PROCEEDINGS

FOR YEAR 1877.

No. 5, Vol. 3. DECEMBER, 1877.

FIELD MEETINGS IN 1877.

1877.

April 23, Walsall.—The arrangements being made by Mr. William Cotterell and other local members. Assembling at Walsall Railway Station the members proceeded in carriages to Rushall Hall, the residence of W. H. Duignan, Esq., where after partaking of a slight luncheon, and inspecting the fine collection of pictures, the ruins of the Castle and other buildings were examined. The members then proceeded to the limeworks of Messrs. G. and H. Strongitharm, at Linley, and descended the extensive caverns made by the excavations of the Dudley and Wenlock Limestone, which were lighted by the proprietors with candles and coloured fires, producing a very interesting and fine effect. The new railway cutting which passes close to the mouth of these caverns, was then examined from end to end, and many fossils were found. A description of this cutting and the local geology, was given in a paper by Mr. J. W. Oliver, F.G.S., and will be found in the Proceedings, and also by the courtesy of the Midland Railway Company the section subsequently constructed by the local committee. The way was then continued to the Old Hay Head Quarries in the Barr or Woolhope Limestone, and thence under the guidance of Mr. Wilson, on whose farm it is found, to the outcrop of the Upper Llandovery or May Hill Sandstone, pointed out by the late Mr. Jukes as giving such an important key to the structure of the Silurian floor of the Coalfield. Returning to Walsall the party assembled in the Guildhall, where the Mayor and other members of the Corporation had laid out for inspection some marvellously interesting ancient deeds and documents. After a meat tea at the George Hotel, an evening meeting was held, when several interesting objects were exhibited, and Mr. E. Terry presented a beautiful drawing of a microscopic section of limestone, a litho-photograph of which will appear in the Proceedings. After appointing a committee of the local members to complete the railway cutting section, and a hearty

vote of thanks to Mr. Cotterell, Mr. Duignan, Mr. Checkley, and other local members, for their kind aid in the arrangements for the day, the meeting separated.

May 29, Droitwich—From the station the members proceeded to the house of Mr. J. Smith, Westacre, where some interesting fossils and other curious objects were seen. After a short address on salt, which will be found in the Proceedings, by the Rev. J. H. Thompson, who was the guide for the day, the works of the Droitwich Salt Company were seen, and then the party proceeded in carriages to Dunhampstead, where special arrangements were made by the Midland Railway Company for the safe examination of the fine section of the railway cutting in the Rhaetic Beds. Mr. W. J. Harrison, F.G.S., of Leicester, here gave an address, which will be found in the Proceedings, and through the courtesy of the Railway Company in bearing the strata for the purpose, a complete section will be also given in the Proceedings. After visiting some Lias Limepits, and obtaining many fossils, the way was taken to Crowle Green, where Mr. M. H. Lower, of Oak House, had kindly arranged for spades and ladders for the better examination of a marl pit where the Rhaetic Beds are again exposed. The Rev. W. N. Woolrych, the vicar of Crowle, here also furnished some particulars of other Lias Pits and Quarries. The way was then taken through Oddingley, calling at St. Peter's Church, where, under the guidance of the Rev. W. Lea, the vicar, and Rev. S. W. Symonds, the church, the house of Nash the historian, and some points of great geological interest were examined. The Saline Baths, which have proved so extremely useful medically, were kindly thrown open to the members by Dr. Bainbrigge, the proprietor. After tea, kindly provided for the ladies at Westacre, by Mr. Smith, and for the rest at the Railway Tavern, most of the members separated, but some visited Westwood Park, under the guidance of Mr. Smith.

June 20, Dudley.—Annual Meeting. The route selected was the walk described by Hugh Miller in his "First Impressions of England," Mr. Beale, of Sedgley, being the guide to those places where fossils were most readily to be found. The members assembled at Dudley Station and proceeded in carriages, through Sedgley, to the Wolverhampton Road, near the site, now covered with cinders, of the famous fossil forest described by Messrs. Beckett and Ick in Geological Proceedings, vol. iv., p. 287, and then entered Mr. Johnson's quarries in the Aymestry Limestone, and thence across Mr. Hickman's Park Farm to the Beacon Tower, 820 feet above the sea, which commands a most interesting panoramic view of the distant country, and also

the structure of the great Sedgley anticlinal with the Wren's Nest and Castle Hills. The way was then taken past Can Lane Church to some marl holes, where Mr. A. Chavasse in charge of the works had reserved a large quantity of beautiful fossil ferns, in nodules of iron-stone. Returning to Can Lane the remarkable upheaval of limestone forming the centre of the anticlinal was examined, the party then proceeding to Mr. Whitehouse's quarries of Hurst Hill, where Mr. Ellis in charge of the works had reserved a goodly selection of the fossils lately found, which were distributed to those present. A second quarry, approached through a tunnel, was then examined, and the carriages were rejoined in the grounds of Turl's Hill, the residence of the proprietor, and after hearty thanks to Mr. Beale, who had secured so rich a find of fossils, the way was taken for tea at the Hotel, Dudley, after which the annual meeting was held. The Committee presented the report and accounts already printed and distributed to members, and Mr. Cochrane was elected President for the third time. After the meeting the President exhibited a drawing of a most remarkable fossil he had lately seen at Stuttgart, and kindly presented the copies of the litho-photograph, which appear in the Proceedings.

July 17, Stiperstones—Assembling by train at Minsterley Station, Mr. Philip and Mr. Parry, members of the Caradoc Club, conducted the members to Snailsbeach Lead Mines, where the process of preparing the ores was explained by the managers. The way was then taken to the Stiperstones, formed by the upturned edges of a thick band of siliceous sandstone, some of the beds of which contain tubular cavities and cylindrical bodies, which are the borings and casts of worm-like animals. The weather had been threatening and showery, and as the Stiperstones were approached, they were enveloped in mist, but a slight breeze dispersed this, as the summit was gained, and the view was then magnificent, the variation of bright sunshine and shadow from the fleeting clouds much increasing the beauty. The Snailsbeach Mine Company having courteously arranged that the whole process of lead manufacture should be seen, the smelting houses were visited on the return journey in order to be present at casting time. After a capital tea at the Minsterley Arms, an unexpected treat was provided by the inspection of Mr. Philip's fine collection of fossils, and Mr. Parry conducted some of the party to some neighbouring quarries, where interesting fossils were seen. The party separated with hearty thanks to the two guides, whose accurate knowledge of the local geology, so readily imparted, had much increased the interest of the excursion.

August 13, Ludlow—Assembling by train the members proceeded in carriages to Ludford Bridge, under the guidance of Mr. Solway and Mr. Cocking, and after noticing the general features of the Old Red Sandstone, upon which the town stands, and the bold escarpments of Upper Ludlow shale, forming the Castle Hill and Whiteliff, which are formed by the deep cutting of the river between them, the famous bone bed was pointed out, and good specimens secured. Mr. Cocking then led the way to Mary Knoll and the lovely Sunny Hill Dingle, the scene of Milton's "Comus," and the various quarries, exposing sections in this interesting Silurian promontory to Overton. A portion of the party extended their drive to Downton Castle, where the grounds were courteously thrown open by the owner, R. P. B. Knight, Esq. After tea, in the antique rooms of the picturesque timber-built Feathers Hotel, the whole party proceeded to the church, and thence to the Castle, and after hearty thanks to Mr. Cocking, returned by train.

September 18 and 19, Ross, Chepstowe, and the Wye.—Assembling at Ross, and after luncheon at the Royal Hotel, the members proceeded in carriages, under the guidance of H. Southall, Esq., to Whitchurch, where they were met by J. Panter, Esq., and conducted to the Doward Bone Caves, several of which were entered and a few remnants of bones were found. Some further caves were explored, under the guidance of Mr. Panter, jun., and J. Robertson, Esq., and some of the party proceeded over the Doward Hill to Symond's Yat. Returning to Ross to supper, Mr. Southall gave some interesting botanical information, and the moon being bright the members were enabled to remain in the beautifully-situated gardens of the Hotel to a late hour, as special arrangements had been made for the whole party there for the night. Early the next morning the train was taken to Chepstowe, and carriages being in waiting the Church and Castle were inspected, and then the way was taken to the top of the Windcliff, where there was a splendid view of the Bristol Channel. Descending the winding steps to the Moss Cottage, the carriages were again in readiness and the party proceeded to Tintern Abbey. At the Tintern Station the special railway carriage, placed at the disposal of the party by the Great Western Railway Company, was found attached to the train, which proceeded to Monmouth, where an hour was allowed for visiting the church of St. Thomas, and the old gateway on the Munnow Bridge, and the remains of the Castle. Proceeding again by train to Ross, sufficient time was allowed for dinner at the Hotel, and the train was again taken for the homeward

journey, the members being well satisfied, that although the time available was very limited, a fair idea of the beauties and interesting objects of the Wye had been obtained.

October 8, Cannock.—With the North Staffordshire Naturalists' Club. At Cannock Station carriages were in waiting, and after a hasty peep at the Church, under the guidance of the Rev. T. W. Peile, the Vicar, they proceeded to the Huntington well of the South Staffordshire Water Works Company, where Mr. Timmis, the contractor, showed the work, and the specimens of the strata passed through. W. Molyneux, Esq., President of the North Staffordshire Club, led the way to a gravel bed near, where traces of copper and lead ore had been found, and where a few specimens had been picked up. The Huntington sinkings for coal by the Chaudron system were then visited, and every information was given by the chairman, directors, and managers, special arrangements having been made to see as much of the process as possible in the short time available. The way was then taken to the new reservoir, constructed by the South Staffordshire Water Works Company, on the Scout House Hill, at Hednesford, and after a slight luncheon, kindly provided by Mr. Walker, the contractor, Mr. Molyneux read a most interesting paper on the Bunter Gravels, which will be found in the Proceedings; and numerous fossils collected by Mr. Beale and Mr. Hawkins, were exhibited. After watching the effects of a large shot of 6 cwt. of gunpowder, in lifting a large piece of the gravel for the excavation of the reservoir, and hearty thanks to Mr. Walker for his arrangements for the party, the way was taken to another South Staffordshire pumping station being constructed at Sheepwash, near which Mr. Molyneux pointed out the leading points of interest in a fine section of the parts exposed by excavations for railway ballast; and the party proceeded to Rugeley, where tea awaited them at the Shrewsbury Arms, after which the interesting ruins of the old Church were examined, under the guidance of Rev. R. M. Grier, the Vicar, on the way to the station for the return journey.

At each meeting sketches of the route, with other information, repeated by the multiplex copying process, have been furnished to the members signifying their intention to be present. These have been prepared by the Secretary, with the assistance of two of the younger members, Mr. James Maginnis and Mr. W. R. Penn, the latter of whom has also furnished the index to the Proceedings, to be found at the end of the present volume.

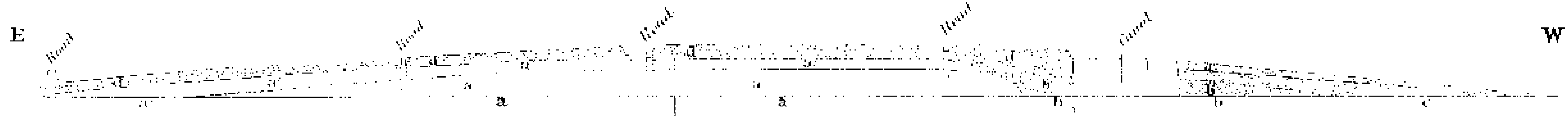
REGISTER OF RAINFALL IN 1876.

Kept at Pedmore, by Mr. E. B. MARTEN.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·06	0·12	0·02	...	0·05	...	0·12	...	0·02	...	...	0·23
2	0·16	...	0·05	...	...	...	...	0·36	0·10	0·07	...	0·49
3	0·02	0·22	0·06	...	0·04	...	...	...	0·42	0·21	0·46	0·37
4	...	...	...	...	...	0·22	...	...	...	0·09	0·06	0·23
5	...	0·14	...	...	...	0·08	...	...	0·11	0·21	...	0·37
6	...	0·04	0·28	...	...	...	0·45	0·07	0·18	0·06	...	0·10
7	...	...	0·12	...	...	0·02	0·15	...	0·02	...	...	0·22
8	...	0·04	0·20	...	...	...	0·10	...	...	0·55	...	...
9	...	0·02	0·06	0·20	...	0·35	...	...	0·10	0·07	...	...
10	...	...	..	0·41	...	...	...	...	...	0·09	...	...
11	...	...	...	0·06	...	...	...	...	0·04	0·01	0·35	0·18
12	0·34	...	0·53	0·46	...	0·31	...	...	...	0·20	0·67	0·10
13	...	0·21	0·04	...	...	...	...	...	0·04	...	0·11	...
14	...	0·33	0·21	...	...	0·02	...	...	0·09	0·06	0·11	...
15	...	0·48	0·06	...	...	0·28	...	0·05	...	...	0·37	0·07
16	...	0·05	0·03	...	...	0·03	...	...	0·14	...	0·05	0·18
17	...	0·08	0·02	0·14	..	0·02	0·79	0·05	0·12	...	0·02	0·20
18	...	0·22	...	0·10	...	...	...	0·19	...	0·02	0·39	...
19	0·02	...	0·02	0·75	...	...	...	0·09	...	...	0·03	0·73
20	0·78	0·32	...	0·06	...	...	...	...	...	...	0·02	0·33
21	0·60	0·02	...	0·70	...	...	...	...	...	...	...	0·04
22	...	...	...	0·16	0·30	0·43	...	...	0·20	...	...	...
23	...	...	...	...	...	0·15	0·20	...	0·15	0·04	...	...
24	...	0·15	...	0·10	0·40	0·17	...	0·08	0·47	...	0·44	0·04
25	...	0·16	...	0·02	...	...	...	...	0·10	...	0·10	...
26	...	0·40	...	...	0·08	...	0·30	0·14	0·05	...	0·10	0·61
27	...	...	0·06	...	...	...	0·22	0·08	0·18	...	0·15	0·10
28	...	0·04	0·02	0·21	...	...	...	0·51	0·62	...	0·06	...
29	...	0·20	0·23	0·55	...	...	...	...	...	...	0·01	0·33
30	0·04	...	0·30	...	...	...	...	0·21	0·56	...	0·21	0·37
31	...	...	0·06	...	...	...	0·40	0·76	...	...	...	0·84
Totals	2·02	3·24	2·37	3·92	0·87	2·08	2·64	2·59	3·71	1·68	3·71	6·13
Total from Jan 1.	2·02	5·26	7·63	11·55	12·42	14·50	17·14	19·73	23·44	25·12	28·83	34·96

Section of the Midland Railway Cutting at Daw End near Walsall, looking South.

