° E., but were found to be too thin for profitable

working. No actual measurements have been taken to the north of this place, but sandstones are seen cropping out at several points and bends in the river; while at about 2 miles distance is a freestone quarry, of very good building stone, called the Eagle Rock quarry.

On the opposite side of Pictou harbour, at the Acadia quarry, the freestones dip 22° S. 67° E. At Dickson's mill, near the Town Gut, Pictou, the sandstones dip 22° S. 85° E., and have numerous erect Calamites shewing through the measures. There is a good deal of drift covering the hills, so that the rocks are not visible, except where cuttings have been made, or trial pits sunk. One pit was put down at the back of the town of Pictou 27 feet. A 6 foot band of sandstone, with coaly markings and pyrites, dipping 17° to the S. E., was passed through, succeeded by light blue shaly marl, dipping 24° not regular. I did not see anything to encourage the expectation of finding a workable seam of coal there. At a hole dug on Mr. Paterson's farm, near the gas works, underlying sandstone, is a small seam of coal, about 7 inches thick, dipping 22° south, with an underclay. Fossil ferns and stigmaria markings are found in the sandstone. A deep borehole has been put down by Mr. Primrose, in his field, but no coal found; and, from the position of these measures overlying the conglomerate ridge of Roger's hill, it would appear that they correspond in geological position with the carboniferous formation to the north of New Glasgow, or the newer coal formation of Dawson. I had intended to have prepared a section of the coal measures, on the eastern side of Cape Breton, so as to compare their fossils with those of the Pictou coal field, but I found that it would extend my paper to an unreasonable length, and I shall therefore only refer to those fossils incidentally for comparison.

The distance from Robert Culton's farm to Skinner's Point is about 7 miles, and the measures dip about one foot to three for 3 miles; that is, from Robert Culton's to the conglomerate ridge at New Glasgow, equal to a vertical thickness of 5280 feet, and the 4 miles from the conglomerate to Skinner's Point have a dip of about 1 to 10, equal to a vertical thickness of 2112 feet, or a total thickness of 7392 feet. Only 3 small coal seams have been yet found in the latter section, and the thickest of them is only 15 inches, and the other two do not exceed an inch apiece, while to the south of the conglomerate there are 18 known seams, giving a total thickness of 136 feet.

Professor Forbes has stated that all varieties of sea-bottom are not equally capable of sustaining animal and vegetable life. In all the zones of depth, there are occasionally more or less desert tracts, usually of sand

Sections of the Carboniferous Formation, Pictou, N. S.

Reference.

a . *Conglomerate.*
b . *Sandstone.*
c . *Coal.*
l . *Limestone.*
o . *Oil coal.*
s . *Shales.*

Mc CULLOCH BROOK

COAL BROOK, ALBION MINES

Mc LELLAN BROOK

Scale, One Inch to a Mile.

Henry Poole.
1863.

C & A. Clarke, Lithographers, Bedford Row, Halifax, N. S.

or mud, on which few animals are found, or, if present, are only peculiar to those localities,—each species being adapted to live on certain sorts of sea bottom, only beds of molluscs do not increase in an indefinite extent. They may die out, in consequence of their own increase changing the nature of the ground. Thus a bed of scallops (*Pecten opercularis*), or of oysters, having increased to such an extent that the ground is completely changed, in consequence of the accumulation of the remains of dead scallops, or oysters, becomes unfitted for the further sustenance of the tribe. The young cease to be developed there, and the race dies out, and becomes silted up or imbedded in sediment; when, the ground being renewed, it may be succeeded either by a fresh colony of scallops, or by some other species. It is precisely the same as what takes place among plants: the American forests of pine and spruce are succeeded by the deciduous birch.

I consider this is a plausible way of accounting for the formation of our oil coal shales in the coal formation, which are irregular in their thicknesses, varying from a few inches up to 2 feet, and also of limited areas, not being found distributed over large surfaces. The homogeneity of the bands does not indicate a succession of thin deposits; while the nearly total absence of vegetable fossils, and the more frequent abundance of fish and mollusc remains, lead me to suppose that animal and not vegetable life has produced the deposit from which our coal oils are being extracted. The streak of these oil shales is also brown, instead of black, which is the characteristic of all true coals.

