

NO. XV.—NOTES ON THE GEOLOGICAL SURVEY MEMOIR. “THE
GEOLOGY OF THE GLASGOW DISTRICT.” By JAMES NEILSON.

[Read 14th December, 1911.]

1. THE HURLET DATUM LINE.
2. THE THORNTONHALL LIMESTONES.
3. THE GARNGAD CEMENT STONE.

INTRODUCTORY.

During the late summer the Geological Survey issued a map of the Glasgow district which will prove a boon not only to the members of this Society, but also to the increasing number of those who, although not members, still take an interest in geology as a branch of liberal education.

The present map differs from its predecessors in that it is colour-printed, and the printing and general details are brought out more clearly than was possible in the hand-coloured maps. This fact has been taken advantage of to add an enormous amount of detail, which is often of such a minute character that after study one feels inclined to wish that he were gifted with microscopic eyes or that the map had been drawn to a larger scale.

Not the least of its benefits is the low price at which it is sold (2s. on paper, and 3s. on cloth), the price of the previous maps having lately become prohibitive (19s. 3d. on paper).

It will be observed that the long way of the map is from north to south. This has doubtless been adopted for good and sufficient reasons, if we only knew them; but I, at least, would have preferred that the long way should have been east and west, with Glasgow in the centre.

The map is accompanied by an extensive memoir of the geology of the district, and the more one reads of it the more one is impressed with the extraordinary amount of information compressed between its covers and the enormous amount of good hard work required to collect, arrange, and classify all that information.

I know of no other class of writing in which so much good work is compressed into so little space and sold at such a

low price, certainly not the cheap novels which are so popular nowadays; but why it should be issued in such trashy paper covers is one of these things no fellow can understand.

By none more than by the members of our own Society will these publications be welcomed, nor will any benefit by them more.

The work of a Society like ours, being carried on in their leisure hours by men engaged in other businesses, cannot fail to be fragmentary, and the advantage of a work like this is that, besides the new information, our work is linked up together into a sort of symmetrical history, which makes it more understandable to ourselves and others. We cannot but feel gratified at the prominent place awarded to the work of our Society in this memoir, and acknowledge with pleasure the handsome and generous manner in which this work has been recognised.

It would, however, be too much to expect that this memoir was the last word to be said on the subject. There are still some "missing links" to the chain, and it may be that some of the other links are not sound and require to be repaired or even replaced; and, if it can be shown that this is the case, I feel sure the authors will welcome the information and readily make the necessary changes.

I desire to-night to draw your attention to three points in which I differ from the Survey.

1. THE HURLET DATUM LINE.

Overlying the thick series of volcanic deposits which are referred to Calceiferous Sandstone age are two different series of beds.

One of these is of deltaic origin, consisting of a great series of sandstones and conglomerates, of which Craigmaddie Moor is an example. These strata, which appear to be local only, and attain a thickness of about 600 feet, are not represented elsewhere.

Contemporaneous with these is a series of shales and limestones of undoubted marine origin. Sometimes, and for comparatively short periods, the land appears to have risen, and the delta (or at least fresh water) would cover the whole

of our area, and even land would appear, as evidenced by thin coal seams; but on the whole there appears to have been a very gradual subsidence, and latterly the delta was driven backwards out of our area, and the whole covered by the sea.

This period is known as the Hurlet Limestone, and is now used by the Survey as the dividing line between the Calciferous Sandstone Series and the Lower Limestone Series.

It was not always so, as in sheet 23, p. 24, dated 1873, the Survey admit some 27 fathoms of strata, including six limestones and a coal, lower than the Main Limestone, as belonging to the Lower Limestone Series; but in their more recent publications this has been departed from.

In the west this has always been recognised since the time of Mr. John Craig's paper "On the Geology of the Lower Ward of Lanarkshire" (1839)¹ and Dr. Rankine's "Geology of the Parish of Carluke";² while in the first paper printed by this Society "On the Geology of the Campsie District" (1860), by Mr. John Young, Mr. Young gives the Craigenglen beds, the Balglass Burn beds, the Millburn beds, and the Balgrochan beds as all under the Hurlet Series, and also gives the journal of a bore 33 fathoms deep containing limestone, coal, and ironstone, with their usual accompaniments of shale, fireclay, fakes, &c., beneath these again.

The lowest persistent limestone of Lanarkshire and Ayrshire goes by the name of the Main Limestone, and has long been regarded as the equivalent of the Hurlet, but recent researches by the Survey have rendered this doubtful, and I would like a definite statement of what the Main Limestone of Lanarkshire and Ayrshire, and also the limestone of Corrie, Arran, really are.³

¹ Prize Essays of the Highland and Agricultural Society, vol vi.

² *Ib.*, vol. viii. About eighty years ago the above Society resolved to prepare Geological Maps and Memoirs of the whole of Scotland, and offered premiums of £50 for a county or a coalfield and £25 for a parish. In this way they must have spent about £1000 in premiums alone, and many good geological papers are found among these essays. The institution of the Geological Survey put an end to these papers. The Society's library contains eight volumes of these essays.