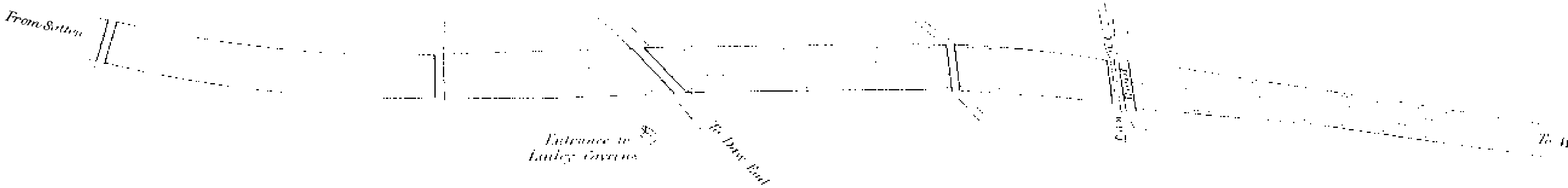
to illustrate Mr Oliver's paper

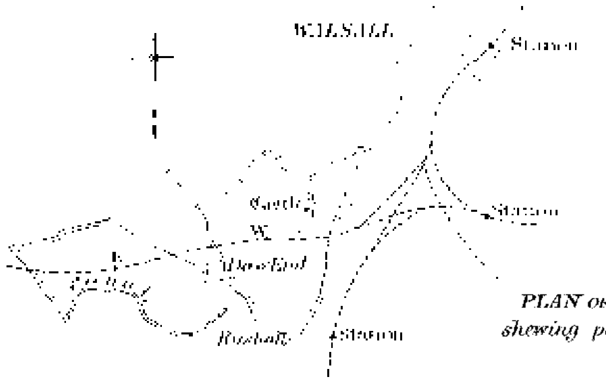


Wenlock Beds:
- a Hard dark grey shales.
- a' Soft light brown shales, upper portions of a
- b Thick limestone, containing masses of chain coral
- b' Nodular limestone, very much like that near Walsall Station

(dip 8° to 10° a little N of W.)

- c Coal measure sandstones, with one or two thin bands of ironstone, dip about 5° W.
- d Drift consisting mainly of fine calcareous clay or marl with entangled masses of red sand.



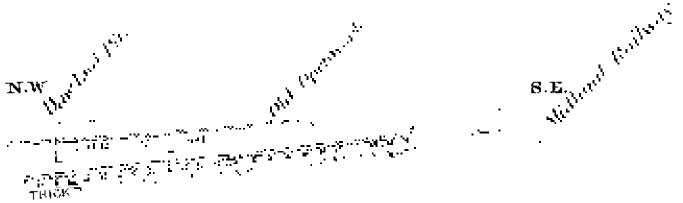


PLAN OF DISTRICT shewing position of cutting.

Vertical Scale for Section. 0 10 20 30 40 50 60 70 80 90 100 Feet

Horizontal Scale for Plan and Section. 0 10 20 40 60 80 100 20 40 60 80 200 Yards

Sketch Section of the Linley Caverns.



Drake, Driver & Leaver, lith. Lon

RAILWAY CUTTING AT DAW END, NEAR WALSALL.

By Mr. J. W. Oliver. *Visited at Field Meeting April* 23, 1877.

This cutting is now approaching completion, and it seems desirable before the banks are finally made and the geological structure obscured, that some account of it should be given. At the request of the secretary I have undertaken to write a short description of the section for publication in the annual report of the Dudley Geological Society. I must premise, however, that my visits have been few and hurried, so that any description that I can give will necessarily be of the most general character.

The cutting runs from west to east, just south of Daw End and the Linley Caverns, and is nearly a mile in length. Its depth for a great part of the distance is from 25ft. to 35ft. The dip of the beds throughout the entire section is to the west, or a little north of west.

The western end of the section for a distance of about 230 yards is occupied by coal measure sandstone with one or two thin seams of ironstone, these dipping westwards at an angle of about 5°.

Rising from beneath these, at a somewhat higher angle, about 10°, is a band of Wenlock limestone which extends for a distance of about 160 yards. It is of a markedly concretionary character, exactly resembling that which is seen on the railway just out of Walsall station, and there can be no hesitation in regarding it as the uppermost of the two bands of Walsall limestone.

The section is interrupted for a short distance on both sides of the canal, the ground having been cut back and the slopes covered. When the rock again comes in it is still found to be limestone, but the nodular character has altogether disappeared. It is here massive, and consists largely of chain coral. Whether this is the basement of the band of limestone seen on the other side of the canal, or whether, as seems more probable, it is the lower of the two bands of Walsall limestone, I have not been able to determine.

This limestone extends but for a very short distance, say about thirty yards. From beneath it rise a series of hard dark-grey shales, with occasional thin bands of limestone, which continue nearly to the end of the cutting, a distance of about 800 yards; certainly the most complete section of Wenlock shale which the South Staffordshire district can present.

I have described these shales as hard and of a dark grey colour, but this is only the case in the lower half of the cutting. In the upper part, as we approach the surface, the shales become quite soft and of a pale brown colour, weathering a darker brown on the exposed surfaces. At first I imagined

that these soft light coloured shales belonged to different beds from those of the harder and darker colours, but a little examination showed that nowhere do the darker shales rise to the surface, or the lighter ones descend to the base of the section. Each bed at a certain point changes somewhat abruptly both in colour and coherency, so that above a given line all the shales are of the one character, while below that line they are of the other. If I am right as to these facts, it becomes an interesting question as to what has caused the change in the upper part of the beds. The only solution that suggests itself to me is that it may have been due to the gradual percolation of acidulated water carrying down iron in solution from overlying Coal-measure, Permian, or Triassic beds; always supposing that the Silurian beds of this district were at one time overlaid by one or other of these formations. This, however, is only a guess, and may or may not be the true explanation.

The entire section is now overlaid by a variable thickness of "drift", consisting mainly of a fine calcareous clay, evidently derived from the shales themselves, and containing fragments of limestone, and occasional smaller or larger masses of soft red sandstone, which seem to have been dropped down in the midst of the clay.

I have omitted to mention a boss of limestone which comes in on the north side of the cutting, close to the new bridge and near the engine house of the old Linley workings. Unless this is brought in by a fault it must be a portion of a lower band than either of the two I have previously mentioned. Further information on this point is needed.

Both limestones and shales contain the usual Wenlock fossils. When the fragments of limestone, which are scattered along the embankment, west of the cutting, have had time to weather, they will doubtless furnish some good specimens to the collector. In the meantime the shales should be diligently searched. Even the harder shales are very friable, and easily yield up their contained fossils. *Phacops caudatus* seems to be the prevailing trilobite. Its tails are tolerably abundant and are known to the workmen as "butterflies." The men usually have a supply on hand and are ready to part with them for a few pence.

I append a list of the fossils I have found or noticed during my few brief visits: — *Cornulites serpularius*, some small cup corals, *Phacops caudatus*, *Atrypa reticularis*, *Meristella tumida*, *Pentamerus galeatus*, *Strophomena euglypha*, *S. depressa*, *Leptæna sericea*, *Spirifera striata*, *Rhynconella* (two or three species), *Mytilus mytilimeris*, *Cardium striatum*, *Modiolopsis*, and stems of *Encrinites*. These were all from the shales. In the soft shales they often occur as casts or impressions only.

PHOTOGRAPH OF A SECTION OF WENLOCK SHALE,

NATURAL SIZE.

From the Wren's Nest, Dudley; taken from a Microscopic Sketch prepared by Mr. Terry for the Evening Meeting in Walsall, April 23rd, 1877.

PHOTOGRAPH OF A SECTION OF WENLOCK SHALE FROM THE WREN'S NEST, DUDLEY, TAKEN FROM A MICROSCOPIC SKETCH.

Prepared by MR. TERRY, *for the Evening Meeting at Walsall, April 23rd*, 1877.

The photograph on the opposite page represents a section of Wenlock shale which had filled up the cup of a *Cyathophyllum truncatum*, found at Dudley, on the Wren's Nest. The section is a genuine one, as it was prepared and ground down by myself for the microscope, and the sketch from which the photograph was taken was drawn by means of the camera lucida. In the photograph the original section is enlarged 24 diameters, or 576 times. The mass consists of fragments of Trilobites, Corals, and Brachiopoda, and as this is only a very ordinary piece of shale which, according to Beete Jukes, is in places 1,400 feet in thickness, an examination of it gives one some slight idea of how full of fossil remains some of the Silurian limestones and shales are, many of the objects seen in the photograph being invisible without the aid of the microscope. The study of the microscope as applied to geology offers a vast field to the observant student, and at present comparatively little has been written on the subject. Much valuable information might be recorded by the members of this and other societies, if, when they are working with the microscope, they would sometimes record by means of these sketches what they then observed. By means of the camera lucida, which can be obtained for a few shillings and used with almost any ordinary microscope, these drawings may easily and accurately be taken. The microscope is placed in a horizontal position, and the camera lucida fixed on to the eye piece in the place of the ordinary cap. The eye of the observer looking down from above, through the camera, can see the image of the object projected upon the surface of a piece of white paper placed upon the table. The only difficulty in sketching this image is in so arranging the light, that the point of the pencil and the object to be drawn can be seen at the same time. If the light is too bright and the object to be sketched is too clearly defined upon the paper, the point of the pencil will not be seen. Amongst other things the igneous rocks of the district and some of the shales of the coal-measures, which are full of fish remains, give most interesting objects for these sketches.

ANALYSES OF VARIOUS LIMESTONES.

Collected for the Walsall Field Meeting, April 23rd, 1877.

	Aymestry.	Wenlock.						Barr.
	Sedgley.	Dudley Castle Hill.	Wren's Nest Hill.	Walsall.	Linley.			Hay Head.
Carbonate of Lime	81·10	90·09	74·64	76·40	63·98	95·38	93·17	80·29
,, Magnesia	2·27	1·26	2·51	2·10	...	·31	...	3·65
,, Protoxide of Iron	2·15	...	1·63	...	...	...	...	3·49
Phosphate of Lime	...	...	...	...	...	...	·24	...
,, Magnesia and Phosphoric Acid	...	...	...	...	1·70	·39	...	...
Phosphate of Protoxide of Iron, Manganese, and Alumina	...	...	...	...	...	...	·86	...
Alumina	·45	...	·75	...	1·00	·40	...	·35
Phosphoric Acid	·21	·46	·35	...	...	...	1·93	·10
Alumina and Susquioxide of Iron	...	2·30	...	...	...	...	...	...
Oxide of Iron	...	...	...	2·50	...	...	...	...
Protoxide and Peroxide of Iron	...	...	...	...	5·17	1·37	...	...
Magnesia and Alkalies	...	...	...	...	1·41	...	Traces	,,
Silica	...	...	...	13·00	...	...	...	...
Insoluble Matter	13·38	5·13	20·03	...	25·66	1·80	3·72	12·12
Organic Matter	...	...	...	5·60	...	...	...	...
Moisture	...	...	...	·40	...	...	...	...
Water, Organic Matter and Loss	...	·76	...	...	...	...	...	...
Loss in Analysis	·44	...	·09	...	1·08	·35	...	...
Total	100·00	100·00	100·00	100·00	100·00	100·00	99·92	100·00

Section of the Midland Railway Cutting at Dun

to illustrate W' h

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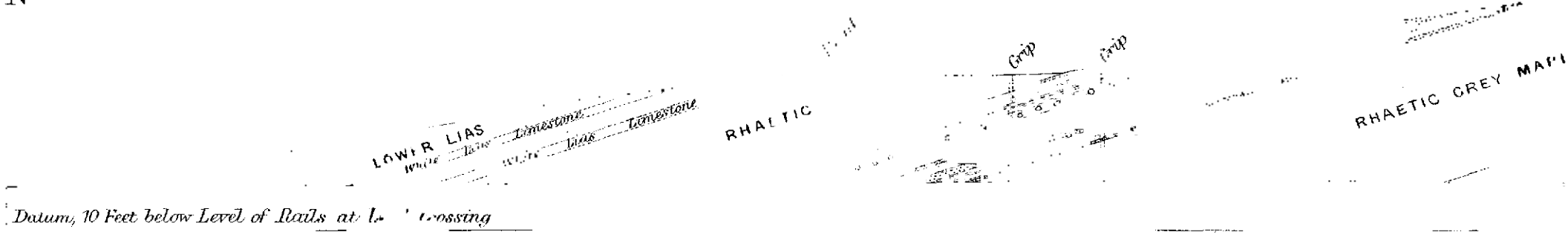


Datum, 10 Feet below Level of Rails at L[illegible] Crossing

Vertical Scal.

