

VII.—*On the UPPER COAL MEASURES of LANARKSHIRE.* By WILLIAM GROSSART, Surgeon, Salsburg, Corresponding Member of the Geological Society of Glasgow.

(Read February 8, 1868.)

INTRODUCTORY.—Considering the importance of the coal-measures of Lanarkshire, as bearing on our commercial prosperity, it is surprising how little has been written to illustrate them. True, we have many admirable writers on general geology, but few specialists; what is wanted is a good local geologist in every parish to record his observations before the true history of those coal measures can be written.

We have a good example of a local geologist in David Ure, in his *History of Rutherglen and East Kilbride*, who is now justly regarded as the pioneer geologist of the West of Scotland. His work, although written upwards of seventy years ago, shows that he was a most accurate observer, and his labours were never more appreciated than at the present day. Little more was done for local geology till about twenty years ago, when a "Sketch of the Geology of Carluke Parish" appeared in the *Transactions of the Highland Society*, by Dr. Rankin; and in the same periodical there was a sketch of the "Carboniferous Formation of Lanarkshire," by the late Mr. John Craig. Mr. Craig also read a paper before the British Association in 1840 on the "Coal Formation of the West of Scotland." These papers, being confined chiefly to the descriptive geology of the localities indicated, and no attempt having been hitherto made to arrange the different beds stratigraphically according to their organic contents, it will be the aim of the following paper to accomplish this as far as a few well-ascertained facts will permit. There are, however, certain peculiarities connected with our coals and their associated beds which it will be better to note before taking up the several beds seriatim.

If the upper coal-measures were divided into two sections, the upper section to include all the beds above the Virtue Well coal, the lower all those from that coal down to the slaty-band ironstone, it would be found that the upper section would contain all the thick beds of coal so extensively wrought in the neighbourhood of Glasgow, the Monkland district, and at Wishaw, and several other places in Lanarkshire. In this section the beds of

bituminous shale are much thinner than those of the lower section where the coal beds are thin, consequently fewer animal remains are to be found, as it is principally in beds of shale that they are met with. In sandstone, with the exception of one species of *Anthracosia*, I have found no animal remains, but it is here that trunks and branches of trees are to be met with in abundance, often uncompressed, affording facilities for estimating the probable diameter of plants belonging to the coal flora. The largest I have seen, a *Sigillaria*, uncompressed, measured 20 inches in diameter.

With regard to the distribution of our coal flora, I may state that, from my own observation, *Sigillaria* and Ferns predominate in the upper, and *Calamites* and *Lepidodendra* in the lower section of the upper coal-measures. In places where the "Pyotshaw" and "Main" coal are in contact, forming one seam, the junction is usually indicated by a few inches of coaly shale entirely composed of several species of *Sigillaria* in a good state of preservation. As a general rule all our coal beds rest on fire-clay, and sometimes a bed of fire-clay is present on the top of the coal likewise.

Immediately above all our coal beds there are from one to three bands of argillaceous ironstone, varying from half-an-inch to six inches in thickness, these being also frequent in other parts of the strata. These coal beds have generally a mussel-band accompanying them, either close on the top of the coal or a few feet above it, mostly composed of shells of *Anthracosia*; in some instances the shells are united by a cement, forming a solid band, having the appearance of limestone or marble when polished; in others they are only masses of compressed shells.

The best example of the solid form is what has been called "Cambuslang marble," a massive mantelpiece of which may be seen at Hamilton Palace. They are of no economic value, except the "Kiltongue" mussel-band, which is wrought in several places for the production of paraffin. This band, about 17 fathoms under the Virtue Well coal, consists of $2\frac{1}{2}$ feet of bituminous shale, and 4 inches of good brown paraffin shale, with a few inches of coal at the bottom; and on the top two bands of clay ironstone, the one occupied exclusively by *Beyrichia arcuata*, the other by *Cythere fabulina*, *C. Rankiniana*, and *C. pungens*. It appears to be a general arrangement that all coal beds and black-band ironstones are accompanied by a few inches of gas coal; sometimes it is obtained in the centre, but this is a very local arrangement, the gas coal

on the top is more general. I have seen, in one locality only, 6 inches of gas coal and 2 inches of good black-band ironstone in the centre of a four-foot coal.

The last thing I will notice in connection with these beds is a band of peculiar structure called *cone-in-cone*, found in several places in the upper coal-measures, but it appears not to be confined to this region, as I have found it as far down in the section as the Lesmahagow gas coal. It is found in bands several inches thick, and I have also found it in detached masses, adhering to the under surface of ironstone balls, half-an-inch to 2 inches in thickness. I can throw no light on its formation, but I have found a structure somewhat similar, in a deposit from hot water from a condensing steam-engine.