³ The answer given to this question is that the Main Limestone is the equivalent of the Blackbyre. In that case it seems to me that the old name "Main Limestone" should be retained and the name "Blackbyre" dropped.

While they are at it, I would like if they would also explain the relation of the Blackbyre Limestone to the Shelly Limestone of Rankine, also where the *Productus giganteus* limestone and the *Productus punctatus* beds come in.

Now, leaving aside in the meantime the deltaic or estuarine beds (Craigmaddie), it will be observed that, while the Survey list includes one plant of Calciferous Sandstone type associated with several belonging to the limestone group, the type of all the other strata, together with their contained fossils, is admittedly the same as the Hurllet Limestone and the overlying strata ("Geology of the Glasgow District," p. 84), yet the Hurllet and the beds overlying it are assigned to the Carboniferous Limestone Series, and those below the Hurllet to the Calciferous Sandstone. This does not seem to me to be a scientific division, and I can hardly think it would ever have been made from the evidence now before us; only, it has grown up, and the Survey have not broken away from the old tradition.⁴

The great thickness of the volcanic rocks of the Clyde plateau is well known. The Survey consider 2000 to 3000 feet not an excessive estimate (p. 98), but I am afraid Glasgow geologists are not sufficiently impressed with the enormous time occupied in the deposition of these rocks.

Some idea of this time may be had by comparing our strata with those in the neighbourhood of Edinburgh. According to the late Mr. Goodchild (*Transactions*, Edinburgh Geological Society, vol. viii.), there are underlying the Lower Limestone Series the

Oil Shale Series to the Burdiehouse Limestone at Broxburn and West Calder, - - - -	2400 feet.
Strata between the Burdiehouse Limestone and the Pumpherston shale, - - - -	800 ,,
Sandstones and shales of Hailes and Redhall, - - - -	500 ,,
Wardie shales in Craiglockhart cutting, - - - -	480 ,,
Granton sandstone, - - - -	850 ,,
	<hr/>
	5030 feet.

⁴ Since the above was in print I have been informed that in adopting the Hurllet Limestone as the base of the Carboniferous Limestone Series, the Geological Survey regards it as an arbitrary boundary, because marine limestones and marine shells occur below that horizon.

Then come the Upper Ballagan beds or Abbey Hill shales.

As we have very few representatives of these beds in our district, it will be seen that our volcanic rocks represent a period equal to some 4000 or more feet of strata.

During this period we have a great palæontological break, many species disappearing at certain points and new species appearing at higher horizons, so that the fossils of the Calciferous Sandstone Series of Midlothian, Fife, the Solway, and Eskdale are very much different from those of the Lower Limestone Series, and my suggestion is that we draw the dividing line between the Calciferous Sandstone and the Lower Limestone Series at this great break in the fauna.

Where the break comes in we cannot say in our district; it is somewhere in the volcanic series, but until it can be localised my suggestion is that we might for convenience consider the whole of the volcanic rocks as Calciferous and all the overlying rocks as of Lower Limestone age.

The Hurler Limestone might still continue a main datum line, and measurements made upward or downward from it.

2. THE THORNTONHALL LIMESTONES.

Thirty-nine years ago, at the December meeting (1872) of this Society, I read my first geological paper, "On Some Sections of Carboniferous Limestone near Busby" (*Transactions*, vol. iv., p. 282). In that paper, after describing the strata, I drew attention to a bed of shale overlying the highest of these limestones, characterised by a very peculiar and distinctive suite of fossils, which I claimed to be an extension of a similar bed described by Mr. John Young, from the South Hill of Campsie, as overlying a limestone "supposed to be identical with the 'Hosie' Limestone,"⁵ the fossils in both beds being remarkably alike.

At the close of the meeting (as reported in the *Glasgow Herald*) "Mr. Young expressed his concurrence in what Mr.

⁵ Whatever it may have been originally, the term "Hosie" must now be considered to apply to a group of limestones near the top of the Lower Limestone Series rather than to a single bed. This particular bed has been dubbed the Blackhall by the *Survey*.

Neilson had stated, as to the bed at Busby being the equivalent of that near Campsie to which he had referred. Local causes would account for any differences observable between them, or in the strata with which they were immediately associated."

These conclusions were also concurred in by the other members of our Society, including Mr. James Armstrong, whose adhesion is to be found in his "Catalogue of the Western Scottish Fossils," 1876 (p. 70), where, after describing this bed on the South Hill of Campsie and its contained fossils, he adds, "Strata on the same horizon are exposed between East Kilbride and Busby."

His remarks on the fossils of this section are equally applicable to the sections at Thorntonhall. He says, "The shale in question contains a large number of rare and beautiful fossils, some of which, as casts, are coated with the sulphide of iron, which gives them a fine metallic lustre." He then gives a list of fifteen of the more typical fossils, and every one of these has been found at Thorntonhall.

Dr. Young again refers to the subject in his paper on Carboniferous Ostracods.⁶ Referring to the genus, he says, "*Polycope*.—This genus is represented by three species, two found in Western Scottish beds. These have been obtained from shales and small ironstone nodules found on the horizon of the Hosie Limestone in the Lower Limestone Series at Campsie, Carluke, and Busby."