Feet 10 5 0 10 20 30 40

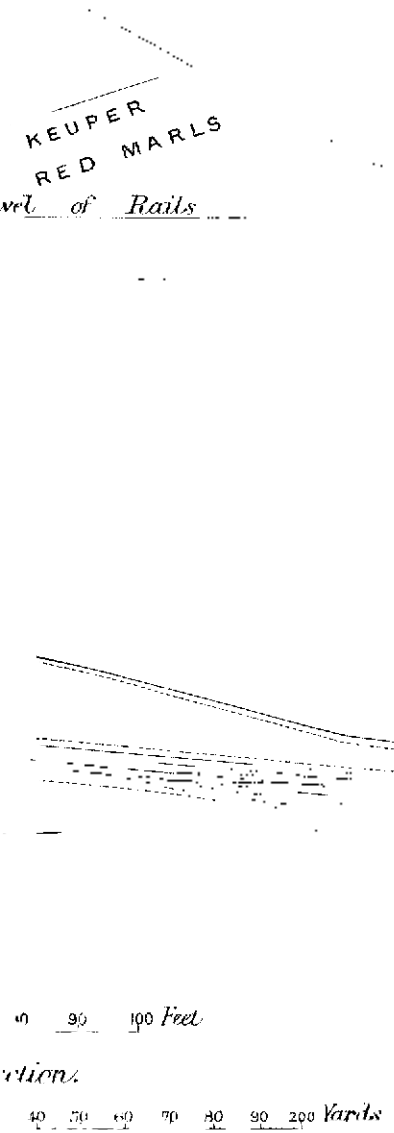
Horizontal Scale for t

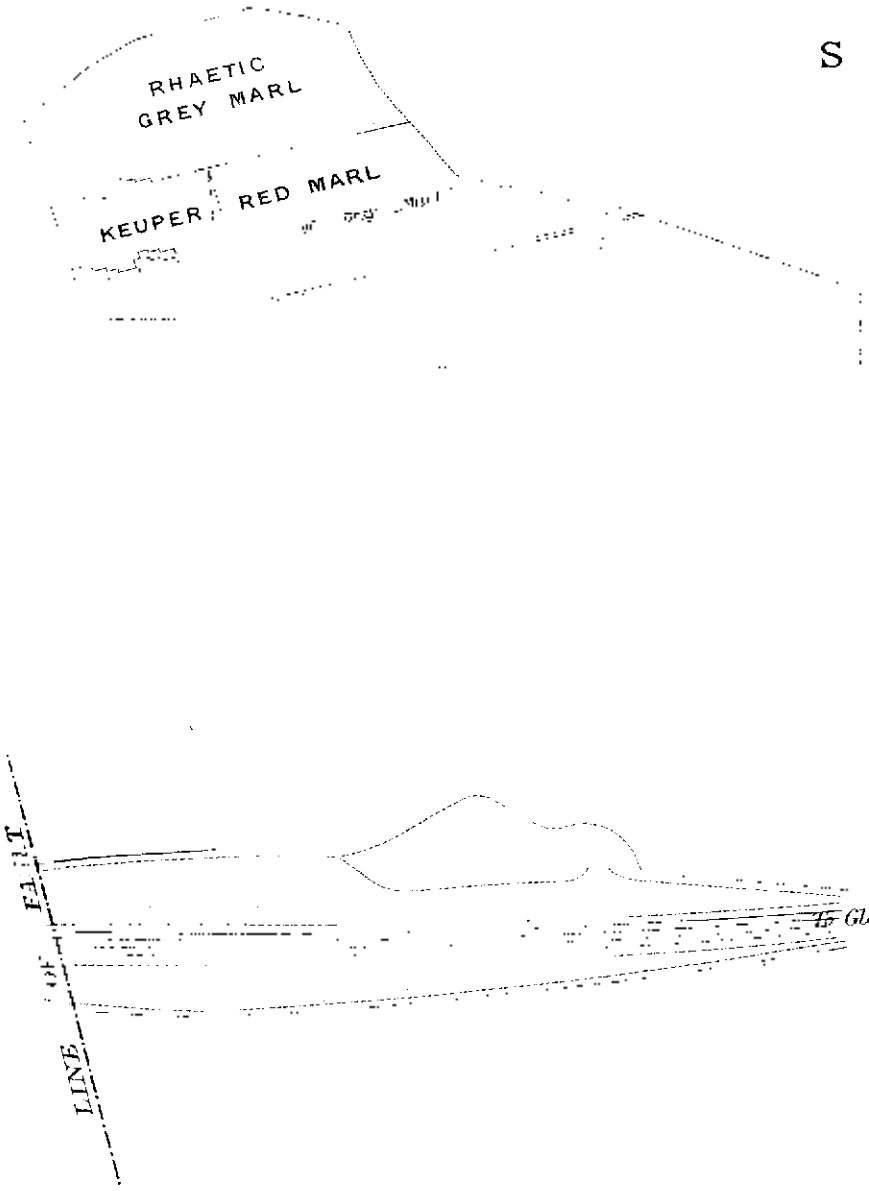
Yards 10 5 0 10 20 30 40 50 60 70 80 9

Drake, Drawr & L[illegible]

PSTEAD NEAR DROITWICH, LOOKING SOUTH.

paper





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ON THE RHAETIC SECTION AT DUNHAMPSTEAD CUTTING, NEAR DROITWICH, AND ITS CORRELATION WITH THE SAME STRATA ELSEWHERE.

By MR. W. J. HARRISON, F.G.S.

Within the last 20 years considerable attention has been directed by geologists to certain beds of grey marl, black shales, and whitish limestones, which intervene everywhere between the great geological formations known as the Trias and Lias respectively. Strickland made some observations on them in 1842 (Proceedings of the Geological Society, 1842, vol iii., p. 586), and in 1843 Col. Portlock, when surveying the north of Ireland, specially noted the occurrence near Portrush, in Antrim, of shale and loose gritty marl, at the very base of the Lias (Report on the Geology of Londonderry, 1843), and in the shale he found a new fossil which he named *Avicula contorta*, from its bent or contorted appearance, and which has since been found everywhere to characterise the middle division of the Rhaetic strata.

On the continent the presence of well-developed fossiliferous beds on this horizon has long been recognised. In the mountainous region of the Alps between Bavaria and Lombardy, to which the Romans applied the name of *Rhaetia*, we find beds with a peculiar and well-developed fauna, known as the Kossen beds, whose thickness is not less than 4,000 feet, and which occupy precisely the same relative position between the Triassic beds below and the Liassic beds above, as the marls and black shales of Portlock do in the British Isles.

In 1860 Dr. Wright, of Cheltenham, described the black shales, &c., of the West of England under the name of the "Zone of Avicula contorta," in a paper read before the Geological Society (Quart. Journ. Geol. Soc., Vol. xvi., p. 374). This was followed in 1861 by a paper by Mr. Charles Moore (Quart. Journ. G. S., vol. xvii., p. 483), in which he first applies the term *Rhaetic* to designate all the beds which lie between the variegated marls of the Keuper (Trias) and the top of the White Lias. This paper of Mr. Moore's is a very valuable and important one, giving descriptions of about 50 species of Rhaetic fossils, and two plates including 58 figures.

Mr. Moore also identified, in 1859, certain shales and thin bands of limestone at so distant a point as Linksfield, near Elgin (Quart. Jour. G. S., vol. xvi., p. 445), as being identical with the White Lias, bone bed, &c., so well known near Bristol.

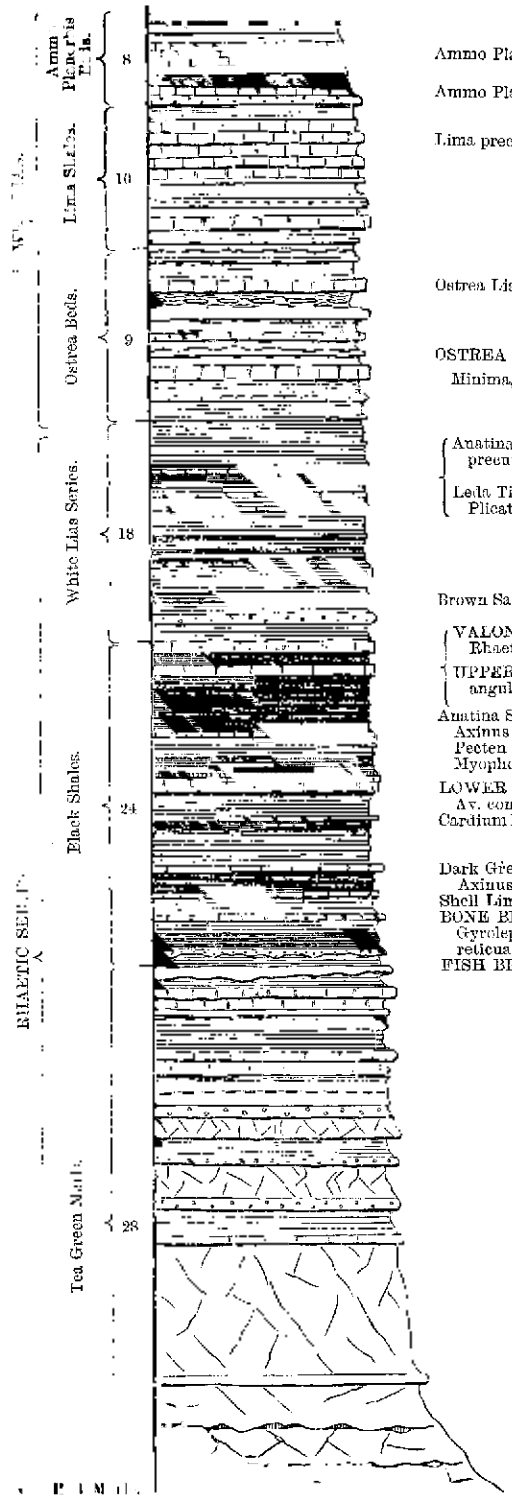
The attention of geologists having now fairly been drawn to these interesting Rhaetic deposits, we get numerous and valuable papers from various writers in the field, describing the strata in various localities.

Rhaetics near Belfast, &c., R. Tate, Quart. Journ. G. S., vol. xx., p. 103.
„ Somerset, Boyd Dawkins, „ „ vol. xx., p. 396.
„ Warwickshire, Rev. P. B. Brodie, „ „ vol. xxi., p. 159.
„ South Wales, E. B. Tawney. „ „ vol. xxii., p. 69.
„ Somerset, Brodie, „ „ vol. xxii., p. 93.
„ N.E. Ireland, Tate „ „ vol. xxiii., p. 297.
„ S. Wales, Bristow, „ „ vol. xxiii., p. 199.
„ Somerset and South Wales, Moore, „ vol. xxiii., p. 449.
„ Gainsborough, Lincolnshire, Burton, „ vol. xxiii., p. 315.
„ Bristol, Stoddart „ „ vol. xxiv., p. 199.
„ Bristol, C. O. G. Napier, „ „ vol. xxiv., p. 204.
„ General, Ramsay, „ „ vol. xxvii., p. 189.
„ Moray Firth, Judd, „ „ vol. xxix., p. 145.
„ Skye and Raasay, Bryce, „ „ vol. xxix., p. 335.
„ Stratford-on-Avon, &c., Brodie, „ „ vol. xxx., p. 746.
„ N.W. Lincolnshire, Cross. „ „ vol. xxxi., p. 115.
„ Leicestershire, Harrison, „ „ vol. xxxii., p. 212.
„ Nottinghamshire, Wilson, „ „ vol. xxxiii., p. 1.
„ N.W. Scotland, Judd, „ „ vol. xxxiv.,
„ Bristol and S. W. of England, Bristow, British Association Report, 1864.
„ Bristol and S. W. of England, Wright, British Association Report, 1876.
„ Penarth, &c., Etheridge, Trans. Cardiff Nat. Soc., 1873.
„ Somerset and Bristol, H. B. Woodward, Memoirs Geological Survey.
„ Yorkshire, Tate and Blake, The Yorkshire Lias.

There are also numerous notes on the subject in the *Geological Magazine*, and in the Proceedings of the various Scientific Societies of the west of England. In 1864 Sir R. I. Murchison resolved to map the Rhaetic strata separately in future, and to indicate their presence on the geological survey maps and sections by a separate colour (brown). It was thought desirable also to have a British name for the beds, and the term PENARTH SERIES was selected, as the various strata are fully developed and finely exposed in the bold headland of Penarth on the south side of the entrance to Cardiff Harbour. The total thickness of the Rhaetic beds here amounts to 100 feet, consisting of 126 distinct layers or stratulae. This is not quite the maximum thickness in England as at St. Audrie's cliffs near Watchet, and at Queen Camel in Somerset it is 150 feet in thickness.

For the accompanying woodcut of the Penarth section we are indebted to Mr. W. Adams, of Cardiff. It shows in great detail the various beds

PENARTH SECTION.



Ammo Planorbis.

Ammo Planorbis, Lima Pectinoides.

Lima precursor, &c., &c.

Ostrea Liassica. Plicatula.

OSTREA BED. Ost. Liassica, Modiola Minima, Lima punctata.

Anatina Suessii, Mod. Minima, Lima precursor, Axinus concentricus.

Leda Titei, Ost. inusstriata. Plicatula.

Brown Sandy Shales

VALONIENSIS BAND. Cardium Rhaeticum, Gervillia precursor, &c.

UPPER SHELL BED. Pleurophorus angulatus.

Anatina Suessi, Placunopsis Alpina, Axinus Cloacinus, A. depressus, Pecten Valoniensis, Pleurophorus, Myophoria postera.

LOWER SHELL BED. P. Valoniensis, Av. contorta. Cardium Rhaeticum. Cardium Rhaeticum, Avicula contorta.

Dark Grey impure Limestone. Pullastra, Axinus. P. Valoniensis.
Shell Limestone, fossiliferous.
BONE BED. Sauriehthys apicalis, Gyrolepis Alberti, Hybodus reticulatus, Acrodus Minimus.
FISH BED.

with their characteristic fossils, and was originally drawn to illustrate Mr. Etheridge's paper referred to above.

Passing up the Severn we find classic sections at Aust Cliff on the east, and Westbury on the west bank; and can thence follow the beds running nearly due north to Dunhampstead cutting, near Droitwich, the point which it is the object of this paper to describe. Here they come to a full stop, being cut off by a fault running east and west, but indications of their former northward extension along this line are to be met with in the outlying masses which occur at Knowle in Warwickshire, Needwood and Bagot's Park in Staffordshire, between Whitchurch and Market Drayton on the borders of Shropshire and Cheshire, and to the south west of Carlisle.

Hastening back to the main line of outcrop we recover the beds at Hob Lench, and near Stratford-on-Avon, whence we can trace this thin but wonderfully persistent Rhætic band past Rugby, Leicester, Newark, Gainsborough, crossing the Humber at Ferriby, curving round near Thirsk and Northallerton, and finally passing under the German Ocean, near Redcar.

At almost every point we can trace a triple division of the Rhaetic strata, viz.,

	Lias.	Average thickness.
Rhaetic Beds	White Lias	12 feet
	Black Shales	15 „
	Grey Marls	23 „
	Trias.	

The White Lias was named by William Smith, from the white earthy appearance of the limestone bands which chiefly compose it, as compared with the hard, blue, thin-bedded Lias limestones which are found higher up. A hard, fine-grained limestone called the *Sun-bed* or *Jewstone* in the Bristol and Somerset district forms the upper boundary of the White Lias, whilst the well known Cotham Marble or *Landscape Stone* may be considered as indicating the base of the White Lias. The beautiful dendritic markings to which this hard limestone band owes its second name, are due to the presence of oxides of manganese and iron.

The Black or Paper Shales are characterised by the invariable occurrence of two genera of bivalve shells, *Avicula contorta* and *Cardium Rhaeticum*, they are indeed usually spoken of as the *Avicula contorta Shales*. The last mentioned shell abounds more especially, however, in the lower, half of these black shales, whilst Cardium Rhaeticum is commoner in the upper division. There are usually two or three sandstone bands interstratified with the shales, and these as well as the latter are highly charged with iron pyrites. Frequently certain layers are almost entirely made up of

the scales, teeth, and spines of fishes, and of rolled and broken saurian bones, coprolites, &c. These layers are termed BONE-BEDS, and must have accumulated at the bottom of a sea in which little sediment was being deposited.

THE GREY MARLS.—The lowest Rhaetic beds are remarkably unfossiliferous. With the exception of a few fish scales towards the top, they yield little or nothing to the collector. At Watchet, however, they are rather better in this respect, and here in 1861 Mr. (now Prof.) Boyd Dawkins made a discovery of high interest and importance.

The oldest known Fossil Mammal. In a "grey, fissile, ripple-marked, sandy marlstone" Mr. Dawkins found a tiny tooth, proved by its double fang and enamelled tuberculate tooth to be certainly mammalian, and probably marsupial, predaceous, and insectivorous. Prof. Owen has named it *Microlestes Rhaeticus*, and states that of living marsupials it resembles most nearly the little banded ant-eater of Australia (*Myrmecobius fasciatus*). The specimen is now in the Geological Museum at Oxford.

Filling up fissures in the Carboniferous limestone of the Mendip Hills at Holwell, near Frome, in Somersetshire, Mr. C. Moore found a clayey deposit of which he had three cart loads removed to Bath. It had evidently been washed into the fissure when it existed as a crack in the floor of the Rhaetic sea. On submitting this deposit to a minute examination, it yielded *twenty-nine teeth* of a small mammal (*Microlestes Moorei*, Owen), besides 70,000 teeth of a fish of the genus *Lophodus*.