Changes produced on the beds by igneous action.—The northern half of the parish of Shotts is thickly studded with trap bosses, affording ample opportunities for observation. These outbursts often take the form of “crag and tail,” the escarpment being generally towards the south and south-west. Skirting these trap hills are beds of anthracite, smithy coal, and semi-bituminous or “steam” coal, varieties caused, not altogether from a variable distance, but from the amount of heat they have been subjected to; for sometimes a bed of shale is found close to the trap completely de-bituminised, of a dirty white colour, and in this state used as slate-pencils; and at another place about the same distance from the trap, a bed of shale is converted into a sort of plumbago, showing that like changes do not take place at equal distances. Black-band ironstone is sometimes rendered magnetic when found near trap dykes, although the ironstone has undergone no change in appearance. I have seen a bed of shale near an outburst of trap thickly studded with sulphuret of iron, finely crystallized in cubes, giving the shale a resemblance to roofing slate.

Division of the System.—The carboniferous system of Lanarkshire has been divided into four groups:—

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| 1st. The Upper Coal-measures. | 3rd. The Lower Coal-measures. |
| 2nd. The Upper Limestone Series. | 4th. The Lower Limestone Series. |

For the present I will confine myself to the first of these groups, the upper coal-measures, comprising an average thickness of about 1500 feet, consisting of sandstones, bituminous and aluminous shales, fire-clays, with numerous thin bands of clay ironstones, but no

limestone; and where the series is best developed, of about seventeen workable beds of coal, varying from 18 inches to 14 feet in thickness, besides numerous thin seams of no economic value at present. The workable black-band ironstones in this group are six, varying from 6 inches to 6 feet thick, and six rudimentary black-bands from half-an-inch to 3 inches thick, which, in some favoured locality, may yet be found to be good workable bands.

Before proceeding further it may be useful to define the upper and lower boundaries of the upper coal-measures. The upper boundary is a natural one, being the junction of the new (?) red sandstone, with the carboniferous system at about 80 fathoms above the "Ell" coal. This junction may be further illustrated by giving some details of the strata in this region. Taking the Palaeocraig ironstone as the highest workable seam in Lanarkshire, being 24 fathoms above the "Ell" coal, it has been ascertained from the boring and sinking of pits that for about 60 fathoms above this ironstone, the usual alternations of white sandstone, grey fire-clay, and dark shale, with frequent beds of red sandstone and fire-clay occur, and above that distance, so far as I have seen, no dark or carbonaceous beds are met with.

The only fossil common to the two formations is the *Estheria tenella*, found a few fathoms below the Palaeocraig ironstone, the only locality in the Lanarkshire coal-field where it has been obtained. This little crustacean also occurs near the top of the upper coal-measures of England, and in the Permian beds of Saxony.

Having now attempted to fix the upper limit, I next propose the "Slaty-band" ironstone as a base for the upper coal-measures, restricting the term Slaty-band to an ironstone wrought for upwards of twenty years at Crofthead, in the parish of Whitburn, in Linlithgowshire, and first discovered there. The reason for adopting this band as a base, is founded solely on palæontological grounds, it being the horizon where Brachiopods are first found in our coal-measures in a descending series.

If this base was universally adopted, it would, in many cases, be a saving of money, and prevent many disputes among mineral borers and mining engineers, who generally reckon three "Slaty-bands" in their sections—an upper, a middle, and a lower—one party placing the true "slaty" in the middle, and another at the bottom, or in its normal position. Now, if we take palæontology as our guide—which is more to be depended on than the colour or texture

of the beds—I would say that the Slatyband at Crofthead, Belstone-burn, Carluke; at Goodockhill, and the lower band at Braco, in Shotts parish, are all on the same horizon, because Brachiopods have been found at all those places, but no higher. There is a black-band ironstone, at seventeen fathoms above the Slaty-band, wrought at Braco, Stapend, and Bowhousebog, in Shotts parish, and at several places in New Monkland, which some call “mid-slaty,” but place it, wrongly, on the same horizon as the Crofthead “slaty;” and to prevent confusion, this ironstone may be called Bowhousebog black-band, having been first discovered at that place: it contains no Brachiopods, and very few animal remains. What has been called “upper slaty” is very local, and never found worth working. These bands will be further illustrated when treating of individual members of the series.

Description of the various beds with their organic remains.—In this section I propose to give, in descending order, a short descriptive list of the workable coals and ironstones belonging to the upper coal-measures, beginning with the Palacecraig ironstone. This ironstone lies 24 fathoms above the “Ell” coal, and is principally wrought in the neighbourhood of Whiflet; also at several other places, but too thin for a profitable working. It belongs to the black-band series, but is not of the best quality; its average thickness is about twelve inches. Here, and above, are found organic remains common to the coal-measures. It has been supposed that the genus *Rhizodus* did not exist in the upper coal-measures from the absence of the true type of teeth belonging to that genus; but having lately found several of these teeth in the Palacecraig ironstone, it may be presumed that they exist throughout the whole of the upper coal-measures. These teeth are about one inch and a-half long, nearly straight, section elliptical, with two cutting edges.¹ The same teeth are found, but more plentiful, in the lower coal-measures, and always associated with a large scale, usually called *Rhizodus Porriocki*, which is also abundant in the upper coal-measures, and will, when carefully examined, probably yield several species. These scales, which vary very much both in shape and size, are generally about one to two inches in diameter, and have a sub-central boss. I have made a careful dissection of some of them with muriatic acid, and find them to consist of three layers. The under surface, marked by