These conclusions have never been called in question till early in the present year, when Mr. R. G. Carruthers read a paper to this Society, in which he maintained that the lower limestone of Thornton was the Blackbyre Limestone, and the Upper Limestone—which I had identified with the Hosie—was in reality the Hurler, and this has been repeated in the Survey memoir of the Glasgow district.

I little thought when I read my paper that I would celebrate its fortieth birthday by standing before you in its defence. It is noteworthy, however, that Mr. Carruthers' conclusions have not been arrived at on fossil evidence. He appears to have overlooked my paper, for, had he consulted it, I can hardly

⁷ *Transactions*, vol. ix., p. 301, 1891.

think he would have come to his present conclusions; for, if fossils prove anything, the identity of these two beds has, in my opinion, been proved up to the hilt.

It has, however, become necessary to revise the evidence on which this identification was made. Dr. Young's paper "On the Geology of the Campsie District" has gone through three editions, and I propose to quote from the second edition, because this (as well as the other papers I will refer to) contains the old names, and so can be compared with my paper. The third edition contains the new names. The lists are taken from the Campsie Memoir.

In comparing the two lists, we will first eliminate the following species, which have a wide distribution:—

1. *Productus longispinus*.
2. *Spirifera glabra* (very abundant here).
3. *Spirifera lineata*.
4. *Leda attenuata*.
5. *Nucula gibbosa*.
6. *Bellerophon decussatus*.
7. *Bellerophon striatus*.
8. *Bellerophon Urei*.
9. *Orthoceras undatum*.
10. *Orthoceras attenuatum*.

All of which, with the exception of *Spirifera lineata*, are also got at Thorntonhall.

Only one of these species, viz., *Bellerophon Urei*, is recorded as from the shale above the Main Limestone, Campsie. About one-half are recorded from Corrieburn, but the horizon is not given.

There now remains a peculiar group of fossils which make their first appearance in our district in this bed, and never (taken as a group) are found in any other bed.

The next list is that of fossils which are not recorded from any other locality in the Campsie district; those prefixed by an asterisk are, so far as known, confined to this bed.

For comparison are shown, in parallel columns, fossils occurring in beds over the Hosie Limestone in other localities.

CAMPSIE.	Thornton.	Hunter, Carluke, & Sheet 23.	Sheet 31.
*1. <i>Trigonocarpion</i> (small distinct species), -	×		
2. Small stems showing structure, - -	×		
*3. <i>Cythere</i> (<i>Polycope</i>) <i>Youngiana</i> , - - -	×		<i>sp.</i>
4. <i>Dithyrocaris testudineus</i> , - - -	×		
*5. <i>Chonetes Hardrensis</i> , - - - -		×	×
Small figured variety Dav., - - -	×		
6. <i>Leda longirostris</i> (<i>brevirostris</i>), - - -	×	×	×
7. <i>Nucula luciniformis</i> , - - - -	×	×	
8. <i>Dentalium priscum</i> , - - - -	×	×	<i>ingens.</i>
9. " <i>inornatum</i> , - - - -	×	×	
10. <i>Euomphalus carbonarius</i> , - - - -	×	×	×
*11. <i>Pleurotomaria conica</i> , - - - -		×	
Var. <i>decussata</i> , - - - -	×		
*12. <i>Bellerophon Oldhami</i> , - - - -	×	×	×
*13. <i>Goniatites Gilbertsoni</i> , - - - -	×	×	<i>some species.</i>
*14. " <i>Looneyi</i> , - - - -	×	×	
15. " <i>micronotus</i> , - - - -	×	×	
16. " <i>striatus</i> , - - - -		×	
17. " <i>vesica</i> , - - - -		×	
18. <i>Nautilus biangulatus</i> , - - - -	×		
19. " <i>subsulcatus</i> , - - - -	×	×	
20. <i>Orthoceras cinctum</i> , - - - -	×	×	
21. " <i>dentaloideum</i> , - - - -			
22. " <i>Goldfusianum</i> , - - - -	×		
23. " <i>Muensterianum</i> , - - - -			
24. " <i>pygmeum</i> , - - - -			
25. <i>Rhizodopsis minor</i> , - - - -	×		
	20	14	

It will be noticed that, with the exception of five species of small *Goniatites* and *Orthoceratites* which are very difficult to identify, the lists are alike, while not one of the above species is recorded elsewhere from the Campsie district.

The following are also recorded from Craigenglen:—

26. *Spirifera Urei* (rare at Craigenglen), - | × | × |

In thousands over the Hosie Limestone in both localities.

27. *Nucula lineata*, - - - - | × | × |
 28. *Loxonema curvilinea*, - - - - | × | × |
 29. *Cyrtoceras rogium*, - - - - | × | × |

The following is recorded from Corrieburn:—

30. *Chonetes* var. *gibberula*, - - - - | × | |
 25 | 17

But as Corrieburn contains a wide range of strata, it is probable that this is from the bed in question.

The remarkable thing is that not one of the above thirty species are recorded from the top of the main limestone of any locality in the Campsie district.