Dr. Dawson has divided the coal formation into three groups. The upper or newer coal formation is about 3000 feet thick—the characteristic fossils are Carboniferous wood, Calamites and Ferns. The localities are north of Cobequid mountain, Colchester, Joggins' coast, west coast of Northumberland, and Pictou. No workable seam has, I believe, been found in this group in Nova Scotia. The second group—lower or older coal formation—is about 4000 feet thick. Its characteristic fossils are Stigmaria, Sigillaria, Lepidodendron, Poacites or Cordaites, Pecopteris, Neuropteris, Sphenopteris, Odontopteris, Dictyopteris, Favularia, Astrophillites, Calamites, Equisetœ among plants. Cypris, Spirorbis, Modiola and Unio among shells. Palœoniscus Holoptychius, Megalicthys, Diplodus, and Diplopterus among fish; and Baphetes Planiceps as a reptile. The localities are, north and south sides of Cobequid mountain, Joggins, East River of Pictou, Port Hood, River Inhabitants, and eastern part of Cape Breton. The finest sections exposed are at Sydney, and Joggins' shore.

The third group, lower carboniferous or gypsiferous formation is about 6000 feet thick. Its characteristic fossils are, Productœ, Terebratulœ, Encrinites and Madrepores among shells found in limestone, Coniferous wood, Lepidodendron and Poacites found in shales and sandstones. Scales of ganoid fish, Trilobites, at Debert river; and Phillipsia, at Windsor. Reptilian footprints, at Partridge Island, near Parrsborough. The localities are Northern Cumberland, Colchester, Hants, Pictou, Musquodoboit, Guysborough, Inverness, Richmond, Victoria, and Cape Breton; also at Chester.

Coal is usually associated with black and gray shales in the carboniferous formation, and the same association occurs in other formations where the coal is too impure, or in too small a quantity to be valuable, Black and gray shales also occur in parts where there is no coal, and in other formations entirely devoid of coal. The coal miner, being accustomed to see coal associated with black and gray shales in other formations, naturally looks upon the occurrence of black and gray shale as indicative of coal. The geologist, on the other hand, having a wider experience, knows that not only do black and gray shales occur where there is no chance of coal being found, but that even thin seams of coal occur in formations where no coal worth working has ever been found. He therefore knows that all "indications" are worthless, as evidence of the presence of the carboniferous formation, except the occurrence of the carboniferous fossils. Even where the fossils occur, there may be no coal; but all sinking for coal, in beds containing any other than the carboniferous fossils, is pure waste of labor and money. The explorer for coal in Nova Scotia should, therefore, bear in mind that no workable seam has been found below the gypsum, or limestone, containing Producta (which, in England, has been called the Farewell coal fossil), Terebratula, or Encrinites; and it would be useless to search for coal in shales below the bands where those fossils occur up the East River, at Stewiacke, Chester bay, New Canaan, Windsor, or other similar formations. At the same time, if the overlying measures continue regular for any distance, I would recommend a careful examination; and should the shales yield fish remains, to carefully note their thickness, and have them tested for oil as well as gas. Many shales are bituminous, from containing innumerable microscopical shells, (Cypris and Spirorbis) and which might be profitably employed as a manure from the quantity of lime which they contain (the present representatives of the former live in ponds or lagoons, and the latter are similar to the *Spirorbis spirillum* now found adhering to the seaweeds on our shores), these shells have been found in many bands with the coals, and generally in the strata overlying the coals.

As might be inferred, when grown where they are found, the Stigmaria or roots of the Sigillaria are found in the underclay; while the upright Sigillaria are met with in a cylindrical state crossing the coal measures at right angles to the present line of dip; and the flattened stems are found in the roof along with innumerable varieties of fern-like leaves which may have belonged to gigantic trees of similar growth to the Sigillaria, or perhaps they may hereafter be found to belong to those very Sigillaria, the same as the Stigmaria are found to be their roots.

Sigillaria stems are rarely found in the Pictou coal measures, while they are abundant in the roof of the Sydney coal mine, and of great size. One that I measured crossing the roof of one of the roadways diagonally, was upwards of forty feet long and over three feet across, but was flattened so that the fossil was not more than two inches thick, and must therefore have been of a cellular nature when growing. There was no branching or break in the whole forty feet, and the side walls of coal prevented the ends of this stem being traced.

The Lepidodendron or "scale marked" plants; like the creeping club moss of our woods, is more commonly met with in the lower coal measures and oil shales of the Pictou coal field. Some specimens obtained at the Fraser mine were beautifully preserved; the markings very sharp and distinct, so that I believe they cannot have been removed from the places where they grew. Some pieces are several inches across, so must have been of much larger growth than the club mosses of the present day. The fruit markings, like Cardiocarpon, having been found only in Culton's shales, would indicate fossils of the lower coal measures; and if found in future explorations would lead me to suppose that the productive coal measures are at some distance above them in geological order. The true Ferns, Pecopteris, Neuropteris, Sphenopteris, &c., are rarely found in the measures of the thick coal seams, and then only as detached leaflets; so may have been drifted, and not grown *in situ*. When found in the Pictou coal measures in any abundance, they are in the overlying clays of the small seams in connexion with the sandstones. They are the most abundant fossils in the roofs of the Sydney and Lingan Mines, which are overlaid by sandstone, and therefore I conclude they are of an arenaceous character, while the overlying argillaceous shales at the Albion Mines seldom contain any thing but the Cordaites, or long narrow leaf markings. I have not observed the Astrophillites in the Pictou coal field, but found them in the roof of the Glace Bay coal, and of an unusually large size by the road side, three miles from Sydney, going from thence to Miré: pieces of coal were dug out of the soil, but no satisfactory exploration has been made