In our geological text-books the "*Upper Trias*" is invariably stated as being the formation in which the remains of the oldest known mammals occur. This statement is incorrect, at all events, so far as the old world is concerned. When Prof. Plieninger, of Stuttgart, in 1847, discovered whilst scrutinizing with a lens, bushels of the sandy Rhaetic bone bed, which occurs at Degerloch, near Stuttgart, two minute mammalian teeth, which he named *Microlestes antiquus*, the true relations of the bone bed from which he obtained the fossils were not known, and it was assigned to the Keuper or upper division of the Trias, rather than to the Rhaetic beds, whose existence as a distinct formation had not at that time been recognised. We are informed by Prof. Judd that there are two bone-beds in Wurtemburg, one in the Rhaetic, and the other lower down in the Keuper. It was from the Upper, or Rhaetic bone-bed, undoubtedly that Microlestes was obtained. In the case of the mammalian remains from the Chatham coalfield of North Carolina, U.S., which belong to a species named *Dromatherium sylvestre*, by Emmons, the exact age of the coal bearing stratum which yields them is still doubtful. It has been referred to the Permian, to the Trias, and to the

Oolitic periods by different writers, so that until this point is cleared up we may fairly consider the *Microlestes Rhaeticus* from the Watchet marls as being the oldest known fossil mammal. The fact of such prizes being obtainable from the Rhaetic strata should certainly stimulate collectors to examine them with diligence and patience.

The Dunhampstead Section.

The vale of the Severn from the point where the river turns southward at Stourport to near Gloucester, is composed of the red marls of the Keuper, which spread in gentle undulations over a tract averaging nine or ten miles in width and extending on each side of the course of the river.

The western boundary of this plain is very sharply defined by the Malvern and Abberley Hills, whose summits form landmarks at great distances. The eastern boundary of the plain is not so conspicuous, but when we approach it closely we find it also to be in most places a distinct though low escarpment.

The slope of this escarpment consists in the lower part of the highest beds of the Triassic red marls, above these come the lowest beds of the succeeding Rhaetic formation, consisting of grey marls about 30 ft. thick, and these are capped by black shales and limestones, the latter beds in fact forming a bulwark against denudation by reason of their superior hardness, and to their presence the escarpment owes its existence.

Ascending this low line of hills we find ourselves upon stiff bluish clays of the Lias, which stretch eastwards for five miles until they are cut off by a north and south fault running near Inkberrow, with an upthrow to the east, so that in that direction the Keuper red marls are again brought in, and we get very interesting exposures of the Upper Keuper sandstone in the little quarries at Inkberrow.

In the Severn Valley we find rich arable land, and the land is found mainly under the plough up to the very top of the Rhaetic scarp which we have already described, so that from a considerable distance we can note in freshly ploughed fields on the hill side, the precise line of junction between the brightly coloured red marls of the Keuper, and the drab or grey marls which form the lowest Rhaetic stratum. But once upon the Lias we find woods and pasture land, and the line of junction of the two great formations might almost be traced in this manner alone, showing how strongly the geology of a district affects the pursuit and mode of life of the inhabitants.

About the year 1840 the Birmingham and Gloucester Railway was constructed, which runs along the western foot of the Rhaetic escarpment, and cuts through it at one or two points, thus affording good sections of

the junction with the Triassic beds beneath. The late Hugh Strickland, then residing, we believe, near Tewkesbury, examined the line during its construction, and gave some general sections of the cuttings (Proc. Geological Soc., Vol. iii., p. 586), but as the Rhætic beds were then not separated from the Lias, he did not study them with the minuteness which is now considered necessary. Of course during the 30 or 40 years which have since elapsed, these railway sections have become obscured by slips and overgrown by vegetation, moreover the fossils near the outcrop of the beds have usually perished from weathering, and the beds themselves have suffered from the same cause, the shales especially being much disintegrated.

The original Birmingham and Gloucester line ran by Stoke Works, through Dunhampstead and Spetchley to Wadborough. It is now used for mineral traffic only, the main line passing through Droitwich and Worcester. It is the section at Dunhampstead cutting, about five miles from Stoke Works, and three miles south-east of Droitwich, which we now wish to describe.

Thanks to the exertions of Mr. E. B. Marten, fresh cuts or "grips" were made in the sides of the cutting at three or four points, so as to clearly expose the succession of the beds, and without this aid it would have been impossible to construct anything like a satisfactory section.

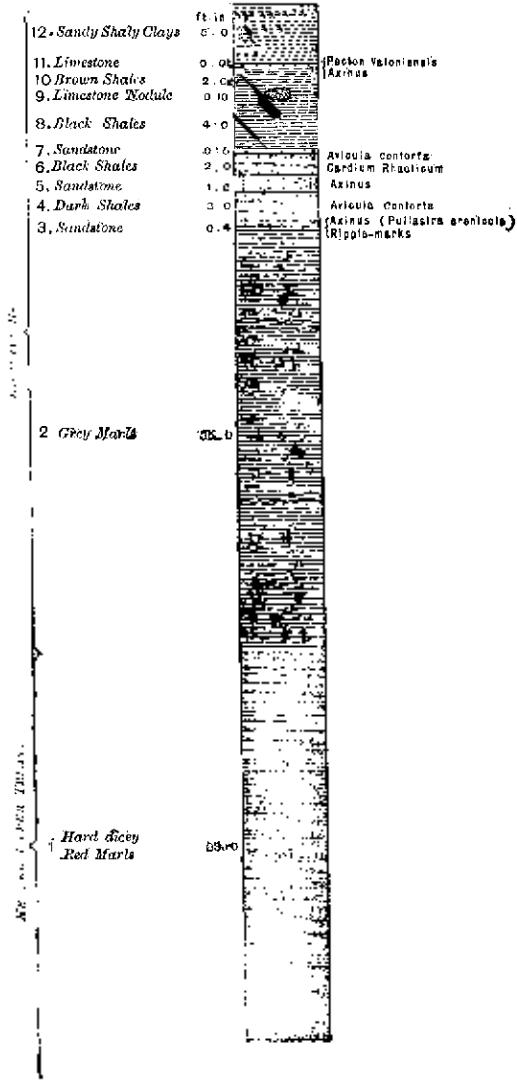
The entire length of the cutting is about half-a-mile, and entering from the southern or Spetchley end, we find on either hand the red marls of Keuper. A little further on these are capped by 30 feet of the Rhætic grey marls, the depth of the cutting here being over 50 feet. Here we have a fine section of a fault, running almost exactly east and west at right angles to the cutting, with a downthrow to the south of over 100 feet. The main fault is accompanied by a number of "step" faults, which owing to the contrast in the colour of the beds, and to the presence here of a hard band in the red marls, stand out with all the clearness of a diagram.

Walking onwards the banks sink, and we pass a level crossing on the line at Dunhampstead Lodge, the hollow being excavated in the red marls, and enter the northern portion of the cutting. Here at first the sides are 47 feet high, but they slope down to 23 feet at the bridge, and continue to fall with a gentle decline to the northern extremity.

All the beds dip N.N.E. at an angle of six degrees, so that the beds on the west side are rather higher than those on the east. In describing the accompanying section we will commence at the base with the Triassic beds.

1.—*The Keuper Marls.* These are of an intense red colour, very hard, and dicey in structure.

VERTICAL SECTION OF THE RHAETIC BEDS AT DUNHAMPSTEAD, NEAR DROITWICH.



2.—*Rhætic Grey Marls.* These attain a thickness of 35 feet, whilst at Aust Cliff they are only 12 feet, and near Leicestor 16 feet in thickness. They are unfossiliferous. Like the red marls beneath they have a dicey structure, breaking up readily into small cubical masses. Occasionally there are hard continuous bands of one or two inches in thickness.

3.—*Micaceous Sandstone.* Between this bed and the grey marls beneath there sometimes intervenes a parting—an inch thick or so—of grey, shaly matter, but usually the sandstone rests directly upon the grey marls. It is hard, micaceous, and white in colour, but darker inside. It weathers out, forming a conspicuous ridge along the side of the cutting. Its surface is broadly ripple-marked, and it contains numerous casts of the small bivalve shell named *Pullastra arenicola* by Strickland, but which Mr. C. Moore refers to the genus *Axinus*. Worm-tracks and other curious markings also occur on the upper surface.

4.—*Black Shales*, 3 feet. These vary in colour from black to brown. They contain a few bad specimens of *Avicula contorta*.

5.—*Pullastra Sandstone*, 18 inches. This is a much softer bed than (3), but also stands out in relief, resisting denudation better than the softer shales. Rabbits burrow in it. It is white internally, but weathers red, owing no doubt to the presence of a little oxide of iron. It is ripple-marked, and contains numerous casts of the *Axinus* already referred to.

6.—*Paper Shales*, 2 feet. These are black shales of surpassing tenuity, splitting into films of extreme thinness. They contain a few impressions of *Avicula contorta* and *Cardium Rhæticum*, but in such a state as to render their extraction or preservation impossible.

7.—*Yellow Sandstone*, 5 inches. In this no fossils were detected.

8.—*Black Shales*, 4 feet. These are clayey and pyritous.

9.—*Limestone Nodule.* This was an oval mass of limestone 2½ feet long by 10 inches in thickness. It was apparently *in situ*, for the shales wrapped round it in an undisturbed manner. This is rather a low horizon for the presence of septaria, but at Leicester bands of similar nodules occur in precisely the same position resting upon the shales.

10.—*Brown Shales, 2 feet.* These were so decomposed that an examination for fossils yielded no results.

11.—*The Pecten Bed.* This is a thin limestone band, about half an inch thick, which cannot be distinguished lithologically from a bed in the same position at Garden Cliff. It is very hard and of a brownish tinge, and is little else than a mass of comminuted shells. Its surface is covered with

large specimens of an *Avinus*, and with *Pecten Valoniensis* very finely preserved.

12.—*Sandy Shales.* From this point the section becomes obscure. A considerable thickness of light sandy and clayey beds ensues, and probably 30 or 40 feet of strata occur before we come to the lowest beds of the Lias.

Still walking northwards we enter a shallower cutting in which contorted lower lias limestones occur. Here saurian bones were found at the time of construction of the railway, but little can now be seen. Finally we have another E. and W. fault crossing the line and bringing in the Keuper Marls to the north. The distance included between the two faults is exactly one mile.

The Bone Bed.—Although we searched as closely as time permitted yet no trace of a true bone-bed was to be found in the Dunhampstead section. The sandstones Nos. 3 and 5, each occupy horizons on which a bone-bed occurs in the Rhaetic beds elsewhere.

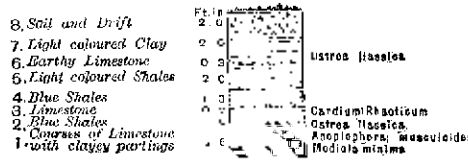
Section at Sale Green.—Walking southwards through Trench Wood, another section of the Rhaetic Grey Marls is well seen in an old marl pit at Sale Green. The red marls of the Keuper are just exposed at the bottom, and above them rises nearly the whole thickness of the Rhaetic Beds, but no trace of the black shales is to be seen on the top. The Grey Marls appear here to be more varied lithologically, than at Dunhampstead.

The White Lias.—This, the uppermost division of the Rhaetic formation, has given rise to considerable discussion, some excellent geologists maintaining that, both on lithological and palæontological characters it should be classed with the Lias proper, and indeed in many places it is impossible to draw an exact line of demarcation. But this is simply because the Rhaetic beds are true *Passage Beds* linking the Trias below to the Lias above, and having affinities in their lower part with the former and in their upper beds with the latter, yet on the whole possessing well marked characteristics which demand for them a separate classification. Thus the limestones of the White Lias may usually be distinguished by their white and earthy appearance, and by the presence in them of fossils which rarely if at all pass up into the Lower Lias proper.

Thrift Wood.—Westwards of Crowle the escarpment becomes very bold and the view from its summit is a very fine one. At one point, on the hill side, just on the south of Thrift Wood, there is an exposure of the White Lias of some interest. It is here a white earthy nodular limestone containing small quartz pebbles.

Churchill Wood. Further to the south we found an interesting exposure in a small pit on the north side of the Worcester and Inkberrow road. This pit would appear to be very nearly in the junction beds between the White Lias and the Lias proper.

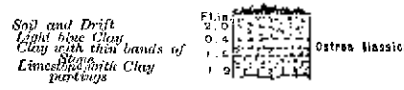
SECTION OF LIMESTONE PIT AT CHURCHILL WOOD.



The limestones (1) at the bottom of the pit are very compact and heavy and of a greyish hue. They contain fine specimens of *Anoplophora musculoides* Schlot, a shell which was formerly known as *Myacites musculoides* Schlot. *Modiola minima* and *Ostrea liassica* also occur. In the blue shales (2) which succeed *Cardium Rhaeticum* is not uncommon; above this point nothing but *Ostrea liassica* was found in a hasty search, but there can be no doubt that this spot is worthy of a more minute examination.

LOWER LIAS.—At an average distance of a mile from the edge of the escarpment we find numerous shallow pits opened in the *Ostrea liassica* limestones of the Lower Lias, near Broughton Hackett, Crowle, Himbleton, &c. The following section near the first mentioned village will give a general idea of the section exhibited.

SECTION OF LIMESTONE PIT EAST OF BROUGHTON HACKETT.



The limestone extracted was compact and fine-grained. Some blocks were 9 inches thick. The surfaces were covered with *Ostrea liassica.*

These lower lias limestones are used locally for building purposes, for road mending, and for burning into lime.

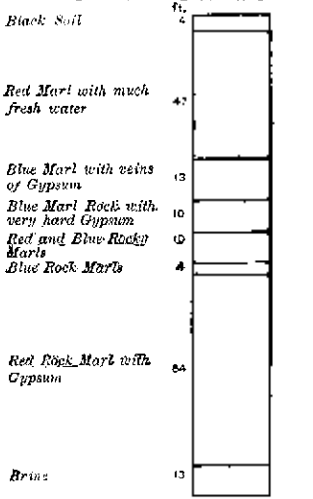
The plate of Rhaetic fossils which forms the frontispiece of this number has been drawn by Mr. S. P. Pick, mostly from characteristic and well-preserved specimens obtained near Dunhampstead or at Leicester. The tooth of Microlestes is copied from the original figure illustrating Mr. Dawkins' paper in the Quart. Jour. of the Geo. Soc., vol. xx., p. 211. The

star-fish *Ophiolepis Damesii* is drawn from the original British specimen, found by myself near Leicester in March, 1874.

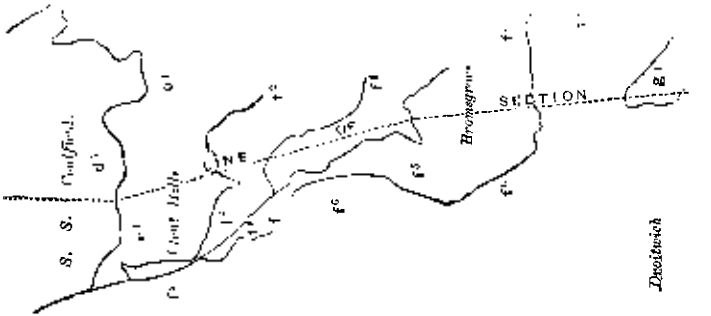
EXPLANATION OF PLATE (RHAETIC FOSSILS).