The species in first list numbered 4 to 10 inclusive also belong to this group, and it is noteworthy that only one, *Bellerophon Urei*, is recorded from the Main Limestone shales of Campsie.

The list of fossils from Thornton is very much longer, this being accounted for by the fact that the fossils from Campsie could, as a rule, only be got from pit sinkings, while Thornton was wrought as an open-cast quarry.

Fossils from Thornton not recorded from Hosie Limestone, Campsie—

	Carluke.	Sheet 31.
1. <i>Stenopora tumida</i> , - - - - -		
2. <i>Patechis cyclostoma</i> , - - - - -	×	×
3. <i>Zaphrentis Phillipsi</i> , - - - - -	×	<i>Sp.</i>
4. <i>Cyathophyllum</i> , - - - - -		
5. <i>Archæocidaris Urei</i> , - - - - -	×	<i>Sp.</i>
6. <i>Actinocrinus</i> , - - - - -		<i>Sp.</i>
7. <i>Serpulites carbonarius</i> , - - - - -		
8. " <i>membranaceus</i> , - - - - -		
9. <i>Griffithides</i> , - - - - -		×
10. <i>Chonetes polita</i> , - - - - -	×	
11. <i>Leda intermedia</i> , - - - - -	×	×
12. <i>Euomphalus tuberculatus</i> , - - - - -		
13. <i>Loxonema scalaroidea</i> , - - - - -		
14. <i>Macrocheilus acutus</i> , - - - - -		
15. " <i>fusiformis</i> , - - - - -		
16. " <i>imbricatus</i> , - - - - -	×	×
17. <i>Platyceras neratioides</i> , - - - - -		
18. <i>Pleurotomaria</i> , - - - - -		
19. <i>Cyrtoceras unguis</i> , - - - - -		
20. <i>Goniatites diadema</i> , - - - - -		
21. " <i>excavatus</i> , - - - - -		
22. " <i>miconotus</i> , - - - - -	×	
23. " <i>mutabilis</i> , - - - - -		
24. <i>Nautilus globatus</i> , - - - - -		
25. <i>Orthoceras ovale</i> , - - - - -	×	
26. " <i>pyramidale</i> , - - - - -		
	8	4

Only two of the above *Serpulites carbonarius* and *Griffithides*, *sp.*, are recorded from the Main Limestone of Campsie.

	Campsie.	Thornton.	Carluke.	Main Limestone, Campsie.
Abstract.				
Fossils generally distributed through Lower Carboniferous, - - - -	10	9	7	1
Peculiar Group from Campsie list, - - -	30	25	17	
Totals, - - - -	40	34	24	1
Peculiar Group from Thornton and later lists,		26	8	2
	40	60	32	3

Dr. Hunter's (Selkirk), of Braidwood, Carluke, list of fossils from Bed No. 560, Hosie Limestone shale, Braidwood (p. 81), shows a resemblance to the Thornton bed, and contains its principal distinctive fossils, including *Bellerophon Oldhami* and *Goniatites Gilbertsoni*.

He also gives a short list (beds 590-2) from shales over the main limestone, of which *Archæocidaris Urei* is the only one got at Thornton. He also gives a very long list from the main limestone, which has no affinity whatever to the Hosie bed.

In the Geological Survey's Explanation of Sheet 23 (preface dated November, 1873) a long list of fossils is given (p. 61) from "main limestone and beds above." At localities 3 and 6 the fossils are from a shale about 15 feet above the main limestone. These are our Thornton localities, and this shale is the one now in question. Eliminating these, the others have no resemblance whatever, while in shale overlying the second Calmy limestone we have *Bellerophon Oldhami*, and in shale above Hosie Limestone, Carluke (p. 66), we have some of our most characteristic species.

In the Survey Sheet 31 (p. 68) we have a list of fossils from shale and nodules above Hosie Limestone which contains several of our characteristic fossils, viz., *Palæchis cyclostoma*, *Polycope*, sp., *Leda brevirostris*, *Bellerophon Oldhami*, and some species of *Goniatites*.

The collection of the late Mr. Linn of Livingstone, however, contained a great many more, so that I could tell him the position of these beds before the Survey memoir was issued. This collection is now, I think, in the Royal Scottish Museum, and can probably be referred to, and Dr. Lee has also given me a list of fossils collected by Mr. James Bennie.

The localities would probably be Nos. 30 to 34 in the Geological Survey's sheet 31, in the Blackburn district.

I also claimed in a previous paper that this bed occurred in the neighbourhood of Dunfermline, and the Survey memoir of Central and Western Fife seems to bear this out, the localities being Nos. 20 to 23, although the number of species given is too small to say definitely.

In looking over Survey Sheets Nos. 23 and 31 one is struck by the paucity of Dimyarian Lamellibranchs in shales overlying the Hurler Limestone, these being all but absent in the majority of localities, while they are the strong point in the shales of the Hosie Limestone.