¹ Since the above was written, the tooth which I have called *Rhizodus* has been determined by Hancock and Atthey to belong to a reptile—*Pteroplax cornuta*.

concentric lines of growth, being removed, reveals the second or middle layer, consisting of radial, slightly waved lines, less than their own diameter apart, with irregularly placed concentric markings. The third, or outer layer, is a very fine structure, and scarcely visible to the naked eye. The concealed portion of the scale is covered with a finely granular or reticulated structure, the exposed portion with elongated, confluent tubercles, running in various directions, and occasionally forming loops, giving to the exposed portion of the scale a vermicular appearance. Between the concealed and exposed portions of the scale there is no line of separation, the one structure gradually merging into the other. There is another scale generally found with the above, but much larger and thinner, having a structure somewhat similar, which, I believe, has now been associated with a tooth called *Strepsodus*.

About 15 fathoms above the "Ell" coal, the highest coal in the Clyde basin is found, generally known as the "upper" coal. In the neighbourhood of Glasgow it is of good quality, and attains a thickness of three or four feet; but out of that district it is seldom wrought on account of its thinness and inferior quality. The "Ell" or "Mossdale" coal of some localities is a well known, and generally a very persistent seam, extending from Glasgow to Carluke, occupying both sides of the Clyde. It is a soft coal of excellent quality, having a variable thickness of $3\frac{1}{2}$ to 14 feet. The name is derived from an old measure of length, the "ell," of five quarters or 45 inches.

The "Pyotshaw" coal lies from 7 to 10 fathoms below the Ell, and is from 3 to 5 feet in thickness; and the Main Coal, about the same thickness, is often found lying close to the bottom of it, forming the "nine-foot" coal, but there is often a distance of seven fathoms between them.

These last coal-beds have not been thoroughly searched for organic remains, as, in working, part of the coal is left to form the roof, thereby preventing any shale being brought to the surface.

I have hitherto, purposely, passed over the organic remains belonging to the above beds, considering it would be better, and save repetition, to put into groups those common to all the beds, and afterwards introduce anything new or peculiar as it occurs. This arrangement will not lessen the value of this paper, as it will be accompanied by a synoptical table containing all the species as far as they have been determined.

GROUP FIRST.

Shells.—Of the genus *Anthracosia*, the species *A. acuta*, *A. aquilina*, *A. ovalis*, *A. centralis*, and *A. phaseola* are found in most of the beds down to the Kiltongue coal, but no farther. *Anthracomya modiolaris*, and *Anthracoptera carinata* and *A. modiolaris* prevail in most of the beds.

Entomostraca.—*Beyrichia arcuata*, *Cythere fabulina* and *C. Rankiniana* are all that have been found in the upper coal-measures, and are met with in most of the beds.

GROUP SECOND.

Fish Remains.—The following genera pervade all the strata: *Platysomus*, *Cealacanthus*, *Rhizodus*, *Megalichthys*, *Rhizodopsis*, *Pleuracanthus*, *Strepsodus*, *Ctenacanthus*; *Palaeoniscus Monensis*, and *P. Egertoni* are plentiful, with many others of the same genus; but as the scales of these fish vary so much on different parts of the body, it becomes very difficult to determine new species, unless entire specimens could be examined.

Annelids.—The *Spirorbis carbonarius* extends through all the upper coal-measures, in many cases adhering to shells and plants.

The "Humph" coal is found at ten fathoms below the last mentioned coal, and is generally too thin to be profitably wrought, until the thicker seams are exhausted. The next coal, the "Splint," or "Lady Ann" coal, lies about seven fathoms below the "Humph," and is of the best quality, its thickness varying from three to five feet. At the horizon of this coal the *Gyracanthus formosus* and *Anthracomya modiolaris* appear to have attained their meridian; and although found both above and below this point, are not plentiful. It has been suggested that *Gyracanthus formosus* and *G. tuberculatus* belong to the same species; but I have never found the tuberculated form in the upper coal-measures, and after a search of a quarter of a century I have only met with one specimen, which was obtained in the lower limestone series of Lanarkshire. There is another shell, *Anthracoptera quadrata*, which appears to have had a very limited range, being seldom, if at all, seen beyond the region of the Splint coal.

The next seam is the "Sour-milk," or "Virgin" coal, at three fathoms below the Splint, and very seldom wrought.

The next seam is the celebrated Airdrie blackband ironstone, discovered by David Mushet, about the beginning of the present century, but very little used till after the year 1830. It lies about 12 fathoms below the last coal, and has an average thickness of 16 inches. It is now nearly all wrought out. This ironstone is at present wrought at Quarter Ironworks, in the neighbourhood of Hamilton, but is inferior and much thinner than in the Airdrie district. *Ctenoptychius serratus* and *C. dentatus* have been found in this ironstone; also a scale called *Rhomboptychius*, which I have not seen elsewhere; and lately a new species of *Megalichthys* has been found in the same bed at Quarter. There is a soft band of ironstone at about three fathoms below the Airdrie blackband, 18 inches thick, but not wrought at present.

