

matted leaves from bed No. 5 of my second section, and I found sixteen layers—from this one might argue that it took sixteen years to form, and hence 6 inches might have taken about a century. I do not know how this compares with other calculations, but I mention it as a note by the way.

I will now briefly allude to the Tourmalines at Craig-y-chroman, the collection I made being now also in the Hunterian Museum. They occur in a vein in a small boss of schist on the south shore, near the west end of Loch Assapoll. The vein is opened on the north face of the boss and is about 100 feet or so above the loch. The vein stuff is white Felspar and black Mica, and a good pick-axe, hammer, and stout chisel or gad, are very handy. The Tourmalines are black, double-ended, and are often very perfect crystals. Some are fairly large and most show the forms 100, 110 and 111 of Miller's system. A man called Campbell who lives at Bunessan was my *fidus Achates* and guide on these expeditions, and I found him very useful.

In conclusion, I must express my acknowledgments to the very excellent papers by the Duke of Argyll and Professor Judd to which I have previously referred. Without their good company I should have misunderstood or passed over much that I saw in the most interesting and beautiful island of Mull, to whose shores I hope it may some day be my fortune to return.

VII.—THE SILURIAN ROCKS OF LOGAN WATER, LESMAHAGOW.
By J. R. S. HUNTER, LL.D., D.Sc., F.R.Ph.S.Ed., Hon. Mem.

[Read 10th March, 1881.]

HAVING been requested to show the members of our society some of the fossil crustaceans which I found whilst working among the Silurian rocks of Logan Water, and to make a few remarks upon them, it may not be out of place to preface the subject by a few introductory remarks to those who may be unacquainted with the classic ground, to geologists, of the Lesmahagow district.

The parish of Lesmahagow is a very important one as regards its geology, its palæontology, and its archaeology. It contains about 65 square miles according to the Ordnance Survey. On the Douglas, Muirkirk, and Strathavon borders the hills are of con-

siderable height—Nutberry, 1712 feet, on the south-west, the source of the Nethan Water; Priesthill, 1655 feet, on the Ayrshire march; Mickle Auchensilloch, 1609 feet, and Little Auchensilloch, 1479 feet, on the Douglas border; Auchengilloch, 1514 feet, east of Strathavon and at the head of the Kype Water; Auchrobert Snout, 1193 feet; Dunside Rigg, 1308 feet, and one of the sources of the Logan Water; the Law, 1376 feet, near the head waters of the Poneil Water; Dillerhill, 1017 feet; and a lower range of heights upwards from the Clyde to the watershed of Nethan Water. The parish is chiefly drained by the Nethan Water, which from Nutberry Hill to the Clyde has a course north-eastward of about 13 miles, including its windings. The Logan Water is next in importance, but is scarcely half the length of the former stream, into which it flows near Stockbriggs. The Kype Water is of considerable size, dividing the parish in the west, and joining the Avon near the town of Strathavon. Besides these larger streams there are numerous burns, as might naturally be expected in a district so hilly, and having so much moss and meadow land.

I know of no locality where a more interesting and instructive geological field presents itself than here. Within a short distance we can trace the strata from the lower members of the Coal Measures down to the various beds of the Upper and Lower Carboniferous limestone series. The Old Red Sandstone and the Upper Silurian strata can be seen exposed in the banks of the Nethan Water and those of its lateral tributaries. Within a short distance of Cragneithan Castle (where I had the pleasure of reading a paper to the society some years ago on the occasion of one of its Queen's Birthday excursions), which has been immortalised by Sir Walter Scott under the name of Tillietudlem Castle in his story of "Old Mortality," we find, at Fence Pit, a most extraordinary and interesting section, embracing strata of the Upper Coal measures, whilst in adjoining glens are to be seen the Lower Limestones, Lower Coal Measures, and Old Red Sandstone. In the parish of Lesmahagow, as well as in Carluke parish, those interesting beds of argillaceous shale and fresh-water limestone deposits, known as the Ballagan series, are awaiting. The Calcareous Sandstones are, however, more or less exposed in the neighbourhood of Stockbriggs House, and continue until we reach the junction of the small stream known as Scotsburn on the

Nethan Water, where the upper members of the Old Red Sandstone are exposed, and are found to consist of concretionary limestone embedded in a red marl. This limestone has been long searched for organic remains, but until recently no traces of such have ever been discovered. These beds were probably deposited in an inland lake supercharged with carbonate of lime, and no doubt similar to the modern Salt Lake of Utah, in America.