Fig. 1. *Microlestes Rhaeticus*, OWEN.
Fig. 2. *Hybodus reticulatus*, AGASSIZ.
Fig. 3. *Hybodus minor*, AG.
Fig. 4. *Gyrolepis Alberti*, AGASSIZ.
Fig. 5. *Acrodus minimus*, AG.
Fig. 6. *Sargodon tomicus*, QUENSTEDT.
Fig. 7. *Nemacanthus monilifer*, AG.
Fig. 8. *Saurichthys apicalis*, AG.
Fig. 9. *Saurichthys acuminatus*, AG.
Fig. 10. *Azinus cloacinus*, OPPEL.
Fig. 11. *Cardium Rhaeticum*, MERIAN.
Fig. 12. *Anoplophora musculoides*, SCHLOTHEIM.
Fig. 13. *Avicula contorta*, PORTLOCK.
Fig. 14. *Monotis decussata*, GOLDFUSS.
Fig. 15. *Pecten Valoniensis*, DEFR.
Fig. 16. *Ophiolepis Damesii*, WRIGHT.

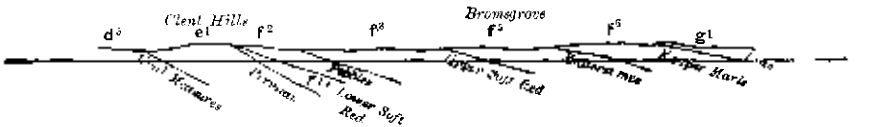
SECTION OF THE RED MARL IN THE CENTRE OF DROITWICH



Presented by the Rev. J.H. Thompson



IDEAL SECTION FROM S. S. COALFIELD TO LIAS.



ADDRESS

By Rev. J. H. Thompson, *on Salt, at the Droitwich Field Meeting, May 29th, 1877. Illustrated by diagrams and specimens.*

Mr. Thompson said it was a popular error to think that salt deposits are confined to the New Red Sandstone, although they were usually found in that formation in Worcestershire and Cheshire. In his own neighbourhood of Cradley he had found a brine spring in the Hawn coal pit, and the Netherton salt springs among the coal measures had long been celebrated. Near Keswick they were found in the Cambrian, and in other parts of Europe they were referred also to the Lias, the Oolite, the Cretaceous, and the Tertiary formations. England was the first country in the world for salt, whilst Droitwich was the most famous salt town in the Midland Counties—(cheers). It was known that Britons, Romans, and Saxons were content with the weak superficial brine springs above the thick hard bed of salt and gypsum. It was not till a century and a-half ago that Sir Richard Lane, Mayor of Worcester, pierced the hard bed (1725), and tapped the grand brine spring which had risen up so abundantly ever since, in strength and purity second to none in the world. Rock salt abounded both in Worcestershire and Cheshire, Mr. Thompson said he had been down among it at Droitwich—(laughter)—in a shaft not now open, but the sight he saw was worth the trouble. There was an immense and magnificent mine of it at Northwich. He had paid visits to various salt works in France, Italy, Prussia, Bavaria, and Spain, and excited much mirth by a graphic description given of his descent in a deep salt mine at Hall, in the Tyrol, and of the various modes adopted for the purpose of producing evaporation, one being by pouring the brine upon thorn-stacks, to procure incrustations. In the absence of the nine-yard and other coals to which the salt-makers of Droitwich had access, Mr. Thompson said, peat, wood, and brown coal were used, whilst in many parts of the Mediterranean evaporation was produced by exposing the brine to the heat of the sun. He exhibited a number of specimens of salt-rock, thorn-stack incrustations, &c., collected during his travels, and which at the close of his address, he liberally distributed amongst the audience. Mr. Thompson next gave an account of the marine plants to be found near Droitwich, which found a congenial soil in the neighbourhood of brine, and on the neighbouring banks of the Salwarp Canal, the seeds of which have remained, it was thought, or may have remained there from the Severn Straits period, and have germinated on a restoration of the original circumstances under which they grow, or have been imported by other means; at any rate, they were not found so far inland near any other town in the kingdom—and they were so abundant that going to the banks of the canal was like going to the seaside. Among

them were:—*Apium graveolens* (abundant), *Glaux maritima* (on the canal banks), *Juncus Gerardi, Atriplex Babingtonii, Lepidium latifolium, Sclerochloa distans, Scirpus maritimus, Lepidium ruderale, Lepidium medium,* (if not *salinum*), *Triticum acutum,* and *Polygonum aviculare* (*var*) *littorale.* Among other rare plants (not marine) found in the neighbourhood, Mr. Thompson said were *Petroselinum segetum, Campanula rapunculoides, Chenopodium polyspermum, Daphne Laureola, Euonymus europæus, Geranium pyrenaicum, Hyoscyamus niger, Lathyrus Nissolia, Medicago maculata, Pimpinella magna, Mentha piperita, Pyrus torminalis, Rumex pulcher, Rosa villosa, Rosa tomentosa, Sium angustifolium, Tanacetum vulgare, Triglochin palustre, Typha angustifolia, Verbascum nigrum,* and *Myosurus minimus.*

PARKFIELD FOSSIL FOREST.

The site of which was visited at the Annual Meeting, June 20, 1877.

This fossil forest was found in the Parkfield Colliery, about one-and-a-half miles from Wolverhampton, on the Sedgley Road, and is illustrated by the small plan and section, with sketches of some of the trees found.

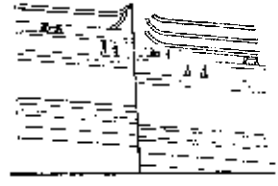
It was described before the Geological Society in a paper on the remains of numerous fossil Dicotyledonous Trees, in an outcrop of the bottom coal, by William Ick, Esq., F.G.S. It was also described by the late Mr. Henry Beckett, in the Proceedings of the Geological Society, 1845. From the latter paper a few particulars are gathered.

The coal being extracted by "openwork" the strata above the trees were removed, but they attracted no attention at first not being recognised as fossil trees. They were all upright, and evidently grew on the spot. They were as much as four feet in circumference and retained the rounded form. The stumps were perfectly bituminised. The principle root extended downwards nearly two feet, and others spread out to form the broad base needed for support. The trunk and roots were covered with bark half-an-inch thick. The thickness of the bed of coal in which the stumps were found was only five inches. Beneath was the bed in which the trees must have grown, composed of shale and fireclay. There were 73 trees in a quarter of an acre as shown in the sketch. In a bed just below similar tree remains are found in equal abundance.

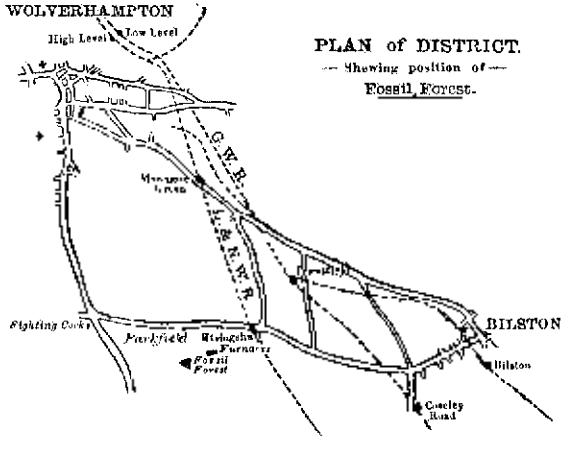
PARKFIELD FOSSIL FOREST.

Site visited at Annual Meeting, June 20, 1877.

—Plan.— —Section.—



—Enlarged view of two stumps of Trees.—



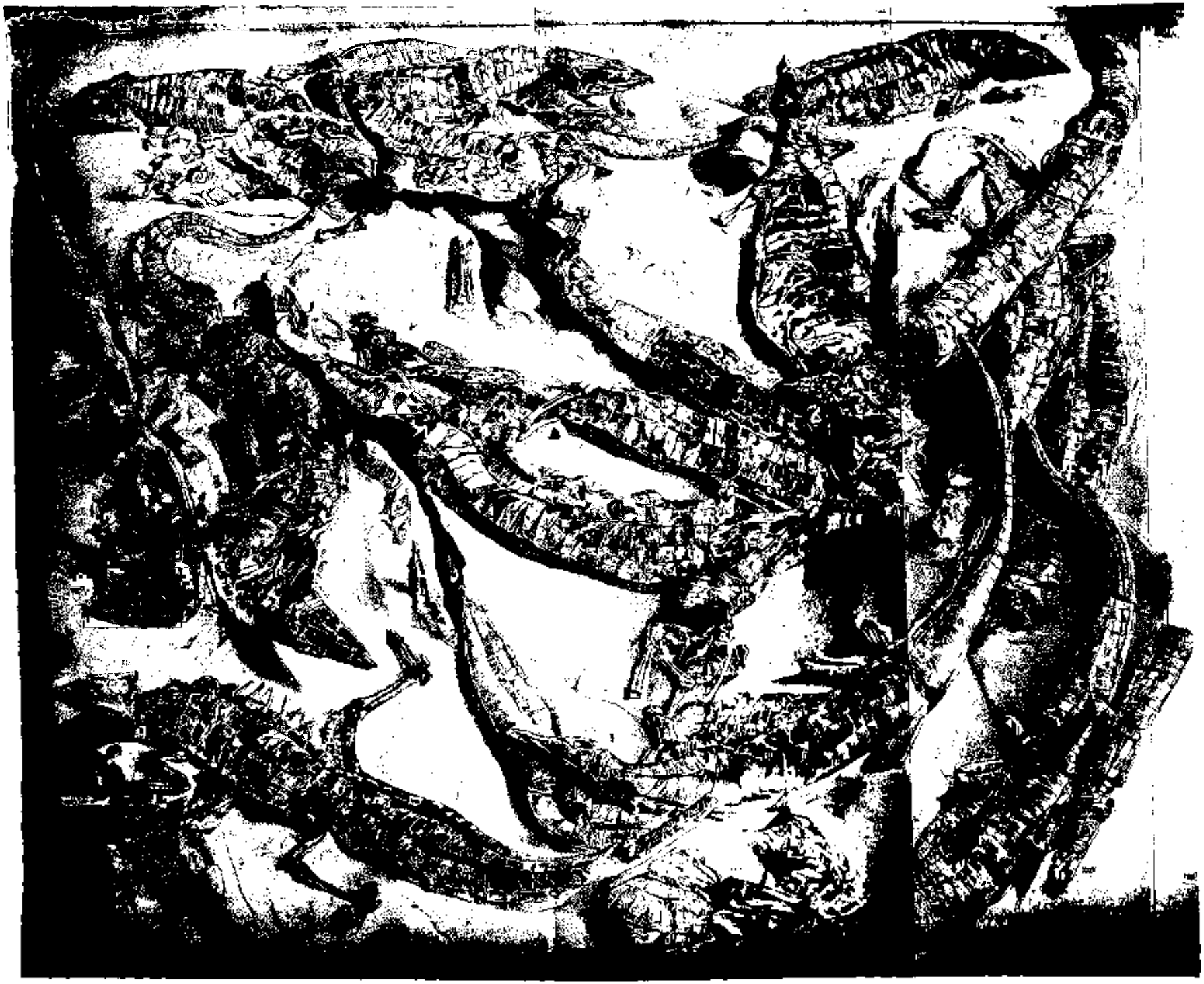
INK PHOTOGRAPH OF THE FOSSIL AETOSAURUS FERRATUS FRAAS,

Presented by MR. CHARLES COCHRANE, *the President, at the Annual Meeting at Dudley, June 20th,* 1877. *Taken from a coloured lithograph, given him by Dr. Oscar Fraas, of Stuttgart.*

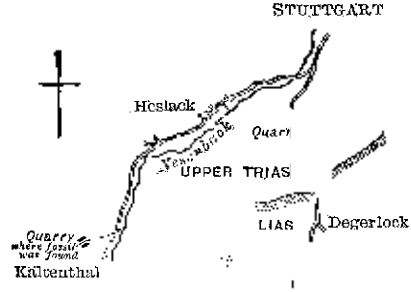
The description of the Aëtosaurus Ferratus Fraas, or Mailed Lizard found in the sandstone, near Stuttgart, is a brief abstract translated from a paper by Dr. Oscar Fraas, written for the University of Tübingen. The woodcut shows the quarry in which it was found, and the sketch plan above it the position of the quarry, and the general bearing of the other places mentioned.

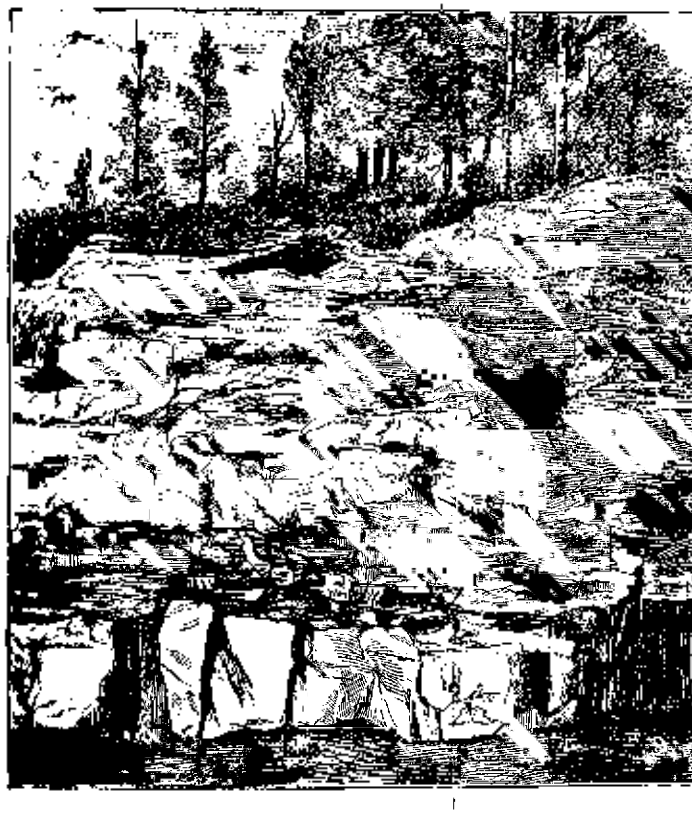
On the way between Tübingen and Stuttgart is to be found the formation called the Keuper Rocks, which form the upper portion of the New Red Sandstone; the Upper, Central, and Lower Keuper lying in regular succession. The new sign-post in Degerlock, not far from Stuttgart, stands in the Black Jura rocks, 470·7 metres above the sea. Five metres below is the junction of the Black Jura (in England called Lias) and the Keuper. The Tübingen entrance to Stuttgart is 254·1 metres above the sea level, and is on Lower Keuper Marls, which extend 41 metres below it, so that altogether the Keupers of Stuttgart are 252·6 metres thick. Where the road makes a turn towards Heslach, some light coarse granulous sandstone may be seen on the side of the hill, which is the horizon of the central Keuper high above the road. There, in the abandoned quarries of the sandstone the lakes of Degerlock have collected. Further down the sandstones become soft and friable. It is in this soft sandstone that for 20 years past in different places, remains of fish and saurians have been found, which have with reason attracted very much attention from Palæontologists.