The next coal is the "Virtue Well," about 15 fathoms below the Airdrie blackband; its usual thickness is about $2\frac{1}{2}$ feet, and has been long wrought in the east end of Shotts parish, where it takes the name of the "Benhar" coal, $4\frac{1}{2}$ feet thick. This coal is generally of good quality, and in the Cleland district it is hard and splinty, and used for iron smelting under the name of the Cleland "Wee" coal.

In the Virtue Well coal, the remains of *Gyrolepis* are first met with, and they are occasionally found in the beds below it. Also some palate teeth, which appear to be confined to this bed; one has very much the appearance of the *Climacodus* of M'Coy; another, of a very peculiar form, is not yet determined. There is a species of *Anthracosia* found in this bed, probably new, the smallest of that genus being about the size of a large pea. In this coal and in the Airdrie Blackband, *Anthracosia centralis* is abundant, but does not extend much beyond these beds.

There is an ironstone 2 fathoms above this coal, called the Cleland "rough band," averaging six inches thick, but seldom workable, except at Cleland and Newarthill. The next band is the Bellside ironstone, at six fathoms under the Virtue Well coal. It is a blackband, six inches thick, and of excellent quality, but very local, being only wrought at Bellside and Greenhill, in the parish of Shotts.

At eleven fathoms below the Bellside ironstone, occurs one of those mussel-bands so often met with in the upper coal-measures, and generally known as the Kiltongue mussel-band. It is not introduced here as being of much economic value, but as a well known

point in our strata, being never absent, as far as I have known. The Kiltongue coal is six fathoms below the last band, and from two to five feet thick. It appears to be in its best condition in the Monkland district, and is not found in the Glasgow field. At Carluke it is the first coal in the Castlehill section. In the parish of Shotts, its position is occupied by a number of thin seams of a few inches thick. At several places in New Monkland parish the position of this coal is occupied by Calderbraes ironstone, a blackband, about nine inches thick, having a good gas-coal of about the same thickness, and some free coal accompanying it.

The next coal is the "Drumgray," occurring at eight fathoms below the last, and is one of the most important points, in a palæontological point of view, in the whole section; as it is here that a test has been found—in its organic remains,—which clearly distinguish it from all the other beds that have already been passed through; and well it is so, as no point in the section has been more disputed than the true position of the Drumgray coal.

I will set aside the palæontological test for the present, and treat the subject in the usual way, or in the language used by those who devote themselves to the discovery of minerals:—First: the Kiltongue is the first coal under the Virtue Well, but as that coal is very often out of the section, the second, or Drumgray coal, becomes the first, and is called the Kiltongue coal in many places at the present day. Second: perhaps nowhere in the section is the distance so variable as that from the Virtue Well to the Drumgray coal, ranging as it does from 24 to upwards of 40 fathoms, and some of those experts who, perhaps, have drilled half their lifetime in strata where they have found the Drumgray at 24 fathoms, would hesitate to go much farther, on the supposition that they had already arrived at its position. I will now apply the palæontological test to this disputed point. It will have been observed that in the different beds already passed through no mention has been made of *Anthracosia rugosa* or its varieties. They are *first* met with in the Drumgray coal, and all other species of that genus having now disappeared, it may therefore be laid down as a rule, that the first coal under the Virtue Well seam, containing *Anthracosia rugosa*, is the Drumgray. And further—there is a zone of upwards of 50 fathoms in depth, beginning at the Drumgray coal, and terminating at several fathoms above the slaty-band, occupied exclusively by different

varieties of *Anthracosia rugosa*. This coal is extensively wrought in the neighbourhood of Shotts Iron Works, under the name of the “furnace coal,” and is the second or “two-foot” coal in the Castlehill section; at both of those places a clay-band ironstone is found above the coal, of a workable thickness, and is at present wrought in the vicinity of Shotts Iron Works. Of fish remains, a species of *Mesolepis* has been found in this bed, and a greater variety of palates than in any other part of the section. *Pleuroodus Rankinii* appears to be nearly confined to this bed, but *Pleuroodus affinis* must have had a wider range, as I have found it in the Palacecraig ironstone. It likewise contains *Helodus*, *Cladodus*, and *Pacilodus*. A coal sometimes occurs at seven fathoms below the last, called the Shotts “Low” coal, but is seldom seen in the section; and at Shotts Iron Works—the only place I have seen it wrought,—it has a thickness of two feet.

The next coal is the “little” Drumgray or Shotts “smithy-coal,” eight fathoms under the last—average thickness, 22 inches. This is the third coal in the Castlehill section, and is probably the last and the present coal united, as it measures 4 feet in thickness at Castlehill.