The Old Red Sandstone is extremely well developed in the parish. Its base passes down conformably into the Upper Silurian strata, and is seen along both of its anticlinal folds, where they begin to join each other. The lithological character of the strata is very variable, consisting mostly of chocolate and grey sandstones, with grey and green flaggy shales, while the uppermost beds of the group are not here developed. The thickness of the strata, from the quartz rock conglomerate upwards, may be not less than 10,000 feet. These conglomerates are seen in Nethan Water, Eaglin Burn, and at various other places. Starting from near Deadwater Bridge, on the Strathavon Road, then in a straight line passing onwards through High Kypeside, Priorhill, and Auchrobert Snout, to the Nethan Water, near the junction of the Eaglin Burn, this track will easily represent the course of the conglomerates separating the Old Red from the red and grey shales. A line drawn from Deadwater, Bellscroft, Dunduff, Ladehead, and onward to Nethan Water, below Kerse House, then going by Auchnotioch and Hallhill to the islands in the Clyde at Underbank, above the village of Crossford; then up the Clyde past Hazelbank, Stonebyres, Cora Linn, and Bonnington Falls, by Harperfield to Douglas mouth, going nearly west by Cora-more and Birkhill to Moat near Bankfoot; then by Auchtool, Devonburn, and Aulton to Nethan Water, between Bracken and Browhill; then by Fulford, Meadow, Craighead, and Bankend, will form nearly the boundary enclosing the Old Red Sandstone, and dividing the Coalburn and Auchenheath coalfields. Although there is such a stretch of the Old Red series, it has as yet proved almost devoid of organic remains, but I am not without hope that a locality may yet be discovered where lie some of those wonderful organisms so ably and graphically described by the late Hugh Miller.

Igneous rocks occur frequently in the parish, causing numerous faults and dislocations, some being of great extent. One dyke, traceable from Douglas through the Hagshaw Hills, sends off

branches in a south-west direction by Craigenrigg, passes through Lawhill, crosses Nethan Water, up the side of and over Nutberry Hill, crosses Logan Water, runs along part of Goodbush Hill, is magnificently exposed at Auchengilloch, and then runs past Hartenrigg, Sidehill, Laigh Drumclog and High Drumclog, whence it branches into Ayrshire. Between Dunside and Shank Castle, on Logan Water, dykes are observed, varying from a few inches up to many feet in thickness, and between Dunside and Auchrobert farmhouse numerous dislocations of the stratified rocks are observed. In the immediate neighbourhood of Lochfennoch, near Dunside, there is an interesting dislocation in the strata, exhibiting a fault which, so far as has yet been ascertained, is from 60 to 70 feet deep. On the one side of the fault the Silurian rocks are shattered into splintery fragments, intermixed with other detrital matter, while on the other side of the fault they remain as a hard, compact, arenaceous deposit, which has yielded, up to the present, no organic remains. To the east of the fault there are numerous dislocations, presenting fine examples of dolerite and intrusive felstone. On Hillcross Knowe, Auchrobert Hill, which is composed of red porphyry, there are two bosses, or pot-holes, of igneous rock, 50 yards separate from each other. One is 12 feet in diameter, the other 6 feet; and they still retain their depressed or cup-like aspect. Under more careful investigation they may prove to be the focal vents of these igneous rocks, while the dykes and dislocations are filled up fissures produced by the volcanic ejection, and the great fault above spoken of may have been produced by the same agency.

In the district of Lesmahagow no traces of the Lower Silurian rocks are observed, but we have magnificent sections showing the gradual and conformable passage of the Upper Silurian series into the basement beds of the Old Red Sandstone. The Upper Silurian rocks are widely distributed throughout the world, being found in various parts of Great Britain, Italy, France, Spain, Germany, Russia, and other countries of Europe, also in America, Asia, Africa, and Australia; but they have been nowhere distinctly seen in true stratigraphical relationship with the lower members. In Ayrshire we observe the uppermost members of the Lower Silurian, but the succession ceases just where we should expect to have seen the rocks of the upper strata developed. The Upper Silurian rocks are found in Lesmahagow, in the Pentlands,

and along the coast of Kirkcudbright. In the two former localities they lie on the northern side of the Lower Silurian belt of the southern uplands, while the latter shows the upper and lower series in close proximity; but here again we have conglomerates, possibly indicating a break between the Upper and Lower members of the Silurian strata. The rocks are twisted, and masses of porphyry and other crystalline rocks make their appearance. At the surface the Upper Silurians of the Pentland Hills are separated from the Lower Silurians by intervening conglomerates of the Old Red Sandstone period, whilst in Lesmahagow the relations of the two series are entirely concealed.