The first traces discovered in the year 1857 were the remains of dinosaurians. A short time after well-preserved fish were found of the species semionotus, together with the stone kernels of molluscs, which are very nearly related to anodonta and paludina. This precludes the idea of marine formations, but points rather to a large, firm ground, rich in marshes and pools of fresh water, in which enormous land lizards were thriving under gigantic ferns and shave-grass. Since those first discoveries scarcely a year passed that did not bring to light some new, unexpected results. Fortunately, the right man was found to save the spoils, and this was Dr. V. Kapff. He was a zealous and learned collector, who knew how to prepare the remains most carefully, and knew also how to spur on the workpeople, rewarding them for every small fragment they brought to him. In order to expose the bones and teeth, he never used any other instrument than a sewing needle, and each exposed part of a bone or a tooth was



SKETCH OF THE POSITION OF THE QUARRY AND THE OTHER PLACES NAMED.





THE QUARRY WHERE THE FOSSIL WAS FOUND.

The exact spot being where the lines joining the marks at the edge would cross.

immediately soaked in thin gum water, and carefully dried before the work proceeded further.

The woodcut shows the quarry near Heslach, out of which most of the saurian remains were taken. In the face of the rock is a bed two metres thick, where green marl comes in contact with sandstone, which has produced the largest number of remains. Also single extremity bones, teeth, and remains of skulls, show themselves in the wall of sandstone, and in the overlying sand marl. The quarry remains in its essential features unchanged from what is seen in the picture, and the strata are nearly the same in the whole valley of the Nesenback.

Last year several new quarries were opened on the right and left of the high road at the borders of the village of Kaltenthal, which in the same way as those lower down have become good places of discovery for fish and saurian remains, especially where the Elsenthal opens on the Valley of Nesen, the brow tho of hill being laid bare, with a rock face of 11 metres exposed from top to bottom.

2	metres	friable sandstone, separated by a parting.
1	,,	lenticular greensand, reddish sandy marl, and in it the group of saurians.
2	,,	soft white sandstone.
1	,,	red marl
5	,,	light sandstone strata, sometimes harder, sometimes softer, and in the face of it Belodon.
11		

When working the five metre sandstone bed, which is quarried as building stone and for floor sand, the workmen noticed in the rubbish and in the one metre lenticular marl bed, a number of light thin bones and scales, the colour of which showed clearly against the upper rock. Like well trained workmen they collected in the spring of 1875 most carefully all the fragments which came out on the breaking up of the rock, and brought them to the long-known collector of their spoils. The rock was then taken out in large clumps and put in a dry place and the cleaning commenced. Of course it was not at first possible to recognise the interior of these clumps. It needed one-and-a-half years of patient pains and most careful manipulation, to remove with the needle the grains of sand one by one and expose the individual specimens. In such a manner this group of lizards has formed a memorial of the production and preservation of nature, and also a memorial of human skill in anatomical preparation of the oldest fossils.

On a narrow surface of not quite two square metres are lying 24 individuals of the same kind. Their natural position is not altered, and in

the stone we have them before us in the same state as when they were taken out of the ground, except that in order to economise space in the Royal Museum pieces of blank rock have been removed between Nos. vii. and viii. and Nos. xix., xx., and xxi., so that the group now occupies only 1·43 square metres, without altering the positions of the specimens.

The bodies of the animals were lying, as already said, in the lenticular enlargement of the sandy marl in contact with the bed of sandstone, which showed a cavity corresponding to the lenticular enlargement of the marl.

They were lying in a cavity or pool in the sand, floating together in contact, or over or under each other just as they came, and as the bodies placed themselves by the currents of the water. In looking at some of the animals one could be tempted to dwell on the last moments of their life. Nos. iv., v., and viii. are lying almost as if they were alive, with windings of the head and tail, which indicate some sudden action surprising the animals, and yet the advanced state of maceration of the bodies does not allow of the supposition that we have in these remains the last expression of life immediately before death. The arrangement of the remains indicates rather that they were driven into the water, and that while they were lying freely in that water decomposition of the body began, and the soft parts putrefied, the ligatures dissolved, and the scales and bones began to drop. Some heads, as for instance No. x., have quite fallen to pieces; in others, like No. viii., the lower jaw is loose, the maxillary bones are wanting, and the metacarpus and metatarsus are dispersed with the phalanges.

The preservation of these remains is very good compared with that of other Trias fossils. All the hard parts of the reptiles' bodies, such as the bones and teeth, are admirably preserved, so that polishing of the scales is possible. The petrifying material itself is red or brown clay ironstone, which is found in large quantities in the central Keuper, and which passes over the sandstone, and leaves everywhere red stripes and red stains. In the same manner every cavity of the bones, the under part of the scales, every opening, every pore is filled with brown clay ironstone; but the bones, the bone skin, and the extremity bones or vertebræ are changed into vivianite, a phosphate of iron of various shades of blue and green. The iron blue colour gives a still more life-like appearance to the group, and the more so because the brown red of the iron oxide forms the back ground. The colour of the sandstone in which the fossils lie is a light grey, with a tinge of green. In order to shew the natural colour as found, the artist has tried to give that colour in the figures and has indeed quite succeeded.

ON THE BOTANY OF THE NEIGHBOURHOOD OF ROSS, AND THE LOWER PORTION OF THE WYE VALLEY.

By MR. HENRY SOUTHALL, *presented at the Ross Field Meeting, September 18th*, 1877. *This paper was prepared for the Severn Valley Naturalists' Field Club, by whose permission it is printed and included in these Proceedings.*

In giving some account of the more interesting plants to be found in the above district, there will be no attempt to present an exhaustive essay on the subject, or even to furnish a complete list of its flora, but we shall confine ourselves to a hasty sketch of what has come under our own notice in the course of rambles in the locality extending over a period of more than twenty years. Many of these have been so pleasant and delightful that it is more than possible that an undue partiality may be shown to what we shall be excused for considering one of the most rich and varied in its vegetation of any equal area in the United Kingdom, viz., the Doward Hills, Symonds' Yat, and the Coldwell Rocks.

In this locality, in a geological point of view, perhaps the most interesting feature may be the junction of the Old Red Sandstone with the Mountain Limestone, of which latter formation most of the Crags overhanging the Wye are composed, whilst large masses of conglomerate obtrude in places from the hill sides occasionally forming blocks in the bed of the river, where no doubt they have rolled, when loosened from their former beds.

I mention this as explanatory of the character of the soil, upon which so much depends as regards the plants and trees growing on it.

Another noticeable feature of the neighbourhood is the large extent of woodland and the luxuriance and the great variety of the trees with which the tops and sides of the hills are clothed, in this respect presenting a marked contrast to Yorkshire, where the timber, especially in Wharfdale, is pretty much confined to the valley, leaving the higher ground nearly bare.

Indeed much of the beauty and picturesqueness for which the Wye scenery is so celebrated, particularly in Spring and Autumn is due to the different colors and foliage of so large a number of almost every kind of tree, many appearing to be indigenous to the soil.

Two or three varieties of the Oak are met with. Mr. Babington, however, does not admit that there is more than one species of Quercus in Britain.

The beeches, sycamores, chestnuts, and birches attain to great size. The large and small leaved varieties of the lime are seen growing close together.

The Yew is very abundant and seems to favour the line of the conglomerate strata.

The genus *Pyrus* is not only represented by the Crab Tree (*Pyrus malus*) and the mountain ash (*Pyrus aucuparia*) but by the service tree (*Pyrus torminalis*) as well as the *Pyrus scandica* and *Pyrus latifolius*, and the white beam (*Pyrus aria*) remarkable, not only for its bunches of white blossoms when in flower, and of berries when in fruit, but for the whiteness on the under sides of its soft and downy leaves, which when shaken by the wind present quite a striking appearance. The sloe and bullace (*Prunus spinosa* and *insitilia*) the dwarf and wild Cherry (*Prunus cerasus* and *avium*) are common, but the bird Cherry (*Prunus Padus*) is very local. The two Buckthorns, (*Rhamnus catharticus* and *frangula*), the spindle tree (*Euonymus Europæus*), the dog wood (*Cornus sanguinea*), the Guelder Rose (*Viburnum opulus*), and the wayfaring tree (*Viburnum lantana*), together with an almost endless variety of Roses and Rubi (amongst them some considered very local by Mr. Baker), these with the black and red Bryony (*Tamus communis* and *Bryonia dioica*) the Honeysuckle and the Elder, of which three separate kinds may be noticed, of which the Danewort is most curious—are specially ornamental either from their foliage, fruit, or blossom. And if we add the poplar and willow, the former often filled with mistletoe, and the latter with its never ending varieties, puzzling even those who have made them a life-long study, together with the common and Wych Elms, the Ash, Maple, Alder, Hazel, and Hawthorn as well as the Scotch, Spruce and Larch Firs, we shall have made a considerable selection from our list of Forest Trees. And now whilst on the subject of woods we may inquire what ferns and other plants are to be found growing in them. Not to mention particularly those which are almost universal, such as primroses, anemones, blue bells, &c., we may note the cow-wheat (*melampyrum pratense*), the wood *sanicle* (*Sanicula Europæa*), the sweet woodruff, wood Betony, the *Luzula forsteri, borreri,* and *pilosa,* three not very common species of the wood rush and the Spurge (*Euphorbia amygdaloides*) as almost everywhere exceedingly abundant. The Caper Spurge (*Euphorbia lathyris*) has been found recently near Welsh Bicknor, and the only locality in Britain for the *Euphorbia Stricta* is near Tintern.

The wood laurel (*Daphne Laureola*) occurs frequently. The bear's foot (*Helleborus viridis*), with its handsome digitate leaves and green flowers, is found in one locality only. The setterwort (*Helleborus fœtidus*) grows in two or three places, some very fine plants of which have been seen this year. The lily of the valley (*Convallaria majalis*) and the Solomon's seal (*Polygonatum multiflorum*) in two or three places only. The herb Paris, plentiful in a few localities, but rather shy. The barberry (*Berberis vulgaris*) and the

box, also scarce. The columbine (*Aquilegia vulgaris*) is another interesting plant, and one of the commonest of all is the traveller's joy or honesty (*Clematis vitalba*) covering the hedges with its feathery masses. The two periwinkles, *vinca major* and *minor*, several of the *orobanches* or broom rapes, with their brown, weedy, withered-looking flowers, and parasitical on the roots of hazel, the singular tooth-wort (*Lathræa squamaria*), and under the beech trees occasionally in autumn, the yellow bird's nest (*Monotropa hypopitys*).

The lesser winter green (*Pyrola minor*) very shy, but very graceful, and near it the pretty little *Rubus saxatilis* are to be found at the Wynd Cliff, as well as *Sedum rupestri* and *Saxifraga hypnoides*. The wild lettuce (*Lactuca virosa*) grows on Doward, as well as the small teasel, or shepherd's rod (*Dipacus pilosus*). We have also a fair sprinkling of orchids. The fly, frog, and bee orchis are abundant in some years, while in others scarcely to be met with.

The butterfly and bird's nest ditto are generally very plentiful. The true *O. Bifolia*, however, is only found in a place or two, as likewise the pretty little ladies' tresses *(Spiranthes autumnalis)*. The *Helleborines*, *Cephalanthera ensifolia*, and *grandiflora*, and *Epipactis ovalis* are quite rare, and found only occasionally.

As an illustration of the curious way in which orchidaceous plants spring up suddenly in fresh spots, we may mention the finding near Bromyard a few years ago of the *Epipogon aphyllum*, which has never before or since been gathered in Britain.

In addition to the above we may include the aromatic *orchis-conopsea*, the rare *pyramidalis* with its beautiful close crimson spike, also *Orchis ustulata* and *latifolia*. One other scarce plant may be noticed as growing very sparingly in one spot, on a very thick part of the woods, the *Cynoglossum montanum* or wood hound's-tongue, the other species being particularly common.

About 27 species of ferns (not including the minor varieties) are to be found round Ross, that is if we extend the boundary as far as the Black Mountain, where the *Asplenium viride* and *Aspidium Thelypteris* are both found.

The Royal fern, *O. regalis*, however, can scarcely be said to grow now, as it appears to have become extinct, one lady in her zeal (as it is reported) having sent a wagon to transplant it to her fernery.

Fragilis was plentiful a few years since on the Coldwell Rock, but is now nearly gone. *Robertianum* or *Calcareum*, the limestone polypody still

abundant, although a very good locality has been temporarily destroyed by railway quarrying.

The sweet-scented *Œmula* has hitherto only been found very scantily growing under the base of a rock. The adder's tongue and moon-wort, both grow near us. The "oak" fern is plentiful on the borders of the Forest of Dean, but the "beech" fern much more rarely. Perhaps in few places do the "hart's" tongue and other commoner ferns grow in greater profusion or strength than in our woods. Several rare grasses are met with, such as the *Bromus erectus, Melica nutans, Hordeum sylvaticum, Alopecurus fulvus, Bromus secalinus* and *velutinus, Brachypodium pinnatum, Calamintha epigejos,* or the wood reed, &c., &c. The "drunken darnel," as it used to be called *(Lolium temulentum)* the only poisonous grass in England, sometimes comes up in the rectory glebe near Ross.

We have also the *Gagea lutea,* or yellow star of Bethlehem, apparently wild; the other species *Ornithogalum nutans* and *umbellatum* being apparently garden escapes. The evergreen *alkanet (Anchusa semperoirens)* with its intensely blue flowers, and the Deptford pink *(Dianthus armeria),* are both good plants. Then of plants used for medical purposes, in addition to some before named, we have the *Digitalis* in profusion; the deadly nightshade *(Atropa belladonna)* with its potato-like haulm, its dull purple flowers and black currant-like fruit.

The Elecampane *(Inula Helenium)* with its soft downy leaves, two feet long, and its large sunflower blossoms. The Henbane *(Hyoscyamus niger)* scarce and uncertain in its growth. The mother's wort, or as it is called by the villagers "the Hand of God" *(Leonurus cardiaca)* a plant held in great veneration by some. The *colchicum, valerian,* and *gentian* and many others. The *Valeriana rubra* is very fine on the Chepstow rocks, where a white variety also occurs.

And now, as we have pretty well explored the woods, let us take a peep at some of the projecting ledges of limestone rock, and we shall find in very early spring the *Carex clandestina, montana,* and *digitata,* and the *Hutchinsia petræa* or rock cress, all very scarce plants. Later on, the pretty little drop-wort *(Spiræa filipendula),* the rock rose (*cistus Helianthemum*) and a profusion of *Geranium sanguineum,* sometimes quite a splendid sight, as also the horse-shoe vetch *(Hippocrepis comosa).*

Water plants are perhaps not quite so numerous as some other kinds, from the comparative absence of bogs and wet places. We can boast, however, of a pretty large variety. The arrow head, flowering rush, are both found in the Wye, and on its banks.