I now enter on a coal-field very little known, and but sparingly developed. In the West of Scotland, no pits have been sunk below the “little” Drumgray, but from journals of boring, there appears to be no workable seam between that coal and the Slaty-band ironstone; but in the east end of Shotts parish, at Crofthead and Armadale, both in Linlithgowshire, and bordering Shotts—also partially developed at Castlehill, in Carluke parish—there are generally five workable coals between the “little” Drumgray and slaty-band ironstone.

First.—Shotts gas coal, six fathoms under the last, and about three feet in thickness, with a half-made black-band a few inches thick in the centre. It only exists as a gas-coal in the central district of Shotts parish and at Armadale, near Bathgate. In the east and west districts of Shotts and the Monklands it exists as a very clean crystalline coal about a foot thick. *Ctenodus* and *Acanthodes* are found here.

Second.—This is called the four-foot coal at Crofthead, but is generally about three feet; and corresponds with the Mill coal in the Armadale district where it is two feet thick. It is about fifteen fathoms below the gas coal.

Third.—At nine fathoms lower there is a two-foot coal which corresponds to the Collinshields coal in the Armadale section. In that locality there is generally a workable ball ironstone above the coal in some places taking the form of a band ironstone of two feet thick, and from its appearance is called the “white ironstone,” and is of oolitic structure.

Fourth.—Five fathoms lower there is a two-foot coal corresponding to the four-foot or Main coal at Armadale. Three fathoms below this coal the last of the mussel-bands is got corresponding to the position of Bowhousebog ironstone.

Fifth.—This is the Crofthead coal and the Coalinburn coal of the Armadale section. It is ten fathoms under the last, and generally two feet thick.

I have now arrived at the lowest bed of the upper coal-measures, the slaty-band ironstone found at an average distance of 10 fathoms below Crofthead coal. This is also the position of the celebrated Boghead gas coal or Torbanehill mineral; but this has been disputed, generally by strangers who have visited the locality and casually examined the section. In “*The Geologist*,” some years ago, there is a “Sketch of the Torbane Mineral Field,” by Mr. Andrew Taylor, where he says—“It occupies a small mineral basin some two or three miles in area, lying immediately above the mountain limestone, but stratigraphically distinct from the upper Lanarkshire coal measures.” That it is not stratigraphically distinct from the upper coal-measures of Lanarkshire, but one of the lower beds of that series will be apparent from a careful inspection of the foregoing section, where I have made a comparison of the coal beds above the slaty-band at Crofthead with those at Armadale near Bathgate, lying above the Boghead gas coal, and find them to agree generally. But a more important test is the finding of *Anthracosia rugosa* in the Bathgate beds which, as I have already proven, is characteristic of the lower beds of the upper coal-measures of Lanarkshire. I hope these remarks will be sufficient to prove the true position of the Boghead gas coal without entering further into the discussion for which I possess ample materials.

The slaty-band ironstone is a black-band of the best quality, and has been wrought at Crofthead for about twenty years. It is generally about ten inches thick, but sometimes it attains a thickness of twenty-two inches. It has been found, and partially wrought, at Castlehill in Carluke parish. It has also been found to the south-

west of Quarter Iron Works near Hamilton. A large field of it is at present being opened up in the east-end of Shotts parish, which is a part of the Crofthead mineral field. In the central district of Shotts parish this ironstone is wrought at several places between Goodockhill and Braco, but is very much faulted. Bowhousebog ironstone lies seventeen fathoms above this, and is of excellent quality, thickness about two feet. These two bands have never been found in the same section except in one pit—at Braco—which is sufficient to establish their relative position. In the ironstone at Goodockhill are found veins of galena running at right angles to the stratification, varying in thickness from a quarter of an inch to that of writing paper. In cavities of this ironstone, quantities of mineral pitch have been found both in a fluid and solid condition. It has likewise been obtained in Crofthead ironstone in a solid condition, and highly elastic. The ironstone at Goodockhill has been wrought at six, four, and two feet thick, thinning out to a few inches, and again swelling out to its usual thickness.

Boghead Gas Coal.—This coal is about 20 inches thick; in some places it thins out to a few inches, and is then accompanied by a black-band ironstone—the slaty-band. In some places the coal is entirely wanting, its place being then occupied by the ironstone, in a workable condition.

I have already stated that the Crofthead and Coalinburn coals occupy the same stratigraphical position at 10 fathoms above the slaty-band; and if distance alone could determine points in the strata, Boghead coal ought to lie 10 fathoms under Coalinburn coal; but this does not prevail in Bathgate district, the distance being usually four feet to about 5 fathoms; but this shortening of the usual distance may be accounted for by the thinning out of the sandstone beds that are usually found above the slaty-band, generally four to six fathoms thick.

The organic remains in the slaty-band are not very abundant; in many cases only single specimens have been got, and it has taken many years of diligent research to collect the following list.