The vicinity of Logan Water was the retreat for many of our brave Covenanting forefathers after the battles of Bothwell Brig, Drumclog, Philipshaugh, &c., and has therefore justly earned a historical place in the annals of our country. It has also in our day found an extended fame in the scientific world as containing the rocks where lie entombed the wonderful crustacean forms first discovered by Dr. Slimon, of Lesmahagow, with which his name will ever be associated in the records of British palæontology. The order *Merostomata*, to which they belong, has been most ably described and illustrated by Dr. Henry Woodward, of the British Museum, and we find in it materials for comparison with recent forms of crustacean life which are wanting in other groups—namely, the larval stages of the highest recent forms, these old organisms being possibly the forerunners of the air-breathing Arachnidæ. One most interesting feature which they possess is the bipartite division into brachyuran and macruran forms, exemplifying the crawling and swimming types—in the one by the body segments, as displayed in *Limulus*, in the other by the somites of *Pterygotus*, thus showing that life in all its forms did not exist at that remote period. On the contrary, there seemingly were successive steps in the work of creation, and the organisms existing at one period, after serving the ends for which they were created, passed gradually away to make room for new types, which in their turn also became extinct.

Suppose we start on Logan Water, at the point where the Old Red Sandstone conglomerates terminate, where we have a most magnificent view of hill and dale, and trace the rocks up the stream, we observe that they form a descending series of strata, often disturbed by igneous action, which has contorted them and

elevated them in various directions, and these conditions continue at short intervals till near the foot of Lochfennoch, not far from Dunside. In that neighbourhood there is an interesting dyke of melaphyre, which, although ejected through the Silurian deposits, in no way affects the crystalline condition of the beds on either side so far as observed.

The Upper Silurian strata occupy an estimated area of about 10 square miles, and are arranged in descending sequence. They consist, in the upper portion, of the following zones, viz., green arenaceous flaggy bands, with partings of grey and red argillaceous hard shales, upwards of 100 feet thick; then a series of dark-grey, green, and chocolate-coloured argillaceous hard shales about 200 feet thick. Below these we have strata, about 400 feet thick, consisting of hard dark-grey shales, with bands of calcareous nodules, and this horizon contains the *Pterygoti* and other crustaceans in their best developed conditions. Below this again we have grey and olive-coloured flagstones, with hard bands of greywacke, possibly 300 feet thick; and following these in descending order there are dark-grey and olive shales, exceedingly hard towards their base, and about 300 feet thick. Last of all, we have hard bands of greywacke with their partings; these forming the lowest visible portion of the Upper Silurian Rocks, being, perhaps, upwards of 2,000 feet thick. Having carefully examined the entire range of the Logan Water, up to its source in the eastern slopes of the Nutberry Hill, I can state, with some degree of authority, that only in certain horizons are any traces of organic remains to be observed. On Dunside Burn, which joins the Logan Water, I made considerable explorations, and was rewarded by finding remains of *Pterygotus bilobus* (or *P. inornatus*), *P. accidens*, *P. anglicus*, *Slimonia acuminata*, and other forms which I have not yet identified with any degree of certainty. From the size of the heads, with their telsons, in some of the specimens, although fragmentary, I am led to believe that only the larger forms of these crustaceans had frequented this area of the inland sea. Underlying these strata we found a bed with *Lingula* in an excellent state of preservation, indicating that this part of the old Silurian sea was more or less brackish, and that while this sheet of water was being separated by lacustrine conditions, the *Lingula* still found a sufficient amount of saline matter in the water to sustain life. It also indicates that there were, during this remote period, frequent

oscillations of the earth's crust, the portion covered at one time by salt water, and at another by fresh water, or being probably for a time dry land. Immediately underlying the *Lingula* bed is a series of thin flags, in which were found the remains of *Pterygoti*, but all in a fragmentary condition; and the beds that in their turn underlie these were, for some considerable depth, absolutely destitute of organic remains, so far as observed in our explorations. About 100 yards further up the Logan Water there is another series of deposits, consisting of thin grey slabs, upon which were found many examples of *Pterygotus bilobus* and *P. perornatus*. A number of these were perfect in outline and in most excellent preservation, while associated with them were several granular masses which, on further investigation, may probably turn out to be the ova of these crustaceans. These beds are the superior members of the Upper Silurian deposits in this district.