in that locality. The Calamites are more frequently found in connexion with thin, than workable seams of coal. Their congeners are the Equisitœ or Horsetails of our swamps and damp shady localities; but I have also observed the latter growing luxuriantly on the sides of the Pictou railroad embankments, where the shales and slack coal have been deposited, and which must be dry localities. I am therefore led to infer that their luxuriant growth is caused by the excess of carbon in the soil, and to theorise that in the period of the coal formation, there was an excess of Carbonic acid in the atmosphere given off from the underlying Limestones, producing the rapid growth of the endogenous plants of those days. Our hops and many other plants annually grow twenty feet and upwards, and therefore there is nothing unreasonable in considering the luxuriant fossils of the coal measures as of annual growth, and consequently rapidly forming a thick bed of decaying vegetable matter; to be afterwards converted into coal.

The following extract, I took from one of our Halifax papers some time ago:—"According to a statement made by Professor Rogers, the number of coal seams in Nova Scotia is about 50, though only five of them are of workable thickness, being equivalent to about 20 feet coal."

In a new edition of the Student's Manual of Geology, by Mr. J. B. Jukes, Director of the Geological Survey in Ireland, published in 1862, page 532, is the following quotation from Dawson's Acadian Geology:—"Altogether there is a thickness of more than 14,000 feet without reaching any exact base, or arriving apparently at the very highest beds of the series. There are 76 beds of coal, of which, however, most are only one or two inches thick, and the thickest not more than four feet." This quotation refers to the Joggins coal field, and not to the whole of Nova Scotia; and it is strange that Mr. Jukes should have overlooked the large coal fields of Sydney and Pictou. The former coal field Dr. Dawson states to show a cross section of 5,000 yards, containing 37 feet of coal included in 34 seams; while further on, he gives the Indian Cove seam at 4 ft. 8 in., the main seam at 6.9; Lloyd's Cove at 5.0, and Cranberry Head seam at 3.8.

Dr. Dawson does not give a detailed section of the Pictou coal field; but he mentions the main seam having a vertical thickness of 37½ feet, and the deep seam 22¼ feet, respectively. As a pillar 36 feet high of the main coal was sent to the Exhibition in London, it is to be hoped that Mr. Jukes will amend this quotation in his next edition.

I feel that the paper which I have just read has not been made as

interesting as I could have wished it to be; but I have had to confine myself to facts; and my reason for bringing it before this Society, is to have the little information I have collected about the Pictou Coal Field preserved among your archives for future reference; and also with the hope that others may also be stimulated to collect facts in this and other fields of enquiry, and make this Society the source from whence any useful knowledge in reference to Nova Scotia may be disseminated.

Art. V. — *Contributions to the Icthyology of Nova Scotia.* By J. Matthew Jones, F. L. S.

[*Read April* 6, 1863.]

Icthyology has unfortunately been a much neglected branch of zoology, and while we have many works treating upon mammalogy, ornithology, and entomology, there are comparatively few authors who have touched upon the natural history of fish. Perhaps this may in some measure be accounted for by the difficulties attending their study, it falling to the lot of few to be situate in the vicinity of a fishing station; a matter of necessity, when not only the habits, but the forms of fishes, are to be carefully observed; as a naturalist, even if placed in the most eligible locality for procuring specimens, can never expect to complete a perfect list of the several species frequenting that locality, without the assistance of fishermen and others, who, from daily experience can add so much valuable information, which it would be almost impossible for one individual, by his own exertions, to become possessed of. At the present day, however, the value of fish considered as an article of food for the human race, attaches an importance to this branch of science which is growing every year, and it is to be hoped that ere long the investigations of naturalists will afford some clue to the occurrence or absence at particular seasons, of those great annual gatherings of fish, which appear on the coasts of north-east America and Europe, and which I would venture to suggest are more particularly influenced by the paucity or abundance of the peculiar food preferred by each genus, and the instinctive habit of searching for suitable positions for spawning.

An interesting fact in connection with the habits of fish is that of the extremely local range of some species, shoals being observed in one particular bay or inlet, while in those contiguous, and only distant a short space,