The celery (*Apium graveolens*), meadow rue (*Thalictrum flavum*), the purple loose strife (*Lythrum salicaria*), the yellow ditto (*Lysimachia vulgaris*), the large *Campanula latifolia*, also *C. Patula* and *rapunculus*.

We have also the bog bean, bog asphodel, sun dews, butter wort, mare's tail (*Hippuris vulgaris*), cotton grass (three species), equisetum, and chara, &c. Also a considerable number of maritime plants on the tidal banks of the river, which are scarcely worth mentioning. We must not, however, forget one relic of monkish times, found in the meadows near Tintern Abbey. The purple goat's beard, or "Go to bed at noon" (*Tragopogon porrifolius*), so called from its shutting up after mid-day.

But we have already extended our ramble far enough, and, fearing we may have tired you, have only to offer our humble apology.

ON THE CONTENTS OF A HYÆNA'S DEN ON THE GREAT DOWARD, WHITCHURCH, ROSS,

Visited at Field Meeting, September 18th 1877; *being extract from description read at Edinburgh,* 1871, *by the* Rev. W. S. Symonds, F.G.S.

The following is the order of deposition of materials in the cave known as King Arthur's Cave:—

1. Fallen debris containing Roman pottery and recent human bones.
2. Cave-earth, No. 1, three feet thick. Flint flakes and a flint knife. Cores of chert and Silurian quartz rock. Teeth and jaws of *Felis spelæa, Ursus spelæus,* and *Hyæna spelæa, Elephas primigenius, Rhinoceros tichorhinus, Equus fossilis, Myaceros hibernicus,* and *Cervus tarandus.*
3. Old river-bed of red sand and Wye pebbles from the Silurian rocks of Rhayader and Builth, three or four feet thick.
4. A thick floor of stalagmite, on which river bed rests.
5. Cave-earth, No. 2. Several flint flakes, with abundant remains of Cave Lion, Hyæna, Rhinoceros, Mammoth (three sizes and ages), Irish Elks, Horse, Bison, and Reindeer.

The Wye now flows 300 feet below the ancient river deposit of sand and pebbles.

In the lower cave-earth are associated the relics of ancient men and the extinct mammalia; and the author expressed his conviction that there are no better authenticated evidences of the antiquity of man in the records of cave-history.

THE BUNTER CONGLOMERATES OF CANNOCK CHASE.

An Address by MR. W. MOLYNEUX, F.G.S., *at the Field Meeting at Hednesford, October 8th*, 1877.

The sources, agents of distribution, and general history of those enormous accumulations of gravel which occupy the middle of the lower division of the New Red Sandstone in British geology offer a field of great and remarkable interest for the *bona fide* investigation of the 'working man' in geological science—a field, it may be remarked, all the more attractive from the fact that in addition to its richness in organic remains, enclosed in fragments of rock derived from the strata of an earlier and varied origin, the multitudinous character of its mineralogical constituents, and the wonderful regularity of its composition, it presents itself for exploration as one of the greatest and the most neglected of the many unsolved problems in physical geology. It is certainly a singular, and to a certain extent unexplainable, circumstance, that this latter should be the case, but there is no question of its correctness; and taking the conglomerates in conjunction with the other main divisions of the Triassic series there is no other formation in English geology so little understood, so little appreciated, or treated with so much indifference as this. It is true that its superficial areas have been laid down, and in the main, without doubt, correctly so, by the officers of the Geological Survey; and Professor Hull has placed on record his opinion that the source of the pebbles of that sub-division upon which we are now standing—the Bunter Conglomerates—is the conglomerate of the Old Red Sandstone of Scotland, while the late Dr. Buckland, and some others of the older school, and the fathers of English geology, have not hesitated to name the Lickey Hills as the source of the quartzites of which the pebbles are largely composed; but beyond this, and the thickness attained by the group in different districts, and their assumed thinning out to the south and south-east, there is, I think, nothing submitted which can be accepted as offering explanatory evidence in regard to the general history and condition of a series of deposits which occupy considerably more than one-half of the surface area of this county and many hundreds of square miles of central England. The dissection, rock by rock, stratum by stratum, and fossil by fossil, which all other of the exposed surfaces of strata belonging to the different horizons of the geological record undergo, not by one, but by many, by multitudes of eager investigators, is entirely wanting here; and the origin of the red marls, the saline and gypseous materials with which they are so thickly permeated, of the sand and marls and pebbles of the Waterstones, and of the gravel of the Bunters, and the physical conditions under which they are deposited, are questions upon

which no answer is seriously or practically attempted, or a concentrated effort made to elucidate or enlighten. It is, of course, an argument of some weight, and may possibly help to give the solution, that there is apparently a remarkable paucity of the remains of contemporaneous organic life in the whole of these deposits—a paucity unparalleled in any other series of sedimentary and unaltered rocks of which the crust of the earth is composed. I say 'apparently,' because, up to the present time, the known list of Triassic fossils is exhausted by the fragmentary remains of a solitary fish; the bones and foot-prints of a few Batrachian reptiles; a shell; a few specimens of a bivalve crustacean; and the remains of a scanty vegetation. But, may I remark, was there not a time, a long time, during which the Old Red Sandstone was held as equally, or really more, unfossiliferous? And further; does it not seem contrary to the operations of Nature in moulding the framework of the earth, that, during a period in which the construction of one of the ribs of that framework, fully 3,000 feet in diameter, was effected, there should have been so faintly, so meagrely typical an accompaniment of the existence of those forms of animal and vegetable life, by which it was so profusely preceded and followed? Why, it may be asked—but the question is not that of a sceptic, it arises in the submission of an untrammelled reverence—should there be this assumed hiatus, the death-plague in the womb of organic life, when there were land and air and seas and rivers for the advent and multiplication of organic beings, as in the previous and subsequent ages of the earth's history? It is, one need not be told, an admitted principle with some, that during the successive stages of the earth's formation, there occurred sudden terminations of certain specific forms of life, and, the as sudden advent of others. If this were so, the change must have been brought about under conditions which admit the application of a miraculous creative action; but I venture to think that the generic and specific dissimilarity which characterises the animal and vegetable life of the great Carboniferous, and so-called Permian systems, and those of the Lias and Oolite, will not need this interpretation. The time may not have arrived—at least the necessary evidence is not forthcoming—for the true explanation of this singular phenomena,—this singular, and now mysterious, break in the order of successive generations; but it will come some day; the gulf will be bridged over; and the connecting links by which it will be effected yet lie hidden within the geological horizon of these Bunters which yawn around us, awaiting, let us hope, to be exhumed by,—and to endow with a lasting name,—some happy member of the Dudley Geological Society, or the North Staffordshire Naturalists' Field Club. Now, I will ask you to look carefully at, and to examine closely, the magnificent section opened up before us by the excavations for the reservoir

of the South Staffordshire Waterworks Company. The same is unique of its kind. I know of no other, and I think I may be certain that upon no previous occasion have so many superficial feet of the Bunter gravels been laid bare so deeply and so uniformly in this country. There are, however, deeper, finer, vertical sections elsewhere; and I shall have much pleasure in pointing out one—the best I know—of this description—a ballast-pit by the side of the railway on our road to Rugeley, and which in that respect is, I believe, unparalleled also. We have, therefore, on the occasion of our visit to the Chase, the opportunity of studying in detail the two largest artificial excavations ever made in these deposits; and, may I express the hope, of making ourselves as thoroughly, as the time at our disposal will permit, acquainted with their general and specific features, and of gaining a more or less sound, but unsatisfied, knowledge, even if it be only fragmentary, of their curious and undeveloped history. You will perceive, in the first place, that the beds are as nearly as possible horizontal—if there be a dip at all it is a westerly one—relieved here and there by a current or false bedding, and made up of pebbles of different sizes, varying in weight from between 40 and 50lbs. to a grain. Occasionally the gravel is intersected by longer or shorter wedges, or intercalations, of coarse open beds of sand or friable sandstone, red, brown, yellow, white, and variegated in colour, and sometimes free from, at others sparingly charged with, small pebbles. Every pebble in the section, whatever its size, composition, or shape, is more or less rounded; there is a total obliteration of angularity. At times they are loosely packed and easily disintegrated; at others they are cemented to a state of extreme conglomeritic hardness by carbonate of lime, silica, iron, or manganese, and, not unfrequently, where loosely bedded, especially if there be the least fissure, they are coated with a red marly paste. As a rule, however, they are remarkably clean and free from extraneous or earthy matter; and this condition, while affording the clearest evidence of the extraordinary amount of washing to which they were subjected at the time of their deposition, places them first on the list of water-bearing strata, as a source of supply, the best adapted in every respect for human consumption. The conglomerates of the Chase vary from 250 to 300 feet in thickness; they are overlaid by from 20 to 60 feet of rather coarse variegated soft sandstone, containing, occasionally, a few pebbles, and showing much false bedding; and they are underlaid by from 15 to 40 feet of coarse white or yellow sandstone also spotted with pebbles and false-bedded; and lying on this, the eastern side of the district, directly upon coal measures; and on the central and westerly portion upon thin beds of red and purple clays, the true horizon of which I need not stop here to discuss. The total aggregate thickness of the Bunters—the upper, middle, and lower divisions of which are, as will be recognised, represented in the

district—is therefore about 400 feet. Now, whether you examine the section before you, or any other where the Bunters are exposed on the Chase, the description I have given will apply there as fully as here. I must, however, add that if one thousand different shafts were sunk on any part of the Chase at that number of points, removed only 30ft. from each other, and carried downward through the bed, the details of no two sections would correspond. There is the greatest irregularity in the disposition or arrangement of the deposits of the conglomerate division, and yet in their general features, in their lithological aspect and condition there is a regularity, a uniformity so distinct and intelligible, that no one need be very deeply read in their peculiar literature to be able to recognize, after but a brief examination, the position they occupy in the geological scale. Well, of what do these pebbles consist? Speaking in general terms, they are found to be composed of typical, and very largely indeed of individual, specimens of the majority of rocks which enter into the composition of the crust of the earth, up to, and including, the Millstone Grit; but it is a remarkable circumstance that, considering the enormous amount of denudation to which the Coal-measures were subjected before the deposition of the Bunters, and the fact that they are over a very large area certainly placed in direct contact with the unconformable edges of every coal seam, band of ironstone, and other beds of which the Coal-measures are composed throughout their entire thickness of at least 2,000 feet—it is a remarkable circumstance that, so far as my experience goes, no traces whatever of ironstone, peldon, or other hard and resisting material of the true Coal-measure groups have ever been found in the Bunter gravels. The more numerous pebbles are quartzites, and these, which are composed of every colour and variety, make up at least 40 per cent. of the entire mass. Sandstones, both in a crystallized and non-crystallized form and of every degree of texture and hardness, come next, and represent fully 20 per cent.; and then come in greater or less regularity the limestones and cherts of the Carboniferous series, followed by indurated marls, trappean ash, pudding-stone, porphyry, felstone, schist, slate, jasper, Lydian stone, carnelian, chalcedony, agate, and, more rarely than all, granite. Many years ago, so struck was I, and interested, in the great variety of pebbles produced by these deposits, that I made a collection of them, and they numbered considerably over a thousand specimens. Many of the pebbles, especially the agates, jasper, carnelian, and chalcedony, are really beautiful, and in the hands of the lapidary, as I have often seen, become gems, or, at any rate, stones well worthy their use in bracelets, brooches, and for other ornamental purposes. I once found a small emerald; and, in fact, there is no reason to doubt the occurrence of a great number of rare stones of this description in the conglomerates. This, however, is by no means a

modern discovery, inasmuch as Plot, in his "Natural History of Staffordshire," written nearly 200 years ago, entered into an elaborate and enthusiastic description of the precious stones found on the Chase; and coming to our own day, the Huntington gravel-pits have acquired fame—at least, locally—as a "diamond field," quartz crystals of some value and frequency being there obtainable. Now, with regard to the general appearance and condition of these pebbles, there are two or three points of peculiar interest, and to which I will ask your attention. The first, and the more striking is this:—The presence upon the surface of almost every pebble in the entire series, whatever its size and composition, of one or more spots, or pit-like indentations. In the quartzites and crystalline pebbles the spots are white, and very superficial; and in the indurated marls, sandstones, and some others, they are cup-like depressions or indentations. This is a characteristic of the Bunters, which I have not known to exist in any other gravels or Conglomerates in the geological scale. It was, I believe, once the opinion that these marks were of chemical origin; but, if anyone will take the trouble to detach a few pebbles from the face of any quarry in the conglomerates, it will be found that the exact points where the white spots or indentations exist, are in direct contact with so many different other pebbles as there are spots or indentations. Their orign is therefore not chemical, but mechanical. If, however, they are mechanical, to what operation must we look for their origin? If the pebbles had lain perfectly quiescent there could have been no abrasion or pressure to produce them, any more than with the ordinary gravels of the boulder clays and others; and I think, therefore, that we have here another field for inquiry as to at what period, and under what conditions these little, but wonderfully suggestive, punctures, were produced. My own opinion, but it is, of course, open to correction, is that they were produced by the oscillating movements of the earth, but at no one particular epoch or period; that, as the Bunter conglomerates show themselves to have been deposited under the most turbulant and stormy cataclysm on the geological record, so have they, as is evidenced in the position, of their present surface exposure, since been subjected to a greater amount of displacement, upheaval, depression, and other disturbances, than any other groups of rocks which enter into the composition of the earth's surface. To explain this anomaly fully would be going into a matter unintended on this occasion: but geologists will have no difficulty in seeing at once the force of the remark, and, in bearing me out, that the Bunter area, although in the aggregate so broad and extensive, is essentially one of disturbance, faults, and confusion; and the range the conglomerates so happily occupy on Cannock Chase, is one of the largest, if not the largest, unbroken, uninterrupted superficial areas of these deposits in England.