I claim therefore—

1. That these two beds are identical.
2. That this peculiar group of fossils made its first appearance in the West of Scotland in this bed.
3. That this group, taken as a whole, is confined to this bed, and never again puts in an appearance.⁷

⁷At the February, 1912, meeting of the Geological Society of Glasgow Mr. Macnair adversely criticised the above conclusions, and in the *Glasgow Herald* of 20th February he is reported to have said—

- (1) That the characteristic fauna discovered by Dr. Young in the shales above the Blackhall Limestone of the South Hill of Campsie also occurs above the Hurler Limestone of Thorntonhall; and
- (2) In the Calderwood Limestone of East Kilbride;
- (3) But it seems likely that this fauna is limited to the Lower Limestone Series, and does not pass into the Upper Limestones.
- (4) That the aforementioned fauna is associated with species which range from the top to the bottom of the Limestone Series.

To which my reply is—

- (1) The bed referred to at Thorntonhall is the bed we have been discussing. His is a very cavalier way of replying. He used no arguments and replied to none, but simply stated in an *ex cathedra* style, such as a pope might use, that this was so. Meantime, I challenge him to produce a list of fossils from any unquestioned Hurler bed at all like the present. I have searched and failed, and I await the result of his researches.

Comparison of Strata.

We will next consider the evidence to be derived from a comparison of the strata at the two localities, and for this purpose we take the section (given on p. 23 of the Survey Memoir) of the old pit on the top of the South Brae and north of Newlands (Campsie), and compare it with the section at Thornton old quarry, as shown in the accompanying diagram, in which I have placed the top of the two Upper Limestones opposite each other.

The explanations are drawn from Mr. Young's memoir, and every word he says regarding the strata between the limestones applies equally well to the beds at Thornton. The topmost black shale is the one we have hitherto been speaking of, and it will be noticed that every important bed represented in the Campsie section has its equivalent in its proper relative position at Thornton. It is also worthy of note that the whole of the strata are fresh water, whereas the Hurler Limestone is, I think, almost invariably underlaid by a marine shale.

The first notable bed under the limestone is a bituminous or oil shale, in which occur numerous fish remains, consisting of scattered scales, bones, spines, and teeth, mostly of Ganoids.

- (2) I know the Calderwood fauna very well. I knew it when the beds were being worked open-cast, and when one had a much better chance of seeing them than now, and I know of no such bed, nor of any list which would warrant Mr. Macnair's statement, and must again call upon him to produce his list.
- (3) Mr. Macnair is very unfortunate in his statement, as of the thirty species given in my list as characteristic of the Campsie bed, no less than seventeen continued into the Upper Limestones, and the curious thing is that a number of them are supplied by Mr. Macnair himself from Thornliebank. (*Transactions*, vol. xii. p. 375.)
- (4) Admitted. I have referred to this bed in two previous papers ("Calderwood Limestone and Cement Stone," *Transactions*, vol. x., p. 74; *History of Geological Society of Glasgow*, p. 160), but my claim was that, as a group, these fossils made their first and last appearance in Carboniferous times in this bed, and I submit that the group is a stronger argument than the single fossil, which is liable to be upset at any moment. Thus, if I had been asked some years ago to name the two most characteristic fossils confined to this bed, I would have replied, *Polycope Youngiana* and *Gonialites (Dimorphoceras) Gilbertsoni*, but this latter has been found by Mr. Tait in the Carboniferous Sandstone of Fife, and is also recorded from the Upper Red Barren Measures of Scotland,⁸ so it may be found in our district any day.

⁸J. Smith of Dalry and C. T. Clough, M.A. See *Summary of Progress of the Geological Society for 1907*, p. 127.

This is followed by three or four ironstone bands, with shale beds between them (Memoir, p. 22), and which the Survey in the Campsie section identify with the Househill.

Underlying this is an Entomostracan shale crammed with, and in some parts almost made up of, cases of *Leperditia Scotoburdigalensis*, Hib. This is certainly not the same as the White Entomostracan Limestone which underlies the Hurlet coal in the Campsie district, as this is a shale, and the Entomostraca with which the latter is charged are *Carbonia fabulina* (3rd Edition, p. 40), and both beds are found in Campsie.

Mr. Young also states, "I have not been able to discover evidence of the existence of any of these (Entomostracan) limestones out of the Campsie district in the same geological horizons, and it is possible that they are merely local deposits soon thinning out."

In my paper I am made to say that "this bed resembles to a certain extent some of the Entomostracan shales of the West Calder coalfield." Now, I never wrote these words, never saw them till I saw them in print, but I am inclined to attribute them to Mr. Young, as a similar remark is made in his paper, and to consider it as a recognition of the Thornton bed as an equivalent to the one at Campsie.

Next in order comes a blue shale 22 fathoms 2 feet thick at Campsie, which has dwindled down to a soft black shale about 1 foot thick at Thornton. Such enormous variations are not unknown, but the fact remains that the Thornton shale, in all but thickness, is a replica of the Campsie bed.

The Lower Limestone is about 4 feet thick at Campsie, against 10 feet at Thornton, and it may well be that part of the latter is contemporary with the thick shale bed at Campsie.

The shale underlying the limestone in both cases is of marine origin, containing many fossils not at all distinctive. I am under the impression that the Hurlet Limestone is always underlaid by a marine shale. The shale underlying the Upper Limestone at Thornton is fresh-water.