The Brachiopods are—*Discina nitida* and *Lingula mytiloides*. The other shells are—*Conularia quadrisulcata*, *Axinus deltoideus* a *Murchisonia*, and a portion of a *Nautilus*. Associated with these truly marine shells is *Anthracopectera modiolaris*. It was in this ironstone that the first nearly entire specimen of a macrourous

decapod Crustacean was found, for which Mr. Salter proposed the genus *Anthrapalæmon*.

Lepidostrobi are abundant, from six to fourteen inches in length; *Lepidophillum lanceolatum*, various *Lepidodendra*, *Ulodendron majus*, *Alethopteris lonchitica*, and *Stigmaria*, are all found in the ironstone.

Twenty-two fathoms below the slaty-band, an ironstone was wrought many years ago, locally known as the "ginstane," consisting of two clay bands, averaging four to six inches each, and separated by about twelve inches of shale. This ironstone was formerly wrought for the supply of Wilsontown Ironworks, in numerous shallow pits along the outcrop, the debris of which are still to be seen scattered over the fields lying between Crofthead and Levenseat. The only pit of considerable depth was begun at the outcrop of the slaty-band, and conducted down to the "ginstane;" but after working for a time was abandoned as unprofitable. In this pit some beds of reddish fireclay were got, and only one seam of coal six inches thick, but no animal remains, except the following close on the ironstone, viz.,—

Discina nitida, *Lingula mytiloides*, *Leda attenuata*, *Nucula gibbosa*, *Pleurotomaria*, *Goniatites* (both imperfect) *Conularia quadrisulcata*, and *Productus semireticulatus* var. *Martini*.

The next workable band is the "Curly" ironstone, and as this region has been little explored, its distance from the "ginstane" has been estimated, from the dip and rise of the minerals, to be forty fathoms, the strata consisting chiefly of thick beds of sandstone, and some fireclay.

The "Curly" is a clay-band of excellent quality, but very irregular in its distribution, consisting, when in its best condition, of large irregular shaped masses, some of which weigh nearly a hundred pounds. It is chiefly wrought at Levenseat and Muldron, in the parish of Westcalder; also at Davisdykes, in Cambusnethan parish; it has been found also in Carluke parish. The pavement of this ironstone is generally a coarse limestone—sometimes absent—about twenty inches thick, and entirely composed of *Streptorhynchus crenistria*, var. *Kellii*.

Levenseat limestone lies twelve fathoms under the ironstone last mentioned, which has been correctly ascertained from a bore lately put down. Levenseat is an elevated ridge, upwards of 1,100 feet above sea-level, on the confines of Midlothian and Lanarkshire, and

parish of Westcaldar. At the east end of this ridge, which terminates rather abruptly, a limestone has been wrought for a century and a half; at least tradition tells us that it was wrought when there were no roads in that part of the country, and that all the lime required for building and agricultural purposes was carried away in baskets or bags, slung over horses' backs.

This limestone is of excellent quality, and about nine feet thick, divided by a parting of calcareous shale; the under division is of the usual colour; the upper is whitish, or near the colour of a newly fractured encrinite. It is very local, and although its position has a wide range, I am not aware if it has been found, except at Levenseat, and at Standhill, close to the chemical works, near Bathgate. In Mr. Charles Maclaren's work on the Geology of the Lothians, it is stated that this lime contains no fossils; they are certainly not numerous, but the following list is a great advance on twenty years.

In the shale above the limestone, *Calamites* and *Lepidodendra* are found, and an ironstone ball embedded in the shale has yielded *Beyrichia fastigiata*, and another entomostracan. There is a good paraffine shale, a foot thick, a few inches above the limestone, containing scales of *Megalichthys Hibberti*, *Palæoniscus Robisoni*, *Palæoniscus Egertoni* (?), and *Gyrolepis Rankini*, *Otenacanthus*, *Acanthodes*, *Petalodus Hastingsia* and *Orodus*. In the limestone and calcareous shale above it, are found *Productus punctatus*, *P. semireticulatus*, *Spirifera Urvii*, *S. bisulcata*, *Lingula mytiloides*, *Streptorhynchus crenistria* (var.) *Kellii*, *Leptodomus costellatus*, and an *Orthoceras*, three inches in diameter (a fragment only), also a fragment of a trilobite, and an encrinite stem of very small diameter.

The next band is that known in the parish of Carluke as the "Gare limestone," varying from four to six feet thick, and thirty fathoms under the Levenseat limestone. This lime has yielded many rare and beautiful specimens, and is so well known to most members of this Society that I will not occupy space with any further details.

In conclusion I may state that the distances given in the foregoing section are those of an average—they may be increased or diminished about one third to suit different localities.

NOTE.—The genus *Anthracosia* appears to be confined to the upper coal-measures of Lanarkshire. I have never found it lower in the section, neither have I seen it in any collection from the lower coal-measures.

LIST OF FOSSILS FROM THE UPPER COAL-MEASURES OF LANARK-SHIRE, CONFINED TO THOSE IN MY OWN COLLECTION.

ANNELIDA.