Another point is the blanched or burnt appearance of the great majority of the carboniferous limestones and cherty pebbles, and the decomposed state of the granite and the agates. These latter are a study in themselves, and afford one of the most interesting examples it is possible to have of the delicately beautiful process of mineralogical construction; and explain, in the simplest manner, that those almost invisible lines peculiar to the petrification of agates, are lines of lamination; and of which the laminæ may be dissected as readily and distinctly as the coats of an onion. Now the granites, limestones, and agates are composed of substances which would naturally be the first to suffer from, or be effected by, extreme heat; but whether, the condition I have described be due to heat, or purely chemical action, I will not now stop long to inquire. The fact, which is an interesting one, will, I have no doubt, attract the attention it deserves; and, in all probability, many will be disposed to hold that heat may have had, or did have, a great deal to do with the operation. Perhaps the conglomerates had something more certainly penetrating than sea water, and more effective than the atmosphere, to have produced so decided and isolated a change in the limestone and felspar. But, if heat was the agent, it was applied, or the pebbles were subjected to it, subsequent in time to their detachment from the parent rock. Now the only evidence in the conglomerates which bears in the least upon the theory of heat, as having played any appreciable part in the disintegration of these pebbles consists of rolled fragments of trappean and felspathic ash. Their presence in the Bunters is curious, and their condition and general character, of more than common interest. They occur in great numbers and variety, and may easily be known by their steatitic or soapy appearance. Will you allow me to add, in parenthesis, that I have on another occasion adverted to the extensive copying of natural forms and compositions by the manufacturers of articles in daily use. But, except as "mottled," I do not know of any "soaps" the colour or composition of which bear the least resemblance to those fragments in question. They, however, offer a source from which the most attractive combinations of colour and material may be obtained, and I can confidently recommend them, for this purpose, to the notice of manufacturers of that useful compound for the toilette—fancy soap. If this mineral were found intersecting the gravels, in veins or dykes, or intruding or spreading in a definite sheet amongst them, it would, of course, be apparent that it was introduced, either contemporarily with, or subsequently to, the deposition of the conglomerates in their present, or some former position, and in a state of fusion, but this could not by any possibility have been the case, because every pebble or fragment of this character, bears exactly the same rounded form, produced by the same process of attrition, as its neighbours, and, from their general admixture, must have been sub-

jected to a common process of rolling. It is, indeed, curious, that the majority of these pebbles are so soft, that, on pressure between the fingers, they crumble to powder, or, become thoroughly disintegrated, a condition certainly not due to existing atmospheric action, inasmuch as they exhibit the same condition in the newly opened face of the quarry as in the deep excavation of a shaft, and which is scarcely likely to have been the case at the time they were originally mixed with the other fragments of the deposit. The locality of the sources of these ashes, like that of the fossils and other rounded fragments, is a subject which, so far as my information leads me, is a thoroughly neglected one, and yet I am sure I need not add another word to impress deeper upon you its extreme interest, and the importance it assumes as a question of physical geology. There can be no doubt whatever of the great and important part taken by volcanoes and volcanic action during all ages of the earth's history in providing material for its wondrous crust; but I do not think there is any chance of being able to add to, or intensify, this interest by associating the time of the introduction of these trappean and felspathic ashes with that of the movements which produced the basaltic columns of Powk Hill and Rowley, or those remarkable sheets of green rock which are too lavishly spread over and between the coal measure strata of South Staffordshire. These were, I think, of post-triassic date, and formed a portion of a series which had a great deal to do with the elevation of those tracts of country that now constitute the coalfields of the Midlands. While upon this subject I cannot but express the conviction, entertained by others, no doubt, as well as myself, that not only were those movements post-triassic in point of time, but that it is to a post-secondary period we may determine the action of those degrading and denuding influences by which the present contour of this part of the country was principally effected; and of which there is confirmatory evidence in the vast accumulations of Liassic, Oolitic, Chalk, and other Secondary rocks, which fill the valleys, and cover, in greater or less thickness, the surface of the country. The evidence as to the period of the volcanic action, the material of which has so largely contributed to the composition of the Bunter gravels, is by no means so clear. From the rolled condition and uniform admixture of these pebbles with the gravels over the entire area of their occurrence in the Midlands, it is indisputable that the sources are far away from the place where they are now found, and it does not require any support from the fact of the absence of basalts, trachytes, or greenstone from the Bunters to demonstrate their independent origin. The same currents which brought the Silurian, Old Red Sandstone, and Carboniferous fragments, brought these also, and they may be as ancient in age, and as varied in origin, as the one or the other. Of one thing we may be certain, that they are in no way associated with, but are antecedent in point

of time to, the coal measure period. I now come to a more captivating but equally important subject—namely, the fossils contained in these conglomerates. We have all of us experienced the pleasure and interest which attend the sudden baring to the human eye of the fragmentary remains of animals and vegetables, which existed in the far-back and untold ages of the earth's history—ages reckoned, it may be, not by hundreds or even thousands, but millions of years, and of which the fossil shell, coral, or plant, offer the concentrated, and, if speechless, unimpeachable record. When fossils are exhumed from rocks *in situ*, they index the fact that these at least thus remain in the place where they died and became embedded in the accumulation of mud, sand, or lime deposited by the waters of the sea, lake, or river in which they lived. These, in this position represent one horizon of geological action, one zone of life, as determinate and characteristic of the period to which they belong as if they were living to-day. It is totally different in regard to the fossils found in the gravels before us. They have not been exhumed from their parent rocks by human hands nor by human agency, but have been brought miles and miles by the guiding currents of a tempestuous sea; and shells and corals lie commingled in one common mass, which lived at times and places separated by epochs of time, and tens of thousands of feet of strata, and passing downwards from the Carboniferous Limestone to the base of the Silurians. I have already referred to the published opinion as to the probable source of the conglomerate; and so far as I am aware, the only allusion beside the notice printed by myself is that by Professor Hull, whose list is exhausted in a few specimens of "screw stones" in encrinital limestone. I have only to draw your attention to the remarkable and interesting collections exhibited to you to-day by Mr. Beale and Mr. Hawkins, and all of which were obtained from the site of the reservoir, to convince you at once of two things—namely, of the exceedingly suggestive character of the number and variety and the geological importance of the fossils themselves; and also of the evidence they afford of the apparent neglect of the interesting details contained in these deposits by physical geologists. In the late Mr. Jukes' "South Staffordshire Coalfield," there is a description of a Permian breccia at Frankley Beeches, and, from the fossils found embedded in fragments of the rocks of which it was composed, the late Mr. Salter compiled a list of no less than sixteen genera principally of shells and corals, all of which are common in Caradoc and other Lower Silurian rocks. It is, therefore, difficult to explain why the presence of fossils in the Bunters, many of which I shall show were specifically identical with those described by Salter, should have been overlooked in the published Memoir of the Survey; especially as the same reason for the prominent notice they obtained at the hands of Professor Ramsey and Mr. Salter—namely, the determination of the situation of the parent rocks,

and the means and direction of the course by which they were transported to their resting place—was fully as critical and important in affording a clue to the source of the Bunter gravels, or, at least, of the situation of the rocks from which they have been, both largely and mysteriously supplemented. With regard to the occurrence of rolled fossils in Bunter gravels, I would remind you that they are not confined either to the present excavations, or even Cannock Chase. They occur in equal numbers and variety, as I can testify from my own personal knowledge, over at least the greater part of the Midlands; and no gravel-pit opened in them fails to yield specimens of both Silurian and Carboniferous age. I may, I hope, be excused for introducing myself in connection with the matter. In 1869 I published a work which contained a list of the fossils then in my collection, and all of which I had obtained from Bunter gravels—"Burton-on-Trent: its History; its Waters; and its Breweries," p. 160. The authenticity of the list is guaranteed from the fact that the whole of these fossils were determined for me by the late Mr. Salter; and of which I have the pleasure to submit a copy.

LIST OF FOSSILS FROM THE BUNTER CONGLOMERATES.

SILURIAN.—MAY HILL SANDSTONE GROUP.

Pentamerus oblongus, rare.
" *lens*, rare.
Atrypa hemispherica, plentiful.
" *reticularis*, var.
Spirifer crispus, and *trapezoidalis*.
Strophomena depressa.
" *compressa*.
" *pecten*.
Pterinea demissa.
Euomphalus sculptus.
Orthis elegantula.
Holopea.
Holopella obsoleta.
Palæocyclus præaculus.
Halysites catenulatus.
Petraia subduplicata.
" var. *crenulata*.
Phacops Weaveri.
Tentaculites Anglicus.

MOUNTAIN LIMESTONE.

Pcteriocrinus crassus, and other species.
Rhodocrinus.
Actinocrinus.
Platycrinus.
Lithostrotion irregulare, and *Martini*.
Michelinia megastoma.
Zaphrentis, 2 or 3 specimens.
Syringopora reticulata.
Fenestella plebeia.
Phillipsia, part of tail.
Productus semireticulata.
Producta concinna.
" *mesoloba?*
Streptorhynchus crenistria, 2 var.
Spirifer triangularis.
" *bisulcatus*.
" *octoplicatus*.
" *glaber?*
Chonetes variolata.
" *Hardrensis*.
Dentalium ingens.

Now you will notice that the list comprises fourteen genera, and twenty species of fossils of Silurian age, many of which are specifically identical with those in Mr. Beale's and Mr. Hawkins' collections, but which contain some that are not mentioned in the list. They correspond more with the May Hill Sandstone group, and, probably, have a common origin. It is, however, a curious fact, and, by analogy, an important one, that the matrix of all the Silurian fossils consists of sandstone, which is, in all probability derived from rocks occupying the different margins of the Silurian system. It is not necessary, nor is it my intention, to dwell upon this fact on this occasion, but merely to draw attention to it. There is, however, one point to which I would invite your notice, and that is the striking difference in the number of fossils of the Carboniferous Limestone obtained here and elsewhere, as contained in the list—which in the local collection is confined to a few corals and encrinital stones, or screw-stones, (the "St. Cuthbert's beads" of Sir Walter Scott's poems) whereas the list shows no less than sixteen genera and twenty-five species. I am disposed to think that their absence from the local collection is not because they do not exist here, but because they do not happen to have been noticed. Of course it is not to be expected that there would, under any circumstances, be a large, or even moderate, accumulation of arenaceous pebbles of the Carboniferous Limestone series; but there are fossiliferous sandstones in the upper division, and whatever the explanation which may be ventured, the fact remains that the carboniferous fossils here are exclusively embedded in limestone or chert, and those of the Silurian series exclusively in sandstone. Some five or six years ago I set myself to ascertain if any additional light could be obtained in elucidation of a subject of so much geological interest, and which bore so directly upon the question of the physical condition of the surface of the earth—that is the surfaces then exposed to the action of water, or which formed land in the central portion of what is now England, prior to and during the earlier portion of the time occupied in the deposition of the conglomerates whose history we are now considering. What I was anxious to discover was whether throughout the entire thickness of the gravels it was possible to trace any definite horizon—any marked line of demarcation between the occurrence of the Silurian and Carboniferous series of fossils. So far, however, as my evidence leads me, there is neither the one nor the other—neither in regard to fossils nor rocks is there the least distinction. They are so thoroughly and completely intermixed and thrown together from top to bottom, that there is no possibility of separating them, and the hope I had long formed of being able to obtain from the pebbles evidence of the direction of the currents, and the situation of the parent rocks, by and from which the material of one set of beds had been derived, became engulfed in the chaotic confusion of the masses of pebbles themselves. I

have, however, learnt something by the investigation, and that is that while it is possible that certain portions of the now exposed area of Carboniferous, Old Red Sandstone, Silurian, and other strata, may have furnished some of the pebbles and fossils of which the Bunter conglomerates are made up, the great bulk of the deposits was obtained from sources the situation of which is more or less problematical, and certainly unrecognisable from the existing physical condition of the earth's surface. While, however, admitting the reasonableness of the conclusion arrived at by Professor Hull as to the Old Red Sandstone of Scotland having contributed a contingent of the quartzose and some other pebbles, the remainder of the deposit, equal to fully one-half, is composed of rocks and fossils entirely unconnected with the Old Red Sandstone, and belonging to formations which both preceded, and succeeded it in point of time, and, therefore, certainly had no part in the economy of the one, and almost as certainly, for other reasons, in that of the other. These are the ordinary conditions, the history so far as I have been able to decipher it, of the Bunter conglomerates of the district. The subject, however, is by no means either exhausted or its interest monopolised by the inquiry. There is, however, one, and that a most remarkable circumstance, connected with these deposits, to which I will only briefly refer; and that is the occurrence in them of both copper and lead ores. I have already described the character of the ores and the manner in which they occur ("British Association Report, 1872," p. 116. *Geological Magazine*, January, 1873); but so far the only two points in the Chase where they may be seen are the gravel pits at Huntington, where I first discovered them five years ago, and at the Fair Oak Sinkings, at which latter place the yellow sandstone which I have described as coming directly between the base of the conglomerate and the coal measures contains lead ore equal to 30 per cent. in richness.

REGISTER OF RAINFALL IN 1877.

Kept at Pedmore, by Mr. E. B. MARTEN.

Date.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0·07	...	0·02	0·05	...	0·33	...	0·02	...	...	...	0·02
2	0·05	0·10	0·13	...	...	0·06	...	0·02	0·58	...	0·10	0·01
3	0·81	0·23	0·31	0·24	...	...	0·10	0·30	0·55	...	...	0·02
4	0·02	...	0·06	0·49	...	...	...	...	...	...	...	...
5	0·11	0·02	0·13	0·08	...	...	0·25	...	...	...	0·11	0·48
6	0·28	...	0·06	0·01	...	0·17	0·01	0·09	...	...	0·07	0·03
7	0·01	0·15	0·16	0·13	...	...	0·11	0·41	...	0·04	...	...
8	0·01	...	...	0·04	0·02	...	0·03	0·40	...	...	0·17	...
9	0·04	...	0·21	0·10	0·15	...	0·01	0·16	...	...	0·07	...
10	...	0·03	0·02	...	0·01	...	0·05	0·04	...	0·05	0·24	...
11	...	0·13	...	...	0·02	0·02	...	...	0·40	0·07	0·82	0·05
12	0·04	0·02	0·01	0·03	0·04	0·05	...	...	0·08	0·23	...	...
13	0·07	0·20	0·08	0·02	...	...	0·28	...	0·04	...	...	...
14	0·32	...	0·01	...	0·27	...	2·43	0·44	0·22	0·04	0·05	...
15	0·01	0·16	0·11	0·43	0·05	...	0·08	0·11	...	0·17	0·03	0·02
16	0·20	...	0·03	...	...	...	0·17	0·06	...	0·13	...	0·01
17	0·10	...	0·04	...	0·38	...	0·03	0·03	...	0·02	0·01	...
18	0·06	0·18	...	...	0·19	...	0·01	0·11	...	...	0·04	0·01
19	0·05	0·34	...	0·02	0·09	...	0·11	0·29	0·03	0·17	0·06	...
20	0·01	0·01	...	...	0·02	...	...	0·03	0·07	0·05	0·13	0·05
21	...	...	...	0·39	...	0·24	...	0·23	...	0·26	0·09	0·01
22	...	0·03	...	0·05	...	0·08	0·01	0·15	0·06	0·12	0·03	0·05
23	0·15	0·01	0·27	0·12	...	...	0·30	...	0·02	0·22	...	...
24	0·09	0·01	0·81	0·05	...	...	0·13	...	...	0·07	0·01	0·10
25	0·11	0·14	0·14	...	...	0·07	0·35	0·49	0·01	0·03	...	0·07
26	0·11	0·03	...	...	..	0·08	...	0·29	...	...	0·27	...
27	0·01	0·03	0·12	...	0·42	...	0·01	0·65	...	0·11	0·07	...
28	0·09	...	0·13	...	0·05	...	...	0·02	...	0·24	0·35	0·53
29	0·45	...	0·19	...	...	...	...	...	...	0·17	0·05	0·02
30	0·04	...	...	0·01	0·09	...	...	0·01	...	0·01	0·02	0·27
31	0·48	...	0·06	...	0·23	...	...	0·08	...	...	...	...
Totals	3·79	1·82	3·10	2·26	2·03	1·10	4·47	4·43	2·06	2·20	2·79	1·75
Total from Jan 1.	3·79	5·61	8·71	10 97	13·00	14·10	18·57	23·00	25·06	27·26	30·05	31·80

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