The absence of the Hurlet coal at Thornton does not affect the argument either way, unless it were sought to prove that neither of these limestones was the Hurlet. The coal is very inconstant; in some localities being very thin, and only of use in burning the limestone.

The grey shale at Thornton is a re-wash from the volcanic rocks, on which the whole section reposes, and which comes to the surface within about 100 yards of the quarry.

I have already referred to the White Entomostracan Limestone.

That the Lower Limestone at Campsie is the Hurlet there is no doubt, as it has the typical accompaniments, limestone, alum shale, and coal, which were long wrought by the Hurlet and Campsie Alum Company."

3. THE GARNGAD AND GLENBOIG CEMENT LIMESTONES.

In the year 1875 I read to this Society a paper entitled "Geological Notes on the Cuttings in the City of Glasgow Union Railway between Bellgrove and Springburn" (*Transactions*, vol. v., p. 222), in which I described the various sections exposed during the progress of the work, also giving a list of their fossil contents. This paper has become a rather important one, not, however, from any special merit it possessed—it is simply a plain record of the sections seen and of their contents, and ought to be an encouragement to our young members, any of whom could have done it equally well, and some a great deal better. In the Survey Memoir it is spoken of as "the valuable paper," its value being due to the fact that many of the sections have been covered up, and it remains the only authority on many of the points stated in it.

Some of these rocks between Blochairn Road and Garngad Road, belonging to the Millstone Grit Series, consist of thin-bedded sandstones and shales, and the peculiar thing is that the sandstones are charged with marine fossils. This section is followed by another, in which we find—

Sandstone, thin-bedded, - - - -	1 ft. 9 in.
Sandstone, with casts of shells, - -	0 ,, 9 ,,
Kingle, - - - - - - - -	2 ,, 6 ,,
Shale, calcareous (fossiliferous), - -	1 ,, 0 ,,
Cement, - - - - - - - -	1 ,, 1 ,,
Shale (not cut through) exposed about, -	6 ,, 0 ,,

At the time my paper was written the Garngad Road Quarry, about 180 yards east of the station, had not been opened, but

the Survey consider that the lowest coal exposed there is about 40 feet above the cement (p. 57), and the sandstones contain plant remains of Lower Carboniferous facies.

The Survey (p. 54) describe "a thin bed of marine limestone" known locally as the "Cement Stone" or "Roman Cement," which is persistent for a long distance several miles east of Glasgow. They, however, state, "Within the city it has been recognised in a small exposure at Garngad Road Station."

They also say, "From the character and fossil contents of this bed it may be inferred that it represents the 'Cement Stone' described in an earlier paragraph as occurring 30 to 40 feet above the base of the Millstone Grit" (p. 57).

It is again referred to in page 90.

I am not, however, prepared to recognise the identity of the two beds, my reason being the great difference in the fossil contents.

In a shale immediately above the cement at Greenfoot Quarry, on the farm of Gain, near Glenboig Station, and elsewhere the Survey found what is probably the most remarkable group of fossils ever recorded in Scotland. The Lamellibranchs and Gasteropods have been described by Dr. Hind.⁹

Dr. Hind says it "contains a number of species hitherto-unrecorded from Europe, so far as my knowledge goes; but, on the other hand, it exhibits a remarkably close affinity to the Lamellibranch fauna described by Meek from the coal measures of Nebraska, Illinois, and other American States.

In all twenty-six species of Lamellibranchs are recorded from Scotland, of which eleven are also found in Nebraska, while five are new, but there is only one species common to Nebraska, Scotland, and England.

Dr. G. W. Lee, palæontologist to the Geological Survey, has favoured me with the following list of Brachiopods:—

Orbiculoidea (Discina) nitida.

Lingula mytiloides.

Lingula squamiformis.

Derbya, sp.

Productus, cf. *semireticulatus*.

⁹ "On the Lamellibranch and Gasteropod Fauna found in the Millstone Grit of Scotland." *Trans. Roy. Soc. Edin.*, 1908, Part II., p. 331.

TABLE SHOWING THE LAMELLIBRANCH FAUNA OF THE COAL MEASURES OF NEBRASKA, AND THE OCCURRENCE OF THE SAME SPECIES IN EUROPE.