<i>Species.</i>	<i>Modes of occurrence and beds in which they are found.</i>
<i>Spirorbis carbonarius</i> , <i>Murch. sp.</i>	In shale, often adhering to plants and shells; in all the beds of the upper coal-measures.

CRUSTACEA.

<i>Beyrichia arcuata</i> , <i>Bean.</i>	In shale and ironstone balls, from Airdrie black-band down to slaty-band.
<i>Cythere Rankiniana</i> , <i>J. & K.</i>	In shale and ironstone, from the splint coal to Shotts gas-coal.
——— <i>fabulina</i> , <i>J. & K.</i>	This species has always been found to accompany the last.
——— <i>pungens</i> , <i>J. & K.</i>	Only in Bellside ironstone and in a ball-ironstone above Kiltongue mussel-band.
<i>Cypridina primæva</i> , <i>M'Coy.</i>	Rare; in black shale seven fathoms below Shotts gas-coal.
<i>Estheria tenella</i> , <i>Jordan.</i>	Abundant in black shale a few fathoms below Palacecraig ironstone, and only found in that locality.
<i>Anthrapalæmon Grossarti</i> , <i>Salter.</i>	In the slaty-band and Airdrie black-band ironstone.

BRACHIOPODA.

<i>Lingula mytiloides</i> , <i>Sow.</i> } <i>Discina nitida</i> , <i>Phill.</i> }	In slaty-band ironstone.
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LAMELLIBRANCHIATA (DIMYARIA).

<i>Anthracosia acuta</i> , <i>Sow.</i>	Common in all the beds down to the Kiltongue coal; in shale and ironstone.
——— <i>ovalis</i> , <i>Mart.</i>	Ironstone and shale; Virtue Well coal and Airdrie black-band.
——— <i>aquilina</i> , <i>Sow.</i>	In all the beds from Kiltongue coal upwards.
——— <i>centralis</i> , <i>Sow.</i>	Rare; Airdrie black-band and Virtue Well coal.
——— <i>phaeola</i> , <i>Sow.</i>	Rare; Airdrie black-band.
——— <i>robusta</i> , <i>Sow.</i> (var.)	Abundant; in all the beds from Drumgray coal to about sixteen fathoms above slaty-band ironstone.
——— <i>sp. nov.</i>	Virtue Well coal; in shale.

<i>Anthracomya modiolaris</i> , Sow.	Not abundant; in shale and ironstone from a point above the Splint coal down to Shotts gas-coal; some fine casts in clay shale above the splint coal.
<i>Anthracoptera quadrata</i> , Sow.	Confined to the region of the splint coal; in shale and ironstone balls.
————— <i>carinata</i> , Sow.	In shale and ironstone; Kiltongue coal to Shotts gas-coal.
————— <i>modiolaris</i> , Sow.	Abundant in all the beds; good casts often found in clay-shale.
<i>Axinus deltoideus</i> , Phil.	Rare; in slaty-band ironstone shale.

GASTEROPODA.

<i>Murchisonia</i> , <i>sp.</i>	In shale; slaty-band ironstone.
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PTEROPODA.

<i>Conularia quadrisulcata</i> , Sow.	Very rare; slaty-band ironstone.
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CEPHALOPODA

<i>Nautilus</i> , <i>sp.</i>	Very rare; in shale; slaty-band ironstone
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PISCES.

<i>Amphicentrum granulosum</i> , Hux.	In shale; Drumgray and Virtue Well coals.
<i>Acanthodes</i> , <i>sp.</i>	Shotts gas-coal; in shale and coal; rare.
<i>Cladodus lævis</i> ,	Rare; Airdrie black-band.
<i>Cladodus conicus</i> , Ag.	Virtue Well coal; in black shale
————— <i>sp.</i>	Drumgray coal; in shale.
<i>Climaxodus imbricatus</i> , M'Coy.	Virtue Well and Drumgray coals; in black shale; rare.
<i>Cœlacanthus</i> , <i>sp.</i>	In all the upper coal measures; in shale and black-band ironstone.
<i>Ctenacanthus</i> ,	In all the beds; more abundant in the upper divisions; in shale.
————— <i>sp.</i>	Rare; Drumgray coal and beds below it.
<i>Ctenodus</i> , <i>sp.</i>	Shotts gas-coal; in the coal.
<i>Ctenopterychius apicalis</i> , Ag.	Virtue Well and Drumgray coal; in black shale.
————— <i>serratus</i> , Ag.	Airdrie black-band and Virtue Well coal; in coal and ironstone.
————— <i>dentatus</i> , Ag.	Airdrie black-band; not plenty.