The next locality where I made explorations was on both sides of the small dyke formerly alluded to, above Dunside, on Logan Water. There we found numerous remains of *Pterygotus inornatus*, *P. accidens*, *P. perornatus*, *Slimonia acuminata*, *Stylonurus Loganii*, *Eurypterus obesus*, *Ceratiocaris papilio*, *Beyrichia Klædeni*, and other forms as yet undescribed, all being more or less in excellent preservation. Going up the stream to Shank Castle there is a descending series of strata, dipping north-east, at angles varying from 20 deg. to 25 deg., and the rocks are greatly disturbed and twisted by porphyritic dykes. In the immediate neighbourhood of the Castle we found a bed containing examples of *Eurypterus obesus* and *Pterygotus inornatus*, some specimens being in excellent preservation. At the same place may be seen a great anticlinal axis, running nearly east and west, the strata being raised up in the centre like the ridge of a house, and being greatly disturbed by volcanic action. From Shank Castle to above Logan House the upper members of the Silurian rocks are seen, but the lower members are also to be found as the thick, hard, flinty beds of Nethan Water make their appearance, and give us unmistakable evidences that a great dislocation of the strata has here taken place, the rocks being twisted and broken, and the lower strata raised to the position of the higher beds. A few hundred yards beyond Logan House occurs a hard and argillaceous rock, containing a large proportion of arenaceous materials.

Underlying these deposits lie a series of argillaceous beds, in

which we find sun cracks, ripple marks, and markings which seem to be the tracks of crustaceans, all giving evidence of shallow-water conditions, with periodical deposits from running water charged with mud. These beds consist of thin flags, which speak of frequent alternate conditions of subaërial and subaqueous exposure, extending over a long period of time. Intermixed with these flags are found a great number of hard beds, many of which I have broken up, but without, as yet, finding any trace of organic remains. Beneath these is exposed a series of beds in which are found a large number of phyllopod crustaceans, with here and there a few gasteropod shells. The forms found were so numerous, and their surroundings so suggestive, that I dare hardly venture to offer an opinion. If, however, I may be permitted to hazard a remark, I would say that their abundance seems to point out that the deposits here exposed were banks lying under the influence of running water, where these crustacean forms found abundance of food. This opinion is strengthened by the fact that within a few feet of them we lose all traces of organic life. Underlying these beds there is a series of soft argillaceous deposits about a foot in thickness, in which lie a great number of hard oblong balls from one to four inches long. When split, these are found to contain the remains of phyllopod crustaceans in a most beautiful state of preservation, and the discovery of which induced me to continue my researches on the spot in the hope of finding other forms. But poor results, however, followed. We quarried for two days, only finding four balls, though one of them contained the largest and one of the best preserved crustaceans I had yet discovered. There were thus fresh indications of a change in the conditions of the bank upon which these forms had lived—and one opposed to their continued existence—whether from the influx of matter detrimental to them, or from changes in the bathymetrical surroundings brought about by the alternation of these deposits by currents, or from the elevation of the inland sea or lake, cannot be as yet stated. Such changes are to be seen in recent days, and I do not overstep the bounds of prudent speculation in supposing similar conditions to have prevailed in this remote period of the Upper Silurian epoch.

Having lost all trace of recognizable fossils in these beds, we tried the banks of the Kip Burn, and were partially successful, finding several specimens of *Pterygotus bilobus*, which, although

few in number, were sufficient to prove continued organic existence.

A record of the fossil remains I have found in the various positions pointed out may help at some future time to assist in arranging these beds chronologically, and thus correlating them with other strata, probably with the Upper Ludlow rocks of England; but the organisms I have obtained are not exactly similar to those found elsewhere in this stage, but possibly further search may afford more conclusive proofs towards a connection between these and other distant horizons. In the meantime my object has been to note the discovery of these interesting forms of ancient Silurian life in the beds I have investigated. At a later date I hope to be able, through further research, not only to record other facts, but to present the results of my work in a more extended and better developed form. Such investigations and such explorations may at least help to assist in clearing up some doubtful points in the palæontological history and arrangement of this most interesting sub-division of the Silurian rocks of Scotland.

VIII.—DESCRIPTION OF AN ERRATIC BOULDER ON THE HIGHLAND RAILWAY. BY E. A. WÜNSCH, F.G.S., Hon. Associate.

[Read 14th April, 1881.]

A CONSIDERABLE number of years ago, when our Society was young, and the story of glacial phenomena was foremost in our minds, my attention was attracted by a large boulder conspicuously exposed near the embankment of the Highland Railway, about 500 yards south of the Dalwhinnie station, on the Loch Ericht side, or the left side going north. So far as could be observed from the railway, the dark rounded mass of the boulder was intersected by several considerable veins of granite, which gave it a reticulated appearance so striking that even a non-geological friend to whom I mentioned the subject was enabled to identify it at once when passing in the train. In the course of years I had passed and repassed it probably a dozen times without ever being able to break my journey for closer inspection. I was glad, therefore, when a prolonged stay in the neighbourhood of Blair Athole last summer afforded me the long-looked-for opportunity of proceeding