	Nebraska.	Scotland.	Congleton Edge.	Hazel Hill.	Base of Bristol Coal Measures.	Russia.
<i>Limatulina alternata</i> , M'Coy, sp., - - -		×				
<i>Palæolima retifera</i> , Shumard, - - -	×				×	
<i>Entolium aviculatum</i> , Swallow, sp., - - -	×					× †
<i>Nucula Beyrichi</i> , V. Schaur. ? - - -	×					
„ <i>gibbosa</i> , Flem., - - -		×				
„ <i>ventricosa</i> , Hall, - - -	×					
<i>Yoldia subscitula</i> , M. and H., - - -	×					
<i>Nuculana laevistriata</i> , M. and W., sp., - - -	×	×				
„ <i>attenuata</i> , Flem., sp., - - -		×				
<i>Ctenodonta laevirostris</i> , Portlock sp., - - -		×				
<i>Grammatodon tenuistriata</i> , M. and W., sp., - - -	×	×			×	×
<i>Protoschizodus curtus</i> , M. and W., sp., - - -	×	×				
<i>Schizodus Wheeleri</i> , Swallow, sp., - - -	×	×				×
<i>Avicula longa</i> , Geinitz, - - -	×					× † †
„ ? <i>sulcata</i> , Geinitz, - - -	×					
<i>Pseudomonotis radialis</i> , Phill., sp., - - -	×					×
<i>Myalina Swallovi</i> , M'Chesney, - - -	×					×
„ <i>subquadrata</i> , Shumard, - - -	×					
„ <i>perattenuata</i> , M. and W., - - -	×					
„ <i>Verneuillii</i> , M'Coy, - - -		×				
<i>Aviculopecten occidentalis</i> , Shumard, sp., - - -	×					
„ <i>neglectus</i> , Geinitz, sp., - - -	×	×				
„ <i>carboniferus</i> , Stevens, sp., - - -	×		×	×		×
„ <i>coxanus</i> , M. and W., - - -	×					
„ <i>obliquus</i> , sp. nov., - - -		×				
„ <i>regularis</i> , sp. nov., - - -		×				

<i>Pterinopecten papyraceus</i> , Sow., sp.,	-	-					x	
" <i>Whitei</i> , Meek, sp.,	-	-	x				x	
<i>Posidoniella levis</i> , Brown, sp.,	-	-		x			x	
<i>Ariculopinna americana</i> , Meek,	-	-	x					
<i>Pinna peracuta</i> , Shumard,	-	-	x					
<i>Modiola ? subelliptica</i> , Meek,	-	-	x					
<i>Pleurophorus oblongus</i> , Meek,	-	-	x					x †
<i>Sanguinolites occidentalis</i> , M. and H., sp.,	-	-	x		x			
<i>Edmondia reflexa</i> , Meek,	-	-	x		x			
" <i>glabra</i> , Meek,	-	-	x					
" <i>nebrascensis</i> , Geinitz, sp.,	-	-	x		x			x † †
" <i>subtruncata</i> , Meek,	-	-	x					
" <i>aspinwallensis</i> , Meek,	-	-	x					
" <i>Lyellii</i> , Hind,	-	-		x				
" <i>sulcata</i> , Phill., sp.,	-	-		x				
<i>Allorisma reflexa</i> , Meek,	-	-	x		x			
" <i>Geinitzi</i> , Meek,	-	-	x					
" <i>subelegans</i> , Meek,	-	-	x					
" <i>granosa</i> , Shumard, sp.,	-	-	x					
" <i>subcuneata</i> , M. and H.,	-	-	x					x †
<i>Tellinomorpha Hindii</i> , Bolton,	-	-		x			x	
<i>Solenomorpha cylindrica</i> , sp. nov.,	-	-		x				
<i>Solenomya brevis</i> , sp. nov.,	-	-		x				
" <i>cylindrica</i> , sp. nov.,	-	-		x				
<i>Prothyris elegans</i> , Meek,	-	-	x		x			
<i>Solenopsis solenoides</i> , Geinitz, sp.,	-	-	x					
Total,	-	52	37	26	2	1	5	8

* Tschernyschew, "Obercarbonischen Brachiopoden d. Ural u. d. Timan," *Mém. Com. Géol. Russie*, 1902.

† Stuckenbergl, "Die Fauna der obercarbon. Suite des Wolgadurbruches bei Samara," *Mém. Com. Géol. Russie*, 1905, Livr. 23.

‡ Jakowlew, "Die Fauna der oberen Abtheilung der Palaeozoischen Ablagerungen im Donetz Bassin: Die Lamellibranchiaten," *Mém. Com. Géol. Russie*, 1903.

These have not the slightest affinity to the shells found in connection with the cement at Garngad, but resemble those found in the quarry about 100 feet higher in the section, and represent the last stage of exhaustion before extinction.

Garngad.

The cement shale at Garngad also contains a characteristic group of fossils, which, while not so startling yet is very striking in its own way.

The prevailing group is that of the Brachiopods, which form two-thirds or three-fourths of the entire fossils; nineteen species are recorded, the commonest being *Orthis resupinata*, followed by some seven species of *Productus*, also *Spirifera*, *Athyris*, *Streptorhynchus*, *Lingula*, and *Discina*, some of these being very noteworthy, e.g., *Productus carbonarius*, de Kon., its only British locality, although it is found in a similar horizon in Belgium. *P. sinuatus*, *P. muricatus*, *Discina Craigii*, *Streptorhynchus* var. *robusta* first figured in our *Transactions* (vol. ii., p. 76), found by Mr. Thomson, Tirfergus Glen, Campbeltown. It was afterwards figured by Davidson under the name of *S. cylindrica*.

The specimens from Garngad Road were, however, casts showing the muscular impressions and dental plates, and a writer in "Paleontologica Indica" (Waagen, 50, p. 606), suggested that this was really a *Meekella*. It has since been described as *Meekella Neilsoni*, Thomas.¹⁰ Mr. Thomson's species now rejoices in the name of *Schwellwienella rotundata*, Thomas.¹¹

Revision of the Lamellibranchs has played sad havoc with the old names, and it may be as well to give the list entire as revised.