<i>Gyracanthus formosus</i> , <i>Ag.</i>	In most of the beds; very abundant in the splint coal region.
<i>Gyrolepis</i> , <i>sp.</i>	Virtue Well and Drumgray coals and downwards; in shale.
<i>Helodus simplex</i> , <i>Ag.</i>	Drumgray coal; in shale.
———— <i>lævissimus</i> , <i>Ag.</i>	Found in the same bed.
<i>Mesolepis</i> , <i>sp.</i>	Drumgray coal; rare; in shale.
<i>Megalichthys Hibberti</i> .	Everywhere; in shale and ironstone.
————— <i>sp.</i>	Palacecraig ironstone.
————— <i>sp.</i>	Black-band ironstone at Quarter.
<i>Palæoniscus Egertoni</i> , <i>Ag.</i>	In all the beds; in ironstone and shale.
————— <i>Monensis</i> , <i>Egerton</i> .	In all the beds, but not so abundant as the last species.
————— <i>Robisoni</i> , <i>Hib.</i>	In several places under the Drumgray coal; in shale.
<i>Platysomus parvulus</i> , <i>Ag.</i>	Abundant in most of the beds; in shale and ironstone.
<i>Pleuracanthus gibbosus</i> , <i>Ag.</i>	In all the upper measures; in shale and ironstone.
<i>Pleurodus Rankinii</i> , <i>Ag.</i>	Drumgray coal; not plenty.
————— <i>affinis</i> , <i>Ag.</i>	Palacecraig ironstone and Drumgray coal; in shale
<i>Pœcilodus obliquus</i> , <i>Ag.</i>	Drumgray coal and beds under it.
<i>Pœcilodus</i> , <i>sp.</i>	Drumgray coal, in shale.
<i>Rhizodus Portlocki</i> , <i>Ag.</i>	Abundant everywhere; in shale, ironstone, and gas-coal.
<i>Rhizodopsis minor</i> , <i>Ag.</i>	In the same beds as last.
<i>Rhomboptychius</i> , <i>sp. Huxley</i> .	Airdrie black-band and Virtue Well coal; rare.
<i>Strepsodus sauroides</i> , <i>Huxley</i> .	Abundant everywhere; in shale and ironstone.

The above list does not exhaust all the species found in the upper coal-measures, as a great many still remain undetermined, and the beds above noted only indicate where I have found specimens, and a further research may greatly extend their range.

PLANTÆ.

In collecting plant-remains from the upper coal-measures, I have not bestowed the same care as on the other organisms, and cannot, therefore, arrange them in their several beds in proper order. All I propose is a simple list of names as far as

they have been determined. There are a few plants belonging to the list requiring special notice, as being rare and probably new forms. In the slaty-band, which appears to have been a stagnant pool, abundance of confervoid-looking plants are met with, consisting of clusters of long narrow tubes about the twentieth part of an inch in diameter, resembling our recent *Conjugatae*, but no appearance of joints or cell-divisions have been detected in the filaments. Also a plant resembling the genus *Chara*, which may probably be *Asterophyllites charaeformis*. In this ironstone other plant remains are abundant, especially *Lepidostrobi*, often measuring fully a foot in length. Some of these are found uncompressed, having a diameter of an inch and quarter. In clay shale above Shotts smithy-coal I find a reedy-looking plant, a specimen before me measures three feet in length, tapering, striated longitudinally, but without joints. In a micaceous sandy fire-clay above Drumgray coal, I find what appears to have been seed-vessels, and apparently of two different species; one measures $2\frac{1}{2}$ inches long by 1-10th broad, slightly dilated in the middle, the one end a little wider than the other. Another measures 3 inches long by 6-10ths wide, and of equal breadth throughout. These are all compressed, with a surface apparently smooth, their outline clearly defined, with no apparent fracture. *Asterophyllites foliosus* and *galioides*. *Calamites approximatus*, *C. cannaeformis*, *C. nodosus*. *Cardiocarpum*, one species. *Cyclopteris*, several species. *Halonia*, one species. *Lepidodendron dilatatum*, *L. elegans*, *L. gracile*, *L. Sternbergii*. *Lepidophyllum lanceolatum*. *Lepidostrobus ornatus*, *L. variabilis*. *Lycopodites*, one species. *Lyginodendron Landsburgii*. *Neuropteris*, several species. *Alethopteris lynchitica*. *Sigillaria oculata*, *L. organum*, *L. reniformis*, *L. Saullii*, *L. tessellata*. *Sphenopteris dilatata*, and a few more species, *Ulodendron Lindleyanum*, *L. majus* and *L. minus*. *Walchia*, one species. There are still a great many more species of plant remains which I have not been able to get named.

VIII.—*The* POST-TERTIARY FOSSILIFEROUS BEDS OF SCOTLAND.
 By Rev. HENRY W. CROSSKEY, F.G.S., and Mr. DAVID ROBERTSON.

(Continued from Vol. ii., page 282.—Read March 26, 1868.)

II.—CUMBRAE COLLEGE.

DURING the sinking of a water tank (1867), a bed of shell-bearing sand was exposed near the College, in the Isle of Cumbrae, which must be classed with the older Arctic deposits of the West of Scotland. We were kindly apprised of its existence by Mr. Levack, and found the depth of excavations reached to be 7 feet, with the following succession of deposits:—

- Earth mould,1½ feet.
- Gravel,4 feet.
- Shell-bearing sand,1½ feet (not pierced through).