**Limatulina alternata*—rare in nodules.

Aviculopecten dissimilis—common.

Aviculopecten interstitialis—rare.

Aviculopecten Murchisoni—rare.

¹⁰ British Orthotetidae. "Memoirs of Geol. Survey of Great Britain," Vol. I., Pl. 2, p. 114; Pl. 13, figs. 3 and 4.

¹¹ *Ib.*, p. 123, Pl. 13, pp. 14-15.

- Allorisma sulcata*. Flem. (Plate xlvi., Fig. 7)—common.
Cardiomorpha limosa (Plate xxi., Fig. 8)—rare.
Cypricardella rectangularis.
Edmondia Josepha—common.
Edmondia traversa. Hind (Plate xxxii., Fig. 13)—common.
Nucula gibbosa—common.
**Nuculana attenuata*—common.
Nuculana Sharmani (Plate xv., Figs. 17 and 18)—common.
Nuculana brevisrostris—rare.
Myalina Flemingi, M'Coy (Plate iv., Fig. 10)—rare.
**Myalina Vernevili*, M'Coy (Plate iii., Fig. 6, and Plate iv., Fig. 4)—common.
Protoschizodus axiniiformis (Plate xvii., Fig. 18)—common.
Tellinomorpha cuneiformis, de Kon.—rare.

It will therefore be observed that, of the twenty-six species recorded for the Survey, only three (marked with an asterisk) are found in Garngad, and not one of these is American. Seven of the above have been figured in Dr. Hind's monograph of Carboniferous Lamellibranchs, besides two Brachiopods by Davidson and Kitchen, and this is the only locality in the West of Scotland from which *Nuculana Sharmani* has been recorded. It was originally described for the Calciferous Sandstones of Midlothian.

With regard to the Gasteropoda, these are rare at Glenboig, but Dr. Hind figures some seven from generally defective specimens, but these can all be paralleled, or very nearly so, from Garngad, though we have been in the habit of giving them different names, and I place opposite his list the names given in my list.

- | | |
|---|--|
| <i>Entalis Meekianium</i> , Genitz. | <i>Dentalium inornatum</i> , McCoy. |
| <i>Ptychomphalus Marcouianus</i> ,
Genitz. | <i>Pleurotomaria striata</i> , Sow. |
| <i>Bellerophon Marcouianus</i> , Genitz. | <i>Bellerophon decussatus</i> , var.
<i>striatus</i> . |
| <i>Euphemus d'Orbigny</i> , Portl. | <i>Bellerophon Urei</i> , Flem. |
| <i>Naticopsis brevispira</i> . | <i>Macrocheilus imbricatus</i> , Sow,
and <i>Naticopsis variata</i> ,
Phill. |

Note, these are great varieties of *Bellerophon Urei*. In the young stage it showed, as in Dr. Hind's figures, without a keel, but as it grew it developed a very strong keel. Sometimes, however, it grew to quite a large size without showing any keel.

Gasteropoda as a whole were quite common at Garngad.

Dr. Hind speaks of the Cephalopoda as represented by a single species, and apparently by a single fragmentary specimen, referred to *Glyphioceras Phillipsi*. Now, while Goniatites were rare at Garngad, *Nautilus nodiferus*, Armstrong (*Pleuro-nautilus dorso-cariniferus*), was common—commoner here than in any other locality I know, while *Nautilus quadratus* (*Stoboceras sulcatus*) was not to call rare.

It will thus be seen that the difference between the two groups of fossils is very great, and these point to great differences in the conditions under which they were deposited.

The Garngad fauna lived under truly marine conditions, yet so near land as to make it unsuitable for Corals and almost so for Crinoids; still the abundance of Brachiopods shows that they were in the open sea. The other beds, as shown especially by their Lamellibranchs, were deposited in more or less brackish water, in which the more marine types could not thrive—possibly lagoons or other enclosed areas; and it is difficult to imagine conditions shutting off these two localities within 8 miles of each other, so that two such different types of fossils existed, and not one American species could find its way to Garngad, although they must have travelled some 4000 miles and passed over this very ground on their way to (or from) Greenfoot; for, although the genus *Meekella* is American, and has hitherto been believed to be confined to the Carboniferous rocks of America, Eastern Europe, and China, still the species found in this locality is neither, being like the one after whom it is named, wholly and solely Scottish.

The sections shown in Dr. Hind's memoir show that the fossils came from more than one horizon and probably more than one cement, and it seems to me that another cement yet requires to be added, viz., that of Garngad.

Another point may be mentioned. Dr. Hind states (p. 334), "I think that all the Lamellibranchs were obtained from beds

containing a Lower Carboniferous flora, and just below the point where the upper and lower flora meet.”

Now the Survey give a list of plants of Lower Carboniferous facies from Garngad Quarry in a position 73 feet above the cement, while the top of the quarry is 58 to 68 feet above that again (total 131 to 141 feet), so the Garngad cement at least can hardly be described as “just below the point where the upper and lower floras